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Rita Mulcahy's™

PMP® Exam Prep

Tenth Edition

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- Proven study techniques
- Practice exams and exercises focused on essential concepts

Aligned with the *PMBOK® Guide, Sixth Edition* and the 2021 *Examination Content Outline* (ECO)
For exams taken after January 2, 2021

Rita Mulcahy, PMP, et al.

PMP® Exam Prep

Accelerated Learning to Pass the Project Management Professional (PMP)® Exam

By Rita Mulcahy, PMP, et. al

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Minnetonka, Minnesota

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This and all editions of this book are dedicated to Rita Mulcahy.
Her vision made RMC the company it is today. She had a profound influence on so many people—her readers, her students, and, not least, her employees.
May we all apply what we learned from her and embody her passion for improving our organizations, our communities, and our world through effective project management.

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History of This Book

The first edition of Rita Mulcahy's *PMP® Exam Prep* was published in 1998, and at the time, it was the first and only comprehensive resource dedicated to PMP exam preparation.

As a project manager in the late 1990s—as well as one of the world's first certified PMPs—Rita was frustrated by the lack of quality PMP preparation materials available to her and her colleagues. So, combining her knowledge of accelerated learning with her extensive project management experience, Rita wrote the first draft of *PMP® Exam Prep*. Since then, the popularity of the book has grown immensely, through ten wildly successful editions. Today, the book is by far the best-selling PMP exam preparation guide in the world, with thousands of copies in circulation.

Tragically, Rita passed away on May 15, 2010. RMC continues her mission today with the tenth edition of the *PMP® Exam Prep* book, and with a growing line of other project-management-related courses and products that promote her vision of improving the world through effective project management. *PMP® Exam Prep* and its related products are used as study tools by many project managers across the globe, and in hundreds of classroom-based prep classes at universities, training companies, and corporations.

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Free Updates The purchase of this book includes access to updates regarding the PMP exam, as well as additional tricks, tips, and information to help you prepare for the exam. Access this information at rmcls.com. Have this book with you when you go to the website as you'll need to verify your product purchase.

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Contact Us We love to hear your feedback. Is there anything in this book that you wish was expanded? Is there anything that we focus on too much, or is there anything not covered that you think should be here? We would love to hear from you. Send us an email at info@rmcls.com.

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Introduction to the Tenth Edition

Welcome to the tenth edition of *PMP® Exam Prep*. It's been 20 years since Rita published the first edition of this book. RMC has come far since the publication of the first edition back in 1998, as has the project management profession.

Back when the first edition was published, most project managers were in the United States. Now there are more international project managers than ever before. As a result of this industry growth, RMC's best-selling materials are now sold all over the world.

Project management is also a more complex profession than it used to be. Along with the processes, concepts, tools, and techniques that were added within the last couple of years, there are now just as many adaptive approaches to project management as there are predictive. The general methodologies and overall practices of project management have changed dramatically, which has increased the size of a project manager's toolbox.

These updates have resulted in changes to the exam. There is more to learn today than ever. This increased complexity is reflected in the tenth edition of our best-selling PMP Exam Prep book.

First, and one of the more significant changes, is the introduction of three new domains within which project management exists: People (Domain I), Process (Domain II), and Business Environment (Domain III). What does this mean for the process groups of initiating, planning, executing, monitoring and controlling, and closing? That's a great question, and we have you covered. Our new and improved chapter three, now titled "Processes and Domains," addresses both the process groups as well as each of the three domains in a clear and easy-to-read format that will prepare you to not only understand the groups and domains, but will give you all of the knowledge you need to pass the exam.

Another big change is the acknowledgement of the importance of PMI's *Examination Content Outline* (ECO). It is now more important than ever to read and understand the ECO as it covers the domains and introduces adaptive approaches to project management and the PMP exam. Throughout each chapter of the tenth edition of this book, we've included agile terms and concepts. You may see these terms and concepts on the exam, but you also need to know them to become a more adaptive project manager.

While these are significant changes, important aspects of our book remain the same. First, and most importantly, is the conversational tone of the book. The tenth edition maintains its down-to-earth conversational style—explaining things simply and clearly. Students say that when they read this book, it feels like Rita is talking to them. In many ways, she still is.

Another thing that remains the same is our continued commitment to helping our students not only pass the exam but also become better project managers. That is what the book, and, in fact, our company, is all about.

As you read this book, know that our plan is not to have you memorize a bunch of rules and formulas just to pass the exam and then promptly forget them. For one thing, given the situational nature of most questions on the exam these days, we believe that such an approach would be unsuccessful. For another, it's not what we're about. This book is not just a prep guide—it's a learning tool. If you master the contents of our book, you will pass the exam, but it's more than that. After you learn what we have to teach, you'll be a better project manager. At the end of the day, that's what the world needs. Still, our goal with this book is to get you to pass the exam on the first try.

I couldn't allow this book to go out the door without acknowledging the efforts of the team at RMC that made this happen. In particular, I'd like to thank Mike Griffiths, Margo Kirwin, Levi Satterlee, and Tori Turnquist for their dedication and hard work on this edition.

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Margo served as our leading subject matter expert. In addition to being an outstanding trainer, Margo has an extensive background in instructional design, which she brought to the development of this edition. She is also a talented writer who was able to maintain the conversational tone and feel of the book while working hard to explain all the elements of project management in a clear and easy-to-read way.

Mike Griffiths was also an important subject matter expert for this edition. Mike has a broad background in agile and is the author of RMC's *PMI-ACP Exam Prep* book, the best-selling resource for passing the PMI-ACP exam. Mike was able to work and collaborate directly with the project team to ensure our new content specific to agile would not only meet the needs of our students but properly prepare someone to pass the new PMP exam on their first try. Needless to say, Mike was a vital resource in creating this book and we couldn't have done it without him.

Finally, there is Tori, who served as the project manager and content editor for this update. In addition to being a fantastic writer, Tori brought an incomparable set of skills that allowed her to help develop and edit content with our subject matter experts while also managing the constantly moving pieces of the project. Without her, this book would not have been published on time, if at all.

When Rita created RMC, she did so to help people. That is still our goal and one of the driving values of this company. So enjoy the book, learn, and have fun.

What are you waiting for? Go get 'em.

Tim Mulcahy
President and CEO
RMC Learning Solutions and RMC Publications

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Tricks of the Trade® for Studying for This Exam

ONE

Preparing to take the PMP exam is a journey. If you let it, this journey can help you grow your career and develop your skills and abilities. This isn't just about passing an exam—you can and will become a better project manager. This opportunity to learn is one of the best reasons to get your PMP certification.

To pass the PMP exam, you cannot simply cram a lot of information into your brain and try to retain it just long enough to get through the test. You need to truly understand the process of project management and what value that process can bring to your projects. The PMP exam is designed to prove your knowledge and experience in applying the art and science of project management.

In addition to the learning opportunity, there can also be financial incentives for passing the exam. A salary survey conducted by the Project Management Institute (PMI®) found that PMP-certified project managers, across all countries surveyed, are paid on average 25 percent more than those without the certification. RMC has had students who received a bonus, a raise, or both when they passed the exam. Others have reported they were offered a job when hundreds of other qualified candidates had applied, simply because they were PMP certified. Having a PMP certification can be the reason you get a job, keep your job, or are promoted.

Qualifying to Take the Exam

To take the PMP exam, you must meet the requirements outlined by PMI. The current requirements are summarized in the following table. Requirements are subject to change, so make sure you review the requirements at pmi.org.

A four-year degree		A high school diploma or an associate's degree (or global equivalent)
	—OR—	
Three years leading projects		Five years leading projects
35 hours of project management education/training or CAPM® certification		35 hours of project management education/training or CAPM® certification

Keep in mind that just because you qualify on paper to take the exam doesn't mean you'll pass it. You must know project management and have experience applying it—this includes both managing and leading. Consider taking PMI's CAPM® exam if you don't meet the requirements listed in the previous table. You can find the requirements for the CAPM® exam at pmi.org.

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Are You Ready for the PMP Exam?

In RMC's experience, half of those who fail the exam do so because they have not had project management training that uses PMI terminology and concepts. This is a serious factor to consider in determining whether you are ready to take the exam. Understanding PMI's approach to managing projects is not as simple as reading the *PMBOK® Guide*. Although reading the *PMBOK® Guide* will help you improve your knowledge, it will not teach you project management. The *PMP® Exam Prep* book will explain the project management process and help you understand it from PMI's perspective; however, if you find that many of the concepts and terms presented in this book are new to you—or you do not use important tools discussed in this book (such as a charter, WBS or prioritized backlog, network diagram, and management plans)—you probably need fundamental project management training before continuing to study.

Another percentage of people who fail the exam do not have real-world experience working on large projects and do not understand the breadth of possible project types. Instead, they may be managing small projects; some might not even be working as a project manager. On the exam, it is helpful to answer questions from the perspective of a project manager who is managing large projects, unless a question scenario tells you otherwise. Therefore, the more experience you have with large projects, the better prepared you will be for the exam.

The following are examples of large projects:

- Designing and building a new call center (versus handling small call center projects)
- Designing a new manufacturing process (versus customizing a standard product for a customer)
- Installing integrated software across a company (versus installing software system updates)
- Designing and constructing a new building (versus repainting an existing building)

What is the depth of your knowledge and understanding of project management? Do you routinely experience two or more of the following problems on projects? If so, you may benefit from learning more about project management prior to taking the exam.

- Cost or schedule overruns
- Unrealistic schedules
- Excessive changes to the scope or schedule
- Communication problems and increased conflict
- Running out of time near the end of the project
- Unsatisfactory quality
- Low morale
- Team member uncertainty about what needs to be done
- Excessive rework and overtime
- Too many project meetings

Now think about your project management experience, particularly your experience working on large projects. Review the following list of topics. Do you understand these topics, and do you currently apply the tools and techniques included in this list when working on your projects?

- The step-by-step project management process, including understanding why each step is necessary
- The roles of the project manager, sponsor, product owner, team, and stakeholders
- The use of historical information from previous projects, including lessons learned
- What a formal project charter is and knowing what it requires
- What a work breakdown structure (WBS) is and how to create it

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- What a prioritized risk-adjusted backlog is and how to use it
- How to manually create a network diagram
- What the critical path is, how to find it, and what benefits it provides the project manager
- Rough order of magnitude (ROM) versus three-point estimating or estimating story points
- Monte Carlo analysis
- Earned value analysis
- Schedule compression (crashing and fast tracking)
- Managing float
- How to create a realistic schedule
- Managing the quality of both the project and the resulting product(s) or deliverables
- Developing relationships with stakeholders, and keeping them interested and involved in the project
- What is included in the process of risk management
- Calculating reserves and understanding their relationship to risk management
- Creating a realistic and approved project management plan that you are willing to be held accountable to achieving
- Monitoring and controlling the project according to the project management plan
- Managing change requests, and controlling change
- Planning and developing iteratively and incrementally for change-driven projects
- Considering the professional and social responsibilities expected of a project manager when managing a project

When working on projects, a project manager doesn't have time for ineffective project management activities. A project can easily get out of control if the project manager spends too much time solving problems rather than preventing them, or micromanaging instead of making sure roles and responsibilities are clear. When preparing for the exam, think about the concepts presented in this book (and those you've learned through your training) in terms of what a project manager of a large project should be doing. This will help you identify gaps between your own project management experience and PMI's approach to managing projects, and will therefore better prepare you to answer questions on the exam.

Applying to Take the Exam

You must submit an application to PMI to take the exam. Applications may be submitted online. After submitting your application, you'll receive a notice that will confirm your application has been accepted; you will then be prompted to pay for your exam appointment. Once payment is received, you'll receive an email authorizing you to make an appointment to take the exam. Once you receive your authorization, you must pass the exam within one year. You can take the exam up to three times within that year; if you fail all three times, you must wait one year to reapply for the exam. You may be subject to an audit of your application before it is approved.

The exam is usually offered on a computer at a designated testing site, but this may vary based on location. Alternatives to traditional testing centers, such as an online proctored exam, may also be an option. It's important to understand that there are specific rules and instructions for each type of exam. In most cases, the confirmation of your scheduled exam will give you specific details. Visit pmi.org for the most accurate and up-to-date information about testing options, locations, and exam languages available.

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How to Use This Book

Be Sure You Have Current Materials for the Exam Before using this book, make sure it's the correct edition. RMC products are updated to give you the most current information available, and take into account the latest changes to the exam. Previous editions of this book are out of date and should not be used to try to pass the exam. This edition of the *PMP® Exam Prep* book is in alignment with the *PMBOK® Guide, Sixth Edition* that was published September 6, 2017, and is meant to be used to study for exams taken after December 31, 2020. This edition also reflects the information in the *Examination Content Outline* (ECO) dated June 2019.

How This Book Is Organized Most of the chapters in this book have been organized the same way: an introductory discussion, a list of Quicktest topics (generally listed in order of importance), review materials, and a practice exam. All page references in this book refer to the *PMBOK® Guide, Sixth Edition*, unless otherwise stated. This *PMP® Exam Prep* book can be used alone, but it is also part of our PMP Exam Prep System that includes our PM FASTrack® Cloud exam simulator as well as our *Hot Topics* flashcards.

Introduction to Each Chapter The introductory discussion provides an overview of the chapter and key information for understanding the material covered in the chapter. Chapters 4 through 13 include tables that outline project management processes and tasks. For the exam, you will need to understand the project management processes in the *PMBOK® Guide*, the domains and tasks in the ECO, and be able to relate them to one another.

Quicktest The list at the beginning of each chapter indicates the topics covered and their general order of importance. To test your knowledge of chapter content and to review what is most important, refer back to this list when you are finished with each chapter.

Rita's Process Chart™ Rita's Process Chart™ will help you understand the process of managing a project. It is a key trick for passing the exam with less study. You will see this chart and its explanation in chapter 3, "Processes and Domains." Use the chart to understand how the different knowledge areas relate to the efforts involved in the project management process.

Review Materials and Exercises This book contains extensive review materials and exercises within each chapter. These materials have been developed based on accelerated learning theory and an understanding of the difficult topics on the exam. Make sure you do the exercises rather than jumping right to the answers. Do not skip the exercises, even if their value does not seem evident to you. The exercises and activities are key benefits of this book and will help you pass the exam.

The answers are listed immediately following the exercises. We have found that it is most effective to place the answers right after the exercises rather than later in the book.

Also be aware that you'll be prompted to create and use an Exercise Notebook. Your Exercise Notebook will serve as an answer log for all of the exercises included in this book. We have numbered each exercise and encourage you to record these numbers in your Exercise Notebook. Use this tool to keep track of any gaps in your knowledge. Pay attention to any patterns in gaps. At any time, you may review your Notebook for any incorrect answers and retry an exercise.

TRICKS OF THE TRADE® Included in the review material are tricks to passing the exam called Tricks of the Trade® (a registered trademark of RMC). These tricks are designated by the image shown here to the left and will give you some extra insight about what you need to know about project management and how to study for the exam.

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Our method of helping you prepare for the exam does not focus on rote memorization, but on understanding project management. The few things you should memorize are designated by this image.

Practice Exam The practice exam at the end of chapters 2 through 13 allow you to review the material and test your understanding. Refer to the "How to Study for the PMP Exam" section on page 13 to understand how and when to use these practice exams as part of your study plan. On the following pages, you will find a score sheet to use as you take the practice exams.

The practice exam questions are representative of the knowledge and principles tested on the exam. Keep in mind that you cannot simply practice answering questions to prepare for the exam. The questions in this book help you assess your knowledge and become familiar with the types of questions on the exam. Make sure to focus your study efforts on reading this book, doing the exercises and review activities, and filling gaps in your project management knowledge.

Endnotes Throughout this book, you will see superscripted note references when many project management terms are first introduced. These notes provide the historical origin of the terms or concepts and are explained in the back of this book. Historical origin is not tested on the exam. These notes are provided for your interest and reference. For some, understanding the development of a concept helps them remember it better. For others, such information is a distraction. If you find these notes distracting, simply focus your study efforts on the primary content of this book.

Resource Page While not directly included in this book, the PMP Exam Prep Resource Page at rmcls.com/extras serves as a location for additional information that will be helpful when studying for the exam. Be sure to frequently review the materials included on this page as it will help solidify your overall understanding of project management.

Using This Book with PM FASTrack® Cloud Exam Simulator

This book may be used on its own or in conjunction with the PM FASTrack® Cloud exam simulator. For information about using PM FASTrack® in conjunction with this book, see Plan A under the "How to Study for the PMP Exam" section on page 13 . For a free exam simulator demo, visit exams.rmcls.com.

PLEASE NOTE: RMC does not currently offer PM FASTrack® via amazon.com, auction sites, or e-commerce sites other than its own (rmcls.com). PM FASTrack® is an extremely valuable study tool, and it has been copied and sold by unscrupulous third parties. These pirated versions do not work and will not be supported or refunded by RMC for any reason. To purchase a subscription to the exam simulator that complements this book, visit rmcls.com.

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Score Sheet Use this score sheet to test your understanding. Make a copy of it or make a similar chart in your Exercise Notebook for each chapter's practice exam. (NOTE: If you are using RMC's PMP Exam Prep System, please see the study plan on page 13.)

Question Number	First Time	Why I Got the Question Wrong	Second Time	Why I Got the Question Wrong
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Question Number	First Time	Why I Got the Question Wrong	Second Time	Why I Got the Question Wrong
29				
30				
31				
32				
33				
34				
35				
36				
37				
38				
39				
Total Score	First Time		Second Time	

How will I improve how I take the exam next time?

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Other Materials to Use to Study for the PMP Exam

You can use this book as a stand-alone prep tool or combine it with the following products for a comprehensive exam prep experience. Do not risk overstudying or confusing yourself by using other prep books or products beyond the following resources.

Rita Mulcahy's™ PM FASTrack® Cloud Exam Simulator

Our PM FASTrack® Cloud exam simulator offers over 1,600 questions—including tricky situational questions with more than one "right" answer. Other than this book, PM FASTrack® is the most important tool for passing the exam. The online subscription allows you to create sample exams by knowledge area, process group, keyword, PMP simulation, and even super PMP simulation. It also saves you a huge amount of time by automatically scoring and keeping records of exams, and it includes comprehensive grading and reporting capabilities. All questions are cross-referenced with this book or the *PMBOK® Guide*, making it easy to go back to the topics on which you need more studying.

Rita Mulcahy's™ *Hot Topics* Flashcards (Hard Copy or Digital Format)

Are you looking for a way to prepare for the PMP exam that fits into your busy schedule? Now you can study at the office, on a plane, or even on a mobile devicewith RMC's portable and extremely valuable *Hot Topics* flashcards—in hard copy or digital format. Over 300 of the most important and difficult-to-recall PMP exam–related terms and concepts are now available for study as you drive, fly, or take your lunch break. Add instant mobility to your study routine.

PMP® Exam Prep eLearning Course

This self-directed eLearning course for the PMP exam offers bite-size, mobile-friendly, interactive lessons, hundreds of audio clips, dozens of exercises and games, digital *Hot Topics* flashcards, unlimited timed and scored practice exams with the PM FASTrack® exam simulator, and all 35 contact hours necessary to apply to sit for the PMP exam. It also includes a comprehensive document library along with a digital copy of this exam prep book.

Instructor-Led PMP® Exam Prep Courses

For those who learn more easily in a person-to-person interactive environment, RMC regularly schedules a variety of instructor-led exam prep classes as well as live virtual courses. All courses were originally designed by Rita Mulcahy to prepare you for the PMP exam in a fun and effective way—with minimal studying after class. For more information or to find a class near you, go to rmcls.com.

PMI Materials

The *PMBOK® Guide, Sixth Edition* (2017), is the international standard for project management from PMI. Use this in conjuntion with PMI's *Agile Practice Guide* (2017) and *Examination Content Outline* (2021).

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What Is the PMP Exam Like?

Keep in mind three important things about the PMP exam. First, the exam is not a test of the information in the *PMBOK® Guide*. Second, you cannot rely only on real-world experience. Third, training in professional project management that is aligned with the *PMBOK® Guide* and the *Examination Content Outline* is critical.

The exam includes 200 multiple-choice questions with four answer choices per question. The exam must be completed in four hours. Twenty-five (25) of the 200 exam questions are experimental questions, meaning they are not included in your score for the exam. These questions will be randomly placed throughout the exam. You will not know which ones are which. The experimental questions are included by PMI to validate questions for future inclusion in their master database. Your score will be calculated based on your response to the remaining 175 questions. PMI does not publish what it considers to be a passing score. Based on the exam history, however, we estimate that it is somewhere between 65 and 69 percent (about 114 to 121 questions correct out of 175).

The questions are randomly generated from a database. The questions may jump from topic to topic, and a single question may integrate multiple concepts. You get one point for each correct answer.

The following table shows the percentage of scored questions on the exam.

Examination Content Outline (ECO) Domains	Percentage of Questions
People	42%
Process	50%
Business Environment	8%
TOTAL	100%

Chapter 3 contains more detail on ECO domains. PMI occasionally makes changes to aspects of the exam, including the qualification requirements, the application process, the passing score, and the breakdown of questions in each domain. For the latest information, please visit pmi.org and read your authorization notice carefully. Any differences between what is listed here and what is communicated by PMI should be resolved in favor of PMI's information.

The following diagram indicates the topics tested on the exam along with their level of difficulty. For many people, the most difficult areas are project management processes, procurement, risk, quality, and integration.

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Topics	Level of Difficulty
Processes and domains	More difficult
Procurement	
Risk	
Quality	
Integration	
Schedule	
Cost	
Framework	
Scope	
Resource	
Stakeholder	
Communications	Less difficult

The following are important aspects of the exam:

- The exam tests knowledge, application, and analysis. This makes the exam more than a test of memory. You must know how to apply the information in this book and be able to analyze situations involving this information. Do not expect the exam to have all straightforward, definition-type questions.
- The exam deals with practical experience. The majority of the questions are situational. For those who do not have project management experience, these questions can be extremely difficult.
- There may be instances on the exam where the same data is used for multiple questions.
- Historically, there have been exam questions requiring you to identify inputs or outputs from the *PMBOK® Guide*. To answer these questions correctly you need to know not just the input and output names, you also need to understand the processes involved and why the inputs feed into and the outputs result from the processes.
- Expect 5 to 10 formula-related calculations on the exam.
- Expect 10 to 15 earned-value questions on the exam. Not all of these require calculations using the formulas.
- Most acronyms will be spelled out (for example, the exam typically uses the full term "work breakdown structure" rather than "WBS"), but you should know both the acronym and the full term. Note that this is especially true of acronyms you'll see for formulas, such as CPI, SPI, CV, SV, etc.
- The correct answers should not include direct quotations from the *PMBOK® Guide*.
- Most people feel uncertain about only 40 or fewer of the 200 questions on the exam.

The questions on the exam are mostly situational, many are ambiguous and wordy, and some even seem like they have two or more right answers. Be prepared for the following types of questions so you will not waste time or be caught off guard when you are taking the exam.

1. **Situational questions** These questions demonstrate why having project management experience is critical to passing this exam. Such questions require you to integrate your real-world experience and your knowledge of the exam concepts. For example:

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Question You receive notification that a major item you are purchasing for a project will be delayed. What is the best thing to do?

A. Replan your project to accommodate this delay.
B. Notify your manager.
C. Let the customer know about it, and talk over options.
D. Meet with the team, and identify alternatives.

Answer D

2. **Questions with two or more right answers** Questions that appear to have two, three, or even four right answers are a major complaint from many test takers. Many questions will list several choices that could reasonably be done, or that less-experienced project managers would be likely to choose.

As you go through questions and review the answers in this book, look for questions you think have more than one right answer and try to figure out why you think multiple choices are correct. We have intentionally included such questions in our products to give you exposure to the types of questions you will see on the exam; we provide explanations to help you understand why your right answer may not be the best choice.

Let's look again at the previous situational question. Couldn't we really do all of the choices? The right answer is D, but isn't it also correct to tell the customer? Yes, but that is not the first thing to do. This question is really saying, "What is the best thing to do next?" As you answer practice questions, keep in mind the concept of the "best thing to do next" to help you decide which answer identifies the next step in proper project management.

3. **Questions with extraneous information** It is important to realize that not all information included in a question will be relevant. For example, the numbers in the following question are extraneous data.

Question Experience shows that each time you double the production of doors, unit costs decrease by 10 percent. Based on this, the company determines that production of 3,000 doors should cost $21,000. This case illustrates:

A. Learning cycle
B. Law of diminishing returns
C. 80/20 rule
D. Parametric cost estimating

Answer D

4. **Questions using made-up terms** Many people taking the exam expect that all the terms used as choices should mean something. But that's not the case. The exam often includes made-up terms. If you consider yourself well trained and see a term on the exam that you do not know, chances are it is not the right answer. For example:

Question The ongoing definition of a project as more information becomes available to the team is called:

A. Scope validation
B. Strategic planning
C. Progressive elaboration
D. Quantitative elaboration

Answer C

In this question, "quantitative elaboration" (choice D) is not a real project management term.

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5. **Questions where understanding is important** Let's look at the following question:

   Question The process of decomposing deliverables into smaller, more manageable components is complete when:

   A. Project justification has been established.
   B. Change requests have occurred.
   C. Cost estimates can be developed for each work element.
   D. Each work element is found in the WBS dictionary.

   Answer C

   In order to answer this question, you must understand the terms used, including the concept of decomposition and what value this technique has in the project management process.

6. **Questions with a new approach to a known topic** There will be many instances where you understand the topic but have never thought about it as described . For example:

   Question In a matrix organization, information dissemination is most likely to be effective when:

   A. Information flows both horizontally and vertically.
   B. The communication flows are kept simple.
   C. There is an inherent logic in the type of matrix chosen.
   D. Project managers and functional managers socialize.

   Answer A

   Many people know what a matrix organization is but have not taken the time to consider how this organizational structure affects the directions in which information is shared.

7. **Questions with more than one item in each choice** Let's look at the following example:

   Question The seller on the project has presented the project manager with a formal notification that the seller has been damaged by the buyer's activities. The seller claims that the buyer's slow response to requested approvals has delayed the project and has caused the seller unexpected expense. The first things the project manager should do are:

   A. Collect all relevant data, send the data to the company attorney, and consult with the attorney about legal actions.
   B. Review the contract for specific agreed-upon terms that relate to the issue, see if there is a clear response, and consult an attorney if needed.
   C. Review the procurement statement of work for requirements, send a receipt of claim response, and meet to resolve the issue without resorting to legal action if possible.
   D. Hold a meeting with the team to review why the acceptances have been late, make a list of the specific reasons, and correct those reasons.

   Answer B

   These questions can seem hard until you apply this little trick: use the process of elimination, one item at a time. Consider the first item listed in each choice and eliminate the choices that contain an implausible first item. Then look at the second item in each remaining choice and eliminate any implausible choices. Keep going until you have only one choice remaining.

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Watch out; sometimes the items in each choice show a flow or process. See the following example:

Question When managing a project, which of the following is the best order to deal with problems that arise?

A. Go to the team, go to management, go to resource managers
B. Go to resource managers, go to management, go to the customer
C. Handle it yourself, go to the customer, go to management
D. Resolve problems with resources you control, go to resource managers, go to the customer

Answer D

In this case, you need to look at each choice independently to see if the process listed is correct.

8. **Excessively wordy questions** Instead of saying, "The project is behind schedule," the exam might use wordier phrasing, such as, "The project float was zero and has recently gone to negative 2." Instead of saying, "The team is not reporting properly," the exam could say, "The team has lost sight of the communications management plan." The first step in answering many questions is to determine what the question is asking, and then to translate the wordy phrasing.

How to Study for the PMP Exam

Some people believe you need to read every resource available and spend as much time as possible preparing for the PMP exam. Do not make that mistake. You should not read everything you can find, as some resources are not well defined. We recommend the approach outlined in the following sections.

The Magic Three Studies have shown that if you visit a topic three times, you are more likely to remember it. Therefore, you should read this book once and then skim through it two more times, focusing most on the activities you do not do in the real world and on the concepts you have trouble understanding or remembering.

You should pass through each chapter in this book more than once. When you go through a chapter for the second time, focus on filling the gaps you discovered during your first time reading it rather than recreating the complete list for each exercise.

Be in Test-Taking Mode Get used to jumping from one topic to another. You'll also need to practice answering questions for four hours. You can do this by skipping all practice exams until you feel ready to answer the questions. Then take all practice exams in one sitting (see step 4 in plan B on page 15). Do not underestimate the physical, mental, and emotional aspects of taking an exam lasting that long. You can also get into test-taking mode using our PM FASTrack® exam simulator.

Your Step-by-Step Study Plan We recommend that you use one of the following study plans. Follow Plan A if you own RMC's complete PMP Exam Prep System. Follow Plan B if you do not own the entire system.

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Plan A: Using This Book with the PMP Exam Prep System (*PMP® Exam Prep* book, PM FASTrack® Cloud Exam Simulator, and *Hot Topics* Flashcards)

One common mistake made by people who purchase the PMP Exam Prep System is to spend most of their study time answering questions in PM FASTrack®. This approach won't work. As we mentioned earlier, focus your efforts on reading this book, completing the exercises and review activities, and filling the gaps in your experience. Use the following steps to study this book in conjunction with PM FASTrack® and *Hot Topics*:

Read this book for the first time and complete the exercises, but don't do the practice exams at the end of each chapter because you will use FASTrack later. Spend more time on the areas where you have the most gaps in your knowledge or experience, and on items you did not know or do prior to beginning this course of study. Refer to Rita's Process Chart™ (included in chapter 3 of this book) frequently, and be sure you understand all the efforts involved in the knowledge areas you are working on. At the same time, skim through the corresponding chapter in the *PMBOK® Guide* to get an understanding of their use of terminology.

1. As you finish each chapter, review the Quicktest on the first page of the chapter. Make sure you know the meaning of each term or concept. Use *Hot Topics* to improve recall and test your understanding of that chapter.

2. If possible, form a study group after you have read the book for the first time on your own. Your study time will be more effective. You will be able to ask someone questions, and the studying (and celebrating afterward) will be more fun. A study group should consist of only three or four people. (See "How to Use This Book in a Study Group" on page 16.)

3. Skim through this book again.

4. Make sure you really know the material, and then take a full exam simulation on PM FASTrack®. This step will give you a baseline against which to track your progress as you continue to study.

   WARNING: Limit yourself to no more than two full exam simulations before you take the actual exam. Otherwise, you diminish the value of PM FASTrack® by memorizing questions and answers that will not be presented in the same way on the exam.

   WARNING: If you do not score over 70 percent the first time you take a full exam simulation (not just an exam on an individual knowledge area or ECO domain), you may need a refresher in core project management concepts. If you have taken a basic project management class, review the materials you received from that class. If you have not had such a class, consider taking one.

5. Review each question you got wrong in PM FASTrack®, writing down the specific reasons for each wrong answer. Assess why the correct choice is correct and why the other answers are wrong.

6. Use your list of why you got each question wrong (from step 5) to determine what to study further. This will help you determine how much more study time you need and which chapters to read more carefully. Continue to study this book, focusing on areas in which you have more gaps and skimming the sections or chapters on which you did well. Correct errors in your understanding. Review the *PMBOK® Guide* to focus on these gaps. And remember, think large project and how proper project management should be done, regardless of how you manage your projects in the real world.

7. If you had difficulty with certain knowledge areas, domains, or concepts, and you have studied your gap areas, you may want to answer a small sample of questions (no more than 20) using the Knowledge Area, Domain, or Keyword function in PM FASTrack®. Analyze why you answered any questions wrong, and continue to study gap areas.

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WARNING: You might be tempted to answer more than 20 questions, but this should be sufficient to help you assess whether you have progressed in the particular subject matter or whether you need to study more. Answering more than 20 questions in a particular area can diminish the value of PM FASTrack® and will not prepare you for the breadth of the exam experience.

8. Take your second and final PMP simulation exam. You should score over 75 percent before you take the real exam. You are overusing PM FASTrack® if you see many of the questions repeated.
9. Use the *Hot Topics* flashcards and other materials to retain the information you have learned until you take the exam.
10. PASS THE EXAM!

Plan B: Using This Book As a Stand-Alone

1. Read this book for the first time and complete all exercises, but don't do the practice exams at the end of each chapter. Spend more time on the areas where you have the most gaps in your knowledge or your real-life project management experience, and on items you did not know or did not do prior to beginning this course of study. Refer to Rita's Process Chart™ (included in chapter 3 of this book) frequently, and be sure you understand all the efforts involved in the knowledge areas you are working on. At the same time, skim through the corresponding chapter in the *PMBOK® Guide* to get an understanding of the flow of the processes.
2. As you finish each chapter, review the Quicktest terms listed on the first page of the chapter to make sure you know the meaning of each term or concept.
3. If it is at all possible, form a study group after you have read the book for the first time on your own. This will actually make your study time more effective. You will be able to ask someone questions, and the studying (and celebrating afterward) will be more fun. A study group should consist of only three or four people. (See the "How to Use This Book in a Study Group" section on page 16.)
4. Once you feel confident about the material, take the practice exams at the end of each chapter in one sitting. This will give you a baseline to tell you how much you have learned. It will also help you determine how much additional study time you need and which chapters to read more carefully.
5. Review each question you got wrong in the chapter practice exams, writing down the specific reasons for each wrong answer on the Score Sheet discussed on page 6. Assess why the correct choice is correct and why the other answers are wrong. Continue to study this book, focusing on the areas in which you have gaps in your knowledge and skimming the sections or chapters on which you did well. Correct any errors in your understanding of the concepts discussed in this book. Review the *PMBOK® Guide* to focus on these gaps.

   WARNING: If you do not score 70 percent or higher overall on the chapter practice exams, you may need a refresher in core project management concepts. If you have taken a basic project management class, review the materials you received from that class. If you have not had such a class, consider taking one. You cannot rely on these practice questions alone to prepare you for the exam.
6. Make sure you really know the material, and then retake the practice exams in the book. As with step 5, use the Score Sheet to identify in writing the specific, not general, reason you got each question wrong.
7. Use your list of why you got each question wrong (from step 6) to determine which material to study further, and then study this material. Remember, think large project and how proper project management should be done, regardless of how you manage your projects in the real world. Make sure you are confident you have filled your gaps before taking the exam.
8. PASS THE EXAM!

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How to Use This Book in a Study Group To get started, pick someone to lead the discussion of each chapter (preferably someone who is not comfortable with the chapter, because the presenter often learns and retains the most in the group). Each time you meet, go over questions about topics you do not understand and review the hot topics on the exam using the *Hot Topics* flashcards, if you have them. Most groups meet for one hour per chapter. Either independently or with your study group do further research on questions you do not understand or answered incorrectly.

Each member of the study group should have their own copy of this book, which provides exercises, homework, and even class activities. (Please note that it is a violation of international copyright laws to make copies of the material in this book or to create derivative works from this copyrighted book.)

Recurring Themes—PMI-isms to Know for the PMP Exam

RMC has been helping people pass the PMP exam and become better project managers for more than 20 years. During that time, we have developed the following list of "PMI-isms" that the exam emphasizes but that many project managers do not know. We suggest you read it now and then remember to reread it before you take the actual exam. Assuming PMI-isms to be true (unless the question evidence says otherwise) will help you pick the best answer from what seems like more than one correct answer. Some of the topics are listed only here, and others are summarized here and described in more detail later in this book. For the exam, assume that you have (or do) all the following and that these concepts are true for your projects. As you review these PMI-isms, think about which ones are true for your projects. If there are any that aren't true for your projects, you may have a gap in your knowledge. It's important to make note of any gaps you may have, and review these gaps as part of your overall study plan.

> IMPORTANT: PMI represents project management practices along a range of approaches that are predictive, change-driven (agile), and hybrid. As you study these PMI-isms, keep in mind that a project manager may use any approach in order to fit the needs of the project.

General PMI-isms

Project managers are the center of the project universe. Without a skilled project manager, a project is destined to fail. With a person educated in the skills of project management, regardless of title, a project will succeed.

The project manager puts the best interests of the project first—not their own interests.

The project manager understands the value of the tools and techniques of project management and knows how to adapt them to a large project. For the exam, it's helpful to assume, unless otherwise stated, that the project manager is working on a large project that involves more than 200 people.

Project managers have all the power described in the *PMBOK® Guide* and perform all the stated activities or have made proactive tailoring decisions.

The project manager is assigned during project initiating, not later in the life of the project.

The project manager understands the process of project management (i.e., what to do first, second, etc., and why).

Organizations have a formal project selection process, and they always choose projects based on how well those projects meet the organization's strategic goals.

The project manager always knows why their project was selected by management, and they make sure those objectives and the business case are met while planning and managing the project.

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General PMI-isms
Team members are motivated, empowered, and engaged, and come prepared with suggestions; they don't require micromanagement from the project manager.
The project manager spends time planning, managing, assessing, and monitoring and controlling scope, schedule, cost, quality, risk, resources, and customer satisfaction.
Organizations have a project management office (PMO), and that office has important, clearly defined responsibilities regarding projects across the organization.
Organizations have project management policies, which the project manager adapts for use on their project. These policies may include project management methodologies, risk procedures, and quality procedures.
A project may be part of a program or portfolio, and the project's relationship to other projects could significantly influence how the project manager works.
Organizations have records (historical information and lessons learned) for previous projects that include what the work packages were, how much each cost, and what risks were uncovered (part of organizational process assets). The project manager uses this history to plan the current project. The project manager feeds historical records and lessons learned from the current project back into the organization's knowledge base.
The project manager works within the existing systems and culture of a company (enterprise environmental factors), and one of a project's results is to provide input to improve those systems.
Every project has a project charter, which authorizes the project and the role of the project manager.
A work breakdown structure (WBS) and WBS dictionary are used on every project. If taking an agile approach, a project manager may also use a backlog and story cards.
A project management plan is not a bar chart, but rather a series of management plans. The project manager knows what is involved in creating a project management plan.
The project manager creates and keeps current other documents (project documents) in addition to the project management plan to help plan, manage, and monitor and control a project.
Stakeholders are involved throughout the project. Their needs are taken into account while planning the project and creating the communications management plan and the stakeholder engagement plan.
People must be compensated for their work and deserve a fair and positive environment in which they can contribute their best work.
Agile stakeholders are represented by a product owner as part of the team. Team members can see customer perspectives through the use of personas and other agile tools.
Gold plating (adding extra functionality) is not in the best interests of the project and should be prevented.
Most project managers manage projects in a matrix environment in which tools and techniques are typically straightforward. However, it's important to know that concepts and tools such as motivation theories and conflict resolution may become more complicated in alternate environments.
The project manager has a professional responsibility to properly use the tools and processes of project management appropriate to the selected approach.

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Planning the Project

Planning is important, and all projects must be planned.

The project manager plans the project with input from the team and stakeholders, not on their own.

Part of planning involves deciding which processes in the *PMBOK® Guide* and *Agile Practice Guide* should be used on each project and how to tailor those processes to the project. The development approach (predictive or agile) should also be determined and documented.

There are plans for how the knowledge areas of scope, schedule, cost, quality, resources, communications, risk, procurement, and stakeholder management will be planned, managed, and monitored and controlled. These are called management plans, and every project has one for every knowledge area (note that plan length and detail may vary by size and importance to the project, as well as by approach).

In an agile environment, a project manager may use guidelines from an appropriate holistic and formalized methodology in use by the performing organization.

The project manager determines metrics to be used to measure quality.

The project manager plans to improve project processes.

The project manager creates a system to reward team members and stakeholders.

All roles and responsibilities are clearly documented and assigned to specific individuals on the project. These may include things such as reporting responsibilities, risk management assignments, and meeting attendance, as well as project work. Agile teams include generalizing specialists who are experts in one or more field but can and will help in other areas where needed.

The project manager and team focus extensively on identifying risks.

Team members and other stakeholders are assigned risk identification and risk management duties.

The project manager realizes that managing risks saves the project time and money.

Project cost and schedule cannot be finalized without completing risk management.

The project manager creates realistic estimates for the overall project schedule and its associated costs.

The project manager assesses whether the project can meet the end date(s) and other project constraints and objectives. They then meet with management to resolve any differences before the project work starts. The project manager knows unrealistic schedules are their fault because they have tools and skills to help solve them.

The project manager plans when and how to measure performance against the performance measurement baseline, as documented in the project management plan, but also has other measurements to use to determine how the project is performing while the work is being done.

The project management plan is realistic, and everyone believes it can be achieved.

The project manager holds a kickoff meeting with the team. Note, the exam defines a kickoff meeting in a way that may be different from your understanding of a kickoff meeting.

While the Project Work Is Being Done

The project is managed to the project management plan, which is realistic and complete at the level of detail supported by the approach.

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While the Project Work Is Being Done
The project manager is responsible for documenting and sharing knowledge acquired during the project.
The project manager measures against the project management plan to help determine project status throughout the life of the project.
Projects are reestimated throughout the life of the project to make sure the end date(s) and cost objectives will be met. Therefore, the project manager almost always knows if the project can meet the agreed-upon end date(s) and budget.
The project manager has authority and power. They can say no and work to control the project for the benefit of the customer.
The project manager lets others know they cannot get something for nothing. A change in scope must be evaluated for its impacts to the project's schedule, cost, quality, risk, resources, and customer satisfaction. The project manager has enough data about the project to do this analysis.
The project manager realizes that, over time, not everyone associated with the project will have the same understanding of what the project is and what could occur during the life of the project. Therefore, the project manager is continually looking to ensure everyone knows what is going on and has appropriate expectations.
The project manager understands, and takes seriously, resource responsibilities on a project.
The project manager spends time on such activities as team building and ensuring high team performance.
The project manager is proactive, and finds problems early, looks for changes, and prevents problems.
The project manager spends more time focusing on preventing problems than on dealing with problems.
Most problems that occur have a risk response plan already created to deal with them.
Risks are a major topic at every team meeting.
Team meetings do not focus on status. That can be collected by other means.
All changes to a project management plan flow through the change management process and integrated change control (or its agile equivalent).
The project manager ensures that organizational policies are followed on the project.
The project manager recommends improvements to the performing organization's standards, policies, and processes. Such recommendations are expected and welcomed by management.
Quality should be considered whenever there is a change to any component of the project.
Quality should be checked before an activity or work package is considered completed.
The project manager works closely with the quality department in performing some of the quality activities discussed in the *PMBOK® Guide*.
The project manager is actively involved with the procurement process and assists in managing procurements.
The project manager understands contract language.
The project manager makes sure all the terms of a contract are met, including those that do not seem important.

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Closing the Project
The project manager archives all project records.
No project is complete unless there has been final acceptance from the customer.
All projects produce a final report that gives the project team a chance to announce the project objectives have been met.

Which items in this list seem different from the way you manage your projects? Which of these items do you not understand? Reread this list when you think you are finished studying, and pay particular attention to those items that aren't true of your projects. Are there any items you need to think about more to make sure you will remember them when you take the exam? Knowing these PMI-isms can make a significant difference.

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Framework

TWO

This is a very important chapter. Yes, we could say that about every chapter in this book, as they all will add to your understanding of project management. But this chapter is especially important because it provides key terms and concepts you'll need to know to understand the other chapters in this book and to pass the PMP exam. Understanding what is presented here will make the rest of your studying easier. Look for gaps in your knowledge as you read on.

Fundamental Project Management Concepts

The basic knowledge and the key concepts in this chapter will serve as a foundation for your understanding of project management as a whole, project selection, project roles, and an organization's business environment. Together, these components make up the framework for project management.

Definition of a Project Many people call their work a project when it is not.

On the exam, a project is assumed to have the following characteristics:

- It is a temporary endeavor—with a beginning and an end.
- It creates a unique product, service, or result.

Does the exam ask, "What is a project?" No, but it will describe situations, and in your analysis of those situations, you will need to ask questions such as, "Is this a project being described?"

So, what is a project? If your manager walked into your office today and said, "The system is broken. Can you figure out what is wrong with it and fix it?" Would this be a project?

QUICKTEST

- Definition of a project
- Stakeholders
- Project management
  - Predictive
  - Agile
  - Hybrid
- Program management
- Portfolio management
- Organizational project management (OPM)
- Project management office (PMO)
  - Supportive
  - Controlling
  - Directive
- Operational work
- Governance
- Organizational structure
  - Functional
  - Project-oriented
  - Matrix
- Organizational process assets
  - Processes, procedures, and policies
  - Organizational knowledge repositories
  - Enterprise environmental factors
- Assumption log
- Constraints
- Data gathering
- Data analysis
- Decision making
- Communication
- Interpersonal & team skills
- Estimating
- PMIS
- Expert judgment
- Meetings
- Work performance data, information, and reports
- Project selection
  - Economic measures
- Project roles
  - Project manager
  - Sponsor/initiator
  - Product manager
  - Project team
  - Stakeholders
  - Functional/resource manager
  - Program manager
  - Portfolio manager
- Environmental factors
- Organizational culture
- Change
  - Project change
  - Transitional change
  - Environmental change

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Are you reading on before you have thought through the question? If so, read it again, and think about your answer. This is an important concept, both for the exam and in the real world.

You must first take what you are given and organize the work into appropriate projects and for each project, a life cycle. The project planning process will produce schedules and budgets. Can you schedule "fix it" if you do not know what is wrong? You can't; in fact, there may be two or more projects in the previous scenario. The "Processes and Domains" chapter goes into more detail about dividing work into projects and life cycle phases.

TRICKS OF THE TRADE In preparing for the exam, be sure your definition of a project is in alignment with the *PMBOK® Guide*. Think of a project as something new to an organization (has not been done before). When taking the exam, you must identify the development approach. You should have a large project in mind if an exam question uses a predictive approach. You should also know that the exam will test your knowledge of agile projects, which may be smaller and embrace adapting to change.

Stakeholders[1] Stakeholders are any people or organizations whose interests may be positively or negatively impacted by the project or the product of the project. They include the project manager and team, customer and sponsor, but can also include individuals and groups you may not have thought about before, such as the project management office, portfolio managers, program managers, functional or operational managers, business analysts, or other departments or groups within the organization (marketing, legal, or customer service, for example). Stakeholders may be actively involved in the project work or may fill an advisory role. Stakeholders may also be external to the organization, including government regulators, consultants, sellers, end users, customers, taxpayers, banks, and other financial institutions.

Although the "Stakeholders" chapter includes an in-depth discussion of stakeholder management, stakeholders are discussed throughout this book because a project manager should analyze and manage the needs and levels of influence of stakeholders throughout a project and in balance with project constraints.

Project Management Project management is both a science and an art. The science is the systematic process of managing project work efficiently and effectively to deliver planned results. This includes tailoring efforts to meet the needs of the project and using the appropriate processes and tools to accomplish the work. The art of project management relates to how a project manager uses skills such as influencing, organizing, strategizing, and other interpersonal and team skills.

This systematic process of managing project work takes many forms that exist along a continuum, from predictive approaches to agile and hybrid approaches, as described below:

- **Predictive** A predictive approach to project management relies on a planning process during which requirements and scope may be defined in detail early in the project. Detailed plans are created for the other project constraints as well (for example, cost, schedule, and risk). Then, the team strives to adhere to the approved plan as closely as possible and protect the project from changes. This approach may also be called plan-driven, traditional, or waterfall.
- **Agile** An agile approach to project management works best for projects where the definition of project scope is emerging. Since it cannot be defined up front, planning, executing, and managing the project happens in much smaller increments so that changes can be easily made as information about the product and project's needs changes. This approach is also known as change-driven or adaptive.
- **Hybrid** A hybrid approach to project management uses aspects of both predictive and agile approaches and the approach varies with the needs of the project and the organizational environment.

There is a big difference between managing small and large projects, and between those with predictive approaches and those that use agile or hybrid methods. On a small project, you may walk over to someone you need to speak to about an issue. On a large project you may have spent weeks planning communications. You have to figure out who should be involved in solving an issue, their locations, contact

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information and communication preferences. You will need to answer exam questions based on the information given in the question. A large project requires you to use the full breadth of project management processes and tools, and also requires you to consider using an agile or hybrid approach to project management to fit the needs of the project, when necessary.

Effective project management ensures that the organization is focused on the most important work and that the right work is done correctly and in the most time- and cost-effective manner. Risks are identified and planned for before they occur, communication is managed effectively, and specific quality metrics are achieved. These efforts result in satisfied stakeholders and achievement of business objectives.

Program Management Grouping related projects into a program allows an organization to coordinate their management of those projects, as shown in figure 2.1. This approach focuses on the interdependencies between projects, works to ensure benefits for which the projects were initiated, may help decrease risk, and improves overall management. In addition to the work required to complete each individual project, the program also includes a program manager's coordination and management activities. So, when you discover that your work involves more than one project, you can manage the projects as a program if the program approach adds value. Or, you may collaborate with a program manager if your project is part of an existing program.

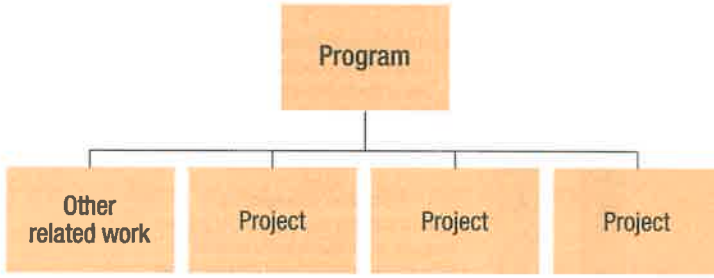

FIGURE 2.1 *Program management*

Portfolio Management A portfolio includes programs, projects, and related operational work that are prioritized and implemented to achieve a specific strategic business goal (see figure 2.2). Programs and projects that make up a portfolio may not be related, other than by their relationship to this common strategic goal. Combining programs, projects, and operations into one or more portfolios helps optimize the use of resources, enhances the benefits to the organization, and reduces risk. The work of an organization can comprise one or multiple portfolios. A project is included in a portfolio based on potential return on investment, strategic benefits, alignment with corporate strategy, and other factors critical to organizational success.

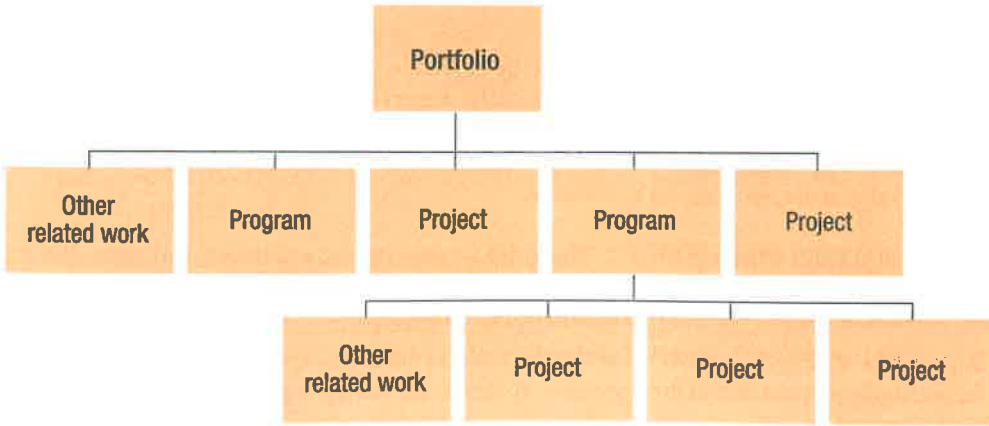

FIGURE 2.2 *Portfolio management*

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Organizational Project Management (OPM)[2] Organizational Project Management (OPM) serves as a guide or driver for project, program, and portfolio management as well as other organizational practices. It is a framework for keeping the organization focused on overall strategy. OPM provides direction for how portfolios, programs, projects, and other organizational work should be prioritized, managed, executed, and measured to best achieve strategic goals and desired benefits. Figure 2.3 shows how OPM drives an organization with project, program, and portfolio management in place to achieve strategic goals. Understanding how these pieces interrelate, as depicted in this illustration, can help you correctly answer questions on the exam. Unless a question tells you otherwise, assume this organizational framework is in place when answering exam questions.

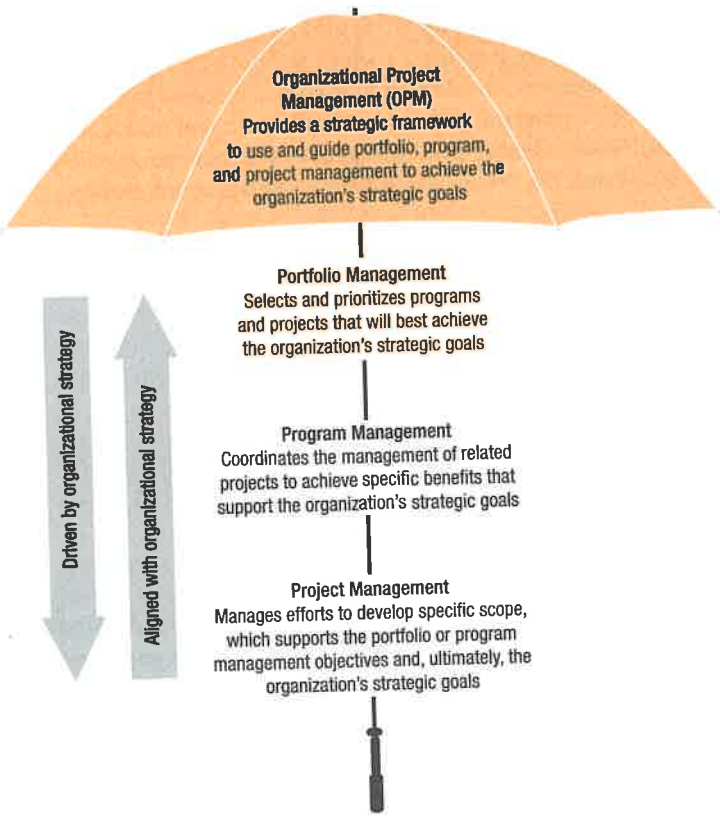

FIGURE 2.3 *Organizational project management*

A key point to understand is that all efforts in the organization—whether they are part of project, program, portfolio, or operational work—should be guided by the organization and support its strategic goals. This means that any changes to the organizational strategy will necessitate changes to the organization's portfolios, programs, projects, and operational work—both ongoing efforts and future initiatives. For example, if a project no longer aligns with the organizational strategy, the project may be changed midcourse to bring it into alignment, or it may be terminated.

Project Management Office (PMO)[3] The PMO is a department within an organization that provides or ensures compliance with project governance. The PMO oversees and standardizes the management of projects. It can take one of several forms, including the following:

- **Supportive** A supportive PMO provides the policies, methodologies, templates, and lessons learned for managing projects within the organization. It typically exercises a low level of control over projects.

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- **Controlling** A controlling PMO provides support and guidance on how to manage projects, trains others in project management and project management software, assists with specific project management tools, and ensures compliance with organizational policies. It typically has a moderate level of control over projects.
- **Directive** A directive PMO provides project managers for different projects, and is responsible for the results of those projects; all projects, or projects of a certain size, type, or influence, are managed by this office. A directive PMO has a high level of control over projects.

The PMO may:

- Manage the interdependencies among projects, programs, and portfolios
- Analyze information from projects to assess whether the organization is achieving its strategic objectives
- Help provide resources
- Recommend the termination of projects when appropriate
- Monitor compliance with organizational processes
- Help gather lessons learned into a repository and make them available to other projects
- Provide templates for documents such as work breakdown structures, user stories, or communications management plans
- Provide guidance and project governance
- Provide centralized communication about projects
- Be more heavily involved during project initiating than later in the project
- Have representation on the change control board
- Be a stakeholder
- Prioritize projects

TRICKS OF THE TRADE

When answering exam questions, assume there is a PMO, unless the question states otherwise. Read situational questions carefully to determine if the PMO is supportive, controlling, or directive.

2.1 Exercise Test yourself! Read the description of the PMO, and determine whether it is likely to be supportive, controlling, or directive, or a combination of the three. Write the answers in your Exercise Notebook.

	Description
1.	Manages all projects throughout the organization
2.	Provides support and guidance; requires all projects within the organization to use designated project management software and templates, but doesn't otherwise exert control over the project
3.	Coordinates all projects within the organization
4.	Recommends common terminology, templates, reporting, and procedures to be used on projects throughout the organization to promote consistency and streamline efforts
5.	Appoints project manager

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	Description
6.	Prioritizes projects
7.	Has the highest level of control over projects

Answer

1. Directive	5. Directive
2. Controlling	6. Controlling or Directive
3. Controlling or Directive	7. Directive
4. Supportive	

Project Management's Organizational Context

ECO
Domain: II
Task: 14
Domain: III
Task: 1, 3, 4

Successful projects provide business value and deliver benefits defined in a business case[4] and a benefits management plan.[5] Projects are designed to bring a positive change to an organization, usually to add or improve products or services, and in some cases to satisfy legal or other regulatory requirements. They are selected, initiated, and exist within an organizational context that influences their desired outputs and what is needed (inputs) to achieve these outcomes (outputs). Organizational context includes an understanding of an organization's operations and projects, governance, and its organizational structure. This context also includes what the *PMBOK® Guide* calls influences: enterprise environmental factors (EEFs) and organizational process assets (OPAs).

Since EEFs and OPAs contribute to and are influenced by the organizational context in which projects exist, they are essential to understanding domain III (Business Environment) in the *Examination Content Outline* (ECO). For a complete view of the project environment, you should also understand that these factors influence and are influenced by a set of frequently used tools and techniques available within the organization and developed through individual experience.

Operations and Projects Most work done in organizations can be described as either operational or project work. Operational work is ongoing work to support the business and systems of the organization, whereas project work ends when the project is closed. Understand the difference for the exam. You may see instances where the real problem in the question is that someone is attempting to manage ongoing (operational) work, such as manufacturing, as a project.

Although these are two distinct areas of work, they are closely connected. When a project is finished, the deliverables are transitioned to ongoing business operations so the benefits of the project work can be incorporated into the organization. A successful transition may require employee training or adjustments to operational processes. For example, when an insurance company's internal project to develop a new caseload tracking system is completed, employees will need to learn how to use the system and adjust their processes to incorporate it into their daily work so the benefits can be realized.

And this relationship goes both ways. While a project may develop a product or service to be used in operational work, the need to change or improve operational work may prompt the initiation of a project. For example, the need to develop a new caseload tracking system may have arisen from problems occurring in the organization's business operations. As another example, imagine the caseload tracking system has moved into operations and users have started working with it, but some bugs have been identified. Fixing

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these bugs would likely be addressed as the operational work of maintaining business systems rather than as a new project. If the organization decides new features or functions must be added to the caseload tracking system after it is in operation, however, this may prompt a new project.

It is important to note that the approach to new projects within an organization is not dependent on a chosen approach used in the past. For instance, the initial caseload tracking system may have been a large project with well-defined requirements that took months or years to complete and had been managed using a predictive approach. Adding new features would be a much smaller project and an adaptive approach could be the best choice for this new project, depending on several factors, including project uncertainty, magnitude, and predictability of outcomes.

Governance

Every organization is different, and governance is designed to support the specific culture and attributes of the organization. Organizational governance affects and is affected by project governance, the organization's culture and structure, and the business environment.

Organizational Governance Organizational governance refers to the overall structure of an organization. It involves setting the policies and procedures for how work will be performed to meet strategic goals and to support organizational operations and decision-making. There may be multiple levels of governance within an organization, although this can vary. Generally, a board of directors is responsible to ensure that work throughout the organization conforms to external (government or regulatory) and internal standards and requirements. Internal requirements include policies and procedures regarding portfolio, program, project, and operations work, which help to ensure that these endeavors are within the strategic plan of the organization and that they contribute to the delivery of specific benefits or value.

Project Governance The ECO task 14 in the Process domain (establish project governance structure) requires project managers to determine their project governance so that the project is in agreement with organizational governance. Do you establish project governance structure on your projects? How does governance differ between predictive and adaptive projects? Predictive governance typically involves formal documentation and upfront analysis and agreement. Agile governance, in contrast, is generally less structured but still aligns with the necessary policies and procedures of the organization. It's important to keep in mind both predictive and adaptive approaches as you may see exam questions that will test your knowledge of both project environments.

Project governance can be established and administered by a PMO. It may involve defining a project manager's authority and the creation or enforcement of processes and policies regarding areas such as risk, resources, communications, and change management.

Governance may also involve planning and managing project compliance in regulations, security, and safety. The awareness of these requirements helps shape the best approach for a project. For instance, potential regulatory restrictions on a new energy project might lead you down the path of an agile hybrid approach, but there are multiple agile methodologies you could choose.

Organizational Structure

One of the primary forms of influence on projects is how the company is organized. The organizational structure will dictate who the project manager goes to for help with resources, how communications must be handled, and many other aspects of project management. This influence is so important that an answer to a question on the exam can change depending on the structure of the organization being discussed.

Questions on the exam are often phrased in terms of the project manager's level of authority and how the form of organization impacts their management of projects. For example, exam questions may deal with who has the power in each type of organization (the project manager or the functional manager), or they may require you to understand the advantages and disadvantages to the project manager in each type of organization.

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As you read through the following sections defining the different organizational structures, take time to think about how each form would impact your work as a project manager and how you would solve problems in different situations within each structure.

Functional This is a common organizational structure. Functional organizations are grouped by areas of specialization within functional areas, such as accounting, marketing, or manufacturing. Projects generally occur within a single department, so when you see "functional" on the exam, think "silo." If information or project work is needed from another department, employees transmit the request to the head of the department who communicates the request to the other department head. Otherwise, communication stays within the project. Team members complete project work in addition to normal departmental work.

Project-oriented In a project-oriented, or projectized organization, the entire company is organized by projects. The project manager has control of the project and personnel are assigned and report to them. When you see "project-oriented" on the exam, think "no home." Team members complete only project work, and when the project is over, they do not have a department to go back to. They need to be assigned to another project or get a job with a different employer. Communication primarily occurs within the project.

Matrix[6] This form is an attempt to maximize the strengths of both the functional and project-oriented structures. When you see "matrix" on the exam, think "two managers." Team members report to two managers: the project manager and the functional manager (for example, the engineering manager). Communication goes from team members to both managers. Team members do project work in addition to normal departmental work.

In a strong matrix, power rests with the project manager. In a weak matrix, power rests with the functional manager, and the power of the project manager is comparable to that of a coordinator (who has some authority and can make some decisions but reports to a higher-level manager) or expediter (who coordinates communications and assists but cannot make or enforce decisions). In a balanced matrix, the power is shared between the functional manager and the project manager.

TRICKS OF THE TRADE The exam typically does not identify the form of organization being discussed. When it does not specify a form, assume matrix. If you remember this, you should answer exam questions correctly.

TRICKS OF THE TRADE A tight matrix has nothing to do with a matrix organization. It simply refers to colocation—the practice of locating workspaces for the project team in the same room. Because it sounds similar to other forms, it has often been used as a fourth choice for these questions on the exam.

2.2 Exercise Test yourself! Questions on the exam will test your understanding of the advantages and disadvantages of the different organizational structures (functional, project-oriented, and matrix). In your Exercise Notebook, list the advantages and disadvantages of each organizational structure. Understanding the differences between these structures will help you evaluate situations presented on the exam, and you'll be able to choose the right answer within an identified constraint.

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Answer

Functional

Advantages	Disadvantages
Easier management of specialists	People place more emphasis on their functional specialty to the detriment of the project
Team members report to only one supervisor	Limited career path in project management
Similar resources are centralized, as the company is grouped by specialties	The project manager has little or no authority
Clearly defined career paths in areas of work specialization	

Project-Oriented

Advantages	Disadvantages
Efficient project organization	No "home" for team members when project is completed
Team loyalty to the project	Lack of specialization in disciplines
More efficient communications than functional	Duplication of facilities and job functions
Project manager has more power to make decisions	May result in less efficient use of resources

Matrix

Advantages	Disadvantages
Highly visible project objectives	Extra administration is required
Improved project manager control over resources (as compared to functional)	Project team members have more than one manager
More support from functional areas	More complex to monitor and control
Maximum utilization of scarce resources	Resource allocation is more complex
Better coordination	Extensive policies and procedures are needed
Better horizontal and vertical dissemination of information	Functional managers may have different priorities than project managers
Team members maintain a "home"	Higher potential for conflict

Inputs and Outputs Inputs are what you need in order to complete a process and outputs or outcomes are what you have when it is completed. Inputs and outputs are logical and should not require memorization if you have a good understanding of the actions involved in each of the knowledge area processes. Test your understanding by answering the following question: What is an input to stakeholder register?

An answer to the question might include a potential stakeholder list and contact information, historical information, and a stakeholder register template with instructions, but there are other inputs you could have thought about. The output or outcome is the completed stakeholder register.

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Do not expect all the inputs tested on the exam to be included or clearly stated in the *PMBOK® Guide*. For example, you know you need the project team (or at least an initial version of the team) to create a WBS, yet the team is not specifically listed as an input to creating a WBS. The remaining chapters in this book will help you understand the processes of project management along with their inputs and outputs.

Let's take inputs to project initiating as another example of working with inputs and outputs. Try this exercise.

2.3 Exercise What does a project manager need to initiate a project? Write your answer in your Exercise Notebook.

Answer If you know what efforts are involved in project initiating (such as drafting the project charter and identifying and analyzing stakeholders), the inputs are easier to logically identify. To initiate a project, you need to know or have the following. Make sure you identify anything from this list that you did not think of. Add it to your gaps list.

- The business case and the benefits management plan for the project.
- The product description and requirements as they are known up to this point; in other words, what is the project supposed to do?
- How the project fits into or supports the company's strategic plan.
- A list of likely stakeholders
- Any known constraints (such as imposed schedule, budget, or resources), risks, and assumptions.
- Any relevant agreements, including contracts, if any of the work will be done under contract.
- Industry standards.
- Marketplace trends and legal, regulatory, or compliance factors.
- The company's change control system.
- Defined processes and procedures for how the company operates.
- Relationships with the sponsor of the project, likely stakeholders, and possible team members.
- Templates from past projects.
- Historical WBSs.
- Historical estimates.
- Lessons learned from previous projects.
- What is going on in the company today, including major projects and the potential impact that current and planned initiatives could have on this project.
- An understanding of the company's culture.
- A list of people who may be good team members.
- Information on organizational and project governance.

TRICKS OF THE TRADE® In preparing for the exam and as you study the rest of this book, keep in mind that all the frequently used influencing factors or tools and techniques within each chapter may not be listed. Instead, the tools and techniques that have been included within a chapter are unique to that knowledge area. For example, when we talk about defining scope in the "Scope" chapter, we highlight product analysis as a tool and technique to be used in this process, but we do not talk about expert judgment, data analysis, decision making, or interpersonal and team skills because these are tools and techniques common to many knowledge areas.

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TRICKS OF THE TRADE Why worry about inputs and outputs? Because "Where am I in the project management process?" is the most important answer you should know immediately as you're reading an exam question. An understanding of inputs and outputs gives you part of that answer. Here is a trick to help you gain confidence in your understanding of the project management processes.

An input means:

"What do I need before I can. . ."

An output means:

"What will I have when I am done with. . ."

Or, *"What am I trying to achieve when I am doing. . ."*

Organizational Process Assets (OPAs)

Most organizations maintain two types of OPAs: processes, procedures, and policies; and organizational knowledge repositories.

Processes, Procedures, and Policies Over time, organizations develop or adopt processes, procedures, and policies for projects. Collectively, these processes, procedures, and policies are referred to as organizational process assets, and they apply to aspects of the project such as quality, procurement, and resource management, as well as change control, safety, compliance, and more. Projects may recommend changes or ways to increase the efficiency of these processes and procedures, but they are generally owned by the project management office or other departments responsible for organizational governance.

Organizational Knowledge Repositories[7] The other type of organizational process asset is organizational knowledge repositories, which include information on many facets of projects.

Historical knowledge bases are maintained and updated by every project and made accessible to the rest of the organization as part of organization repositories. Historical information can be used to plan and manage projects, thereby improving the process of project management and avoiding challenges experienced by past projects. Here are examples of historical information:

- Activities
- WBSs
- Backlogs
- Benchmarks
- Reports
- Risks and risk response plans
- Estimates
- Retrospective findings
- Resources used
- Project management plans
- Project documents
- Prototypes
- Baselines
- Correspondence

Another aspect of historical information is lessons learned. We will discuss lessons learned in more detail in the "Integration" chapter. For now, you need to know that lessons learned, which are created throughout projects, document what went right, what went wrong, and what the team would do differently if they had the opportunity to start the project over again. Lessons learned from each project become part of the lessons learned repository[8] after project closure.

Other organizational knowledge repositories include:

- Configuration management, including file structure, file-naming conventions, baselines of organizational standards, and templates of project documents
- Financial data, including budgets and actual costs of completed projects
- Issue logs and documentation regarding defects on projects
- Metrics that may be useful for other projects
- Project management plans and baselines, as well as project documents, such as network diagrams, risk registers, and stakeholder registers

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When answering questions on the exam, assume the organization has information such as historical records and lessons learned from previous projects and that the company has incorporated these records into an indexed organizational knowledge repository available to all.

Enterprise Environmental Factors (EEF) EEFs are similar to organizational process assets as they provide context within which to plan the project. However, enterprise environmental factors are generally outside the control of the project team.

Enterprise environmental factors external to the organization include governmental or other rules and regulations that apply to the performing organization.

Internal enterprise environmental factors include the structure, culture, systems, and geographic location(s) of the organization. Resource-related EEFs include the technology and resources available for assignment to projects, such as documentation of the skills and abilities of internal and preapproved external resources that are available through approved agreements. EEFs related to project management may include a resource management system, a procurement system, and a quality management system.

When answering questions on the exam, assume that the impacts and limitations imposed by enterprise environmental factors are taken into consideration during planning and as the work is carried out.

Assumption Log[9] The assumption log is a repository of both assumptions and constraints. It is started at the time the project charter is developed. Assumptions and constraints are first identified at a high level in the business case and project charter. They will receive further attention as the project progresses. The assumption log is an input to many project processes, and assumption log updates are a frequent output.

Assumptions are comparable to expectations, as they may not be entirely based on fact. Stakeholders may not realize they are making assumptions, and therefore may not articulate them when communicating their requirements. Incorrect assumptions introduce risk to the project, so they must be identified and managed by the project manager.

Constraints[10] Constraints are easier to identify than assumptions, as they are usually clearly imposed by management or the sponsor. A project manager must juggle many things on a project, including project constraints such as schedule, cost, risk, scope, quality, resources, customer satisfaction, and any other factors that limit options (see figure 2.4). For example, the date a milestone deliverable is due, the date by which the project must be completed, and the maximum allowable risk a project may have are all constraints.

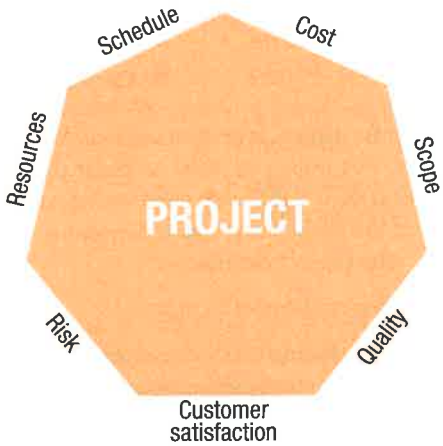

FIGURE 2.4 *Project constraints*

Management directly or indirectly sets the priority of each constraint. This prioritization is then used to plan the project, evaluate the impact of changes, and prove successful project completion. It is important to evaluate the effect a change to one constraint has on another. Changes to the project plan generally impact multiple constraints.

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Take time to really understand the discussion of integrated change control in the "Integration"chapter. Understanding the relationship between the constraints and how they impact a project can help you get several questions right on the exam.

Frequently Used Tools and Techniques There are over 100 tools and techniques in the *PMBOK® Guide*, and there are many more that we discuss in this book. The key is to use the right ones for the right purpose under the right conditions. It is also important to realize tools and techniques can have multiple applications throughout the project management process.

You don't have to be an expert at using all of them, but you do need to understand the purpose of each tool and technique. The following are categorized by their function.

Data Gathering If you need to collect input from stakeholders, you can use one or more of the following data-gathering tools and techniques:

- Benchmarking
- Brainstorming
- Prompt lists
- Checklists
- Interviews
- Market research
- Questionnaires and surveys

Data Analysis Depending on the type of data you are working with and the depth of analysis you need to do, you can choose from many data analysis tools and techniques, including the following:

- Alternatives analysis
- Assumptions and constraints
- Cost-benefit analysis
- Document analysis
- Earned value analysis
- Performance reviews
- Reserve analysis
- Root cause analysis
- Simulation
- SWOT
- Trend analysis
- Value stream mapping
- Variance analysis
- What-if analysis

Data Representation Throughout the project, you will gather and generate data from various sources for a number of purposes and transform that data to information through data analysis. This category includes options for representing, or communicating, data and information. Data representation tools and techniques include the following:

- Affinity diagrams
- Cause-and-effect diagrams
- Control charts
- Flowcharts
- Hierarchical charts
- Histograms
- Logical data models
- Matrix diagrams/charts
- Mind mapping
- Probability and impact matrices
- Release maps
- Scatter diagrams
- Stakeholder engagement assessment matrices
- Stakeholder mapping/representation
- Text-oriented formats

Decision-Making Throughout the project, you will have to make countless decisions, often with the input of the project team. The use of data analysis and representation all support decision making. There are many approaches to decision-making, including the following techniques, which are used in many project management processes:

- Fist of five
- Multicriteria decision analysis
- Voting

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Communication As you will read later in this book, a great deal of a project manager's time is spent communicating with management, the team, the customer, and other stakeholders. The following are several important communication techniques and concepts you will use throughout the project:

- Active listening
- Appreciative inquiry
- Feedback
- Presentations
- Meeting management
- Communication methods
- Communications technology

Interpersonal and Team Skills Interpersonal and team skills are elements of the art of project management. Closely related to the communication techniques and concepts listed above, the following skills are essential for project success:

- Conflict management
- Cultural awareness
- Decision-making
- Emotional intelligence
- Facilitation
- Influencing
- Leadership
- Meeting management
- Motivation
- Negotiation
- Networking
- Observation/conversation
- Political awareness
- Team building

Estimating The project manager is responsible for leading estimating efforts for many aspects of the project, including schedule, cost, and resources. The following are common estimating techniques you will learn about in this book:

- Analogous
- Bottom-up
- Parametric
- Top-down
- Expert judgment
- Planning poker

Project Management Information System (PMIS) An organization's project management information system is part of its enterprise environmental factors. The PMIS includes automated tools, such as scheduling software, a configuration management system, shared workspaces for file storage or distribution, work authorization software, time-tracking software, and procurement management software, as well as repositories for historical information. The PMIS is used in many planning, executing, and monitoring and controlling processes.

Expert Judgment Sometimes, the easiest way to get information is to consult experts. Often, those with expertise needed by the project are working on the team, or at least within the organization. Expert judgment is a common tool of the project management planning processes, although it is not frequently discussed in this book.

Meetings Meetings are often used in the planning processes of a project, although you will not always see meetings discussed in this book as a planning tool. Meetings can be an effective way to get input or feedback from groups of people, but they can be overused. The project manager is responsible for determining whether a meeting is worth the time of those who would attend it, or if there is a more efficient way to achieve an objective. The value of meetings, as well as some suggested ground rules for meetings, is discussed in the "Resources" chapter.

Work Performance Data, Information, and Reports A great deal of data and information is generated, considered, and communicated throughout the life of a project, from initial observations and measurements to analyzed content and reports. The *PMBOK® Guide* uses three different terms to identify the stages through which this data and information move. Work performance data includes the initial measurements and details about activities gathered during the Direct and Manage Project Work process in

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executing. When monitoring and controlling a project, work performance data is analyzed to make sure it conforms to the project management plan. It is also assessed to determine what the data means for the project as a whole. The result is known as work performance information. Work performance information can then be organized into work performance reports, which are distributed to the various stakeholders who need to receive and possibly act on the information.

For example, let's say a project team performs their assigned work according to the project management plan. A certain activity took 10 hours and was completed on July 21. This is work performance data. The next step is to look at how this data compares to the project management plan (in this case, the project schedule). The activity was estimated to take 12 hours, with an estimated completion date of July 22. You can analyze why this activity took less time than planned and what this will mean for the rest of the project. Why was the work completed early? Will this mean improved performance for the rest of the project? Did the team follow the communications management plan and notify resources assigned to successor activities about the anticipated early completion so they could start their work early? Should future activities be reestimated if similar resources will be performing similar work? The result of this analysis is work performance information. This information can then be organized into work performance reports that are distributed through the Manage Communications process. If the activity was on the critical path and had taken longer than scheduled, a formal change request might have been required to adjust the rest of the schedule.

Project Selection

In addition to understanding the general organizational context in which projects exist, you should understand what happens before a project is initiated. A project manager should know a project's history in order to manage it effectively and achieve the results for which it was intended.

The departments and individuals within your company present management with requests for many different initiatives (potential projects), all of which would require an investment of corporate resources. When answering questions on the exam, assume that the organization has a formal process to review and analyze these potential projects and select the project that best aligns with the strategic goals of the organization. There might even be a project selection committee in place to evaluate project proposals.

A project manager is not typically involved in project selection. So, you might ask, "Why is this an important topic to understand?" Good question! The reasons a project is selected and the value it is expected to bring to an organization indicate its significance to the company. The project manager needs to know if the project was selected because it will establish a new area of business, if it is being implemented to meet regulatory or compliance requirements, or if it was chosen because it was the least expensive or most feasible solution to a problem. The reasons a project was selected can impact which constraints are most flexible and will influence how the project manager plans and manages the project. A project manager must keep the reasons the project was selected in mind throughout the project to ensure the objectives are achieved.

For the exam, you should be familiar with the project selection methods described next, but understanding these methods is not as important as knowing that such activities occur prior to initiating a project. These activities fall outside the project boundaries (the period from project authorization through closure).

Economic Measures for Project Selection The following sections discuss several economic measures[11] that can be used for analyzing potential projects for selection. Some of these measures are also used in processes such as quality, cost, and risk management, and in integrated change control. The measures can be used to develop project metrics, determine when changes to the plan are needed, and evaluate progress, changes, and overall project success. Such economic measures take a comparative approach.

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Keep in mind that these measures aren't generally used on their own; that is, an organization would likely consider more than one of these measures (along with other factors) when selecting a project.

Return on Investment (ROI) Return on investment determines the potential profitability of an investment by calculating the benefits received in relation to the cost.

Present Value (PV) Note that you may encounter a couple of questions on the exam that require you to calculate present value. Present value means the value today of future cash flows, and it can be calculated using the following formula:

$$PV = \frac{FV}{(1+r)^n}$$

FV = future value
r = interest rate
n = number of time periods

The acronym PV is also used for planned value (described in the "Cost" chapter). You can avoid confusing these terms by considering the context in which they are used. If the question involves project work that has started and you are evaluating schedule or cost performance, the acronym PV represents planned value within earned value management. If the question is discussing how the project was evaluated for selection or funding, PV represents present value.

Using a simple example, see if you can answer the following question:

Question Is the present value of $300,000 to be received three years from now, with an expected interest rate of 10 percent, more or less than $300,000?

Answer Less. You can put an amount of money less than $300,000 in the bank and in three years have $300,000.

To perform the calculation: $300,000/(1 + 0.1)3 = $300,000/1.331 = $225,394.

Net Present Value (NPV) You will not have to calculate NPV; just know that it is the present value of the total benefits (income or revenue) minus the costs over many time periods. Generally, if the NPV is positive, the investment is a good choice—unless an even better investment opportunity exists. The project with the greatest NPV is typically selected.

Do you already have a good understanding of this topic? Test yourself with the following question.

Question An organization has two projects from which to choose. Project A will take three years to complete and has an NPV of $45,000. Project B will take six years to complete and has an NPV of $85,000. Which one is a better investment?

Answer Project B. The number of years is not relevant, as that would have been taken into account in the calculation of the NPV.

Internal Rate of Return (IRR) To understand this concept, think of a bank account. You put money in a bank account and expect to get a return—for example, 1 percent. You can think of a project in the same way. If a company has more than one project in which it could invest, the company may look at the returns of the different projects and then select the project with the highest return.

IRR does get confusing when you give it a formal definition: the rate ("interest rate") at which the project inflows ("revenues") and project outflows ("costs") are equal. Calculating IRR is complex and requires the aid of a computer. You will not have to perform any IRR calculations on the exam. Simply know that the higher the IRR number, the better.

Question An organization has two projects from which to choose: Project A with an IRR of 21 percent and Project B with an IRR of 15 percent. Which one is a better option?

Answer Project A

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Payback Period This term refers to the length of time it takes for the organization to recover its investment in a project before it starts accumulating profit. For example:

Question There are two projects from which to choose: Project A with a payback period of six months and Project B with a payback period of 18 months. Which one should the organization select?

Answer Project A

Based on the information given in this example, the project with the shorter payback period is the best choice, but that payback period is likely to be one of several financial factors, along with other considerations, used in selecting a project. In some cases, the best choice might be a project that has a longer payback period but various other advantages.

Cost-Benefit Analysis Cost-benefit analysis compares the expected costs of a project to the potential benefits it could bring the organization. (For project selection purposes, benefits are the same as revenue. Remember that revenue is not the same as profit.) This analysis results in the calculation of a benefit-cost ratio, which can be expressed as a decimal or a ratio. A benefit-cost ratio of greater than 1 means the benefits are greater than the costs. A benefit-cost ratio of less than 1 means the costs are greater than the benefits. A benefit-cost ratio of 1 means the costs and benefits are equal.

Question What does a benefit-cost ratio of 1.7 mean?

A. The costs are greater than the benefits.
B. Revenue is 1.7 times the costs.
C. Profit is 1.7 times the costs.
D. Costs are 1.7 times the profit.

Answer B. The benefits, or revenue, the project brings to the organization are 1.7 times the cost of the initiative. Remember, the benefit-cost ratio calculation is looking at revenue, not the smaller figure of profits.

The organization may use the benefit-cost ratio to help choose from many potential projects. A project manager may also perform cost-benefit analysis to determine the best solution approach once a project is selected. The project manager may perform the analysis at a high level during project initiating and at a more detailed level during project planning. This information helps determine things such as what level of quality efforts are appropriate for the project, what equipment or technology should be purchased, and whether it would be best to outsource certain pieces of work.

2.4 Exercise Remember, you do not have to use accounting formulas to pass the exam (aside, possibly, from a couple of present value questions). But you do need to have a general understanding of what the terms mean. So, test yourself! For each row of the following chart, write down in your Exercise Notebook which project (A or B) you would pick based on the information provided.

		Project A	Project B
1.	Net present value	$95,000	$75,000
2.	IRR	13 percent	17 percent
3.	Payback period	16 months	21 months
4.	Benefit-cost ratio	2.79	1.3

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Answer:

1. A
2. B
3. A
4. A

The following are some additional accounting terms related to project selection that you should be familiar with for the exam.

Economic Value Added (EVA)[12] For project selection, this concept is concerned with whether the project returns more value than the initiative costs. (Note that this is a different concept than earned value analysis, which can also have the acronym of EVA. Earned value (in the "Cost" chapter) is frequently mentioned on the exam, whereas economic value added should rarely appear in questions or answer choices.

Opportunity Cost This term refers to the opportunity given up by selecting one project over another. This does not require any calculation. See the following example:

Question An organization has two projects to choose from: Project A with an NPV of $45,000 and Project B with an NPV of $85,000. What is the opportunity cost of selecting Project B?

Answer $45,000. The opportunity cost is the value of the project not selected.

Sunk Costs Sunk costs are expended costs. People unfamiliar with accounting standards might have trouble with the following question:

Question An organization has a project with an initial budget of $1,000,000. It is half complete and has spent $2,000,000. Should the organization consider that it is already $1,000,000 over budget in determining whether to continue with the project?

Answer No. The money spent is gone.

Sunk costs should not be considered when deciding whether to continue with a troubled project.

Law of Diminishing Returns[13] This law states that after a certain point, adding more input (for example, programmers) will not produce a proportional increase in productivity (such as modules of code per hour). A single programmer may produce at a rate of 1 module per hour. With a second programmer, the two may produce at a rate of 1.75 modules per hour (0.75 increase). With a third programmer, the group may produce at a rate of 2.25 modules per hour (0.5 increase). This disparity may be due to many factors. For example, additional coordination is required as more programmers are added to a project.

Working Capital This term refers to an organization's current assets minus its current liabilities. In other words, it is the amount of money the company has available to invest, including investing in projects.

Depreciation Large assets, such as equipment, lose value over time. Accounting standards call this depreciation. Several methods are used to account for depreciation. The exam may ask you what they are. You will not have to perform any calculations. (See, we said we could make this easy for you!) Rather, you should simply understand the following concepts about the two forms of depreciation:

- **Straight-line depreciation** With straight-line depreciation, the same amount of depreciation is taken each year.

  Example: A $1,000 item with a 10-year useful life and no salvage value (the value of an item at the end of its life) would be depreciated at $100 per year.

- **Accelerated depreciation** For many years, the exam has not asked detailed questions on this topic. Just know the following:

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- There are two forms of accelerated depreciation:
  - » Double declining balance
  - » Sum of the years digits
- Accelerated depreciation depreciates faster than straight-line depreciation.

Example: A $1,000 item with a 10-year useful life and no salvage value (the value of an item at the end of its life) would be depreciated at $180 the first year, $150 the second, $130 the next, and so on.

TRICKS OF THE TRADE®

The exam may present information about project selection in the following ways.

First, the exam may ask questions relating to business cases and project selection methods. You need to understand that there is a selection process for a project, know what that process is, and be aware that the project must support the company's strategic goals.

Second, the exam may use a project selection concept, such as internal rate of return, as an answer to a question or as a distractor. Such information may be provided in the question even when you do not need it to answer the question. Read the questions carefully to pick out the relevant data.

The project selection process includes the development of a business case. The business case describes the business need, the proposed solution, and the expected value of the change. It includes both tangible and intangible costs and benefits of the proposed solution. The business case will influence how you approach every project management process covered in this book, beginning with the creation of a project charter – the first of many processes that facilitate the success of a project.

Project Roles

For the exam, it's important to understand who's involved in a project and what they should be doing. This section will help you focus on roles and responsibilities within the context of the exam for the project manager, the sponsor, team, and other stakeholders as well as functional (resource) managers and program and portfolio managers. Each role is explained and then there is an exercise for reviewing more specific responsibilities for each role.

The Role of the Project Manager In a traditional plan-driven environment, the project manager is accountable for managing the project to meet project objectives and deliver its value and benefits to the organization. In a change-based environment, the project manager may perform similarly to an agile coach (also known as a scrum master or team lead) who manages the processes and facilitates work for the team, while a product owner is accountable for delivering the project's value and benefits. As you prepare for the exam, think about your role on projects. Do you have the knowledge, abilities, and authority described in this book? Do you fully plan and control your projects? Are you leading and managing effectively?

This role includes gathering information to get the project started, ensuring that the project is completed according to the schedule and budget, including approved changes and that it meets other objectives. The project manager directs and contributes to the project's planning and manages the team's work and physical resources while the team works to build the product of the project.

It's important to know that using interpersonal and team skills, team building, and enabling a safe and motivating environment may be more useful than using a "command and control" approach (this is described in more detail in the "Resources" chapter). In this type of project environment, the focus is on understanding what motivates your team members and then aligning their project tasks with the project purpose and their goals.

A good way to think about this is to compare the concepts of "management" and "leadership" as shown in Figure 2.5.

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Management Focus	Leadership Focus
Tasks/things	People
Control	Empowerment
Efficiency	Effectiveness
Doing things right	Doing the right things
Speed	Direction
Practices	Principles
Command	Communication

FIGURE 2.5 *Management vs. Leadership Focus*

Can you have leadership without management? No. You need the mechanics of management in place. But to be truly effective, you need to have a good balance of leadership and the mechanics of management to successfully manage a project. Team productivity is best amplified through a combination of management and leadership.

Too often project managers may not realize they lack knowledge of what proper project management involves, and traditionally many companies do not understand why project management is so important in delivering the benefits they want to realize. A project manager's level of authority to make decisions can also vary depending on organizational structure and other factors, such as whether they are assigned part-time or under contract.

The Role of the Project Sponsor/Initiator A basic definition of a sponsor is one who provides the financial resources for the project – typically someone in management. The sponsor also supports the project and protects it from unnecessary changes. The role of the sponsor may be filled by two or more individuals, working together. In procurement situations, the project sponsor also represents the buyer. In such cases, the selling organization should also have a sponsor.

In agile and hybrid approaches, the product owner's role is in some ways analogous to that of a sponsor, being responsible for ensuring the project delivers value and benefits. But notice that in the previous section the product owner was also described as having a role similar in some ways to that of a project manager. For the exam, be careful to think about the role being described in the question.

Think about your company's management as you read this. Do they know what their role is on projects? How can you help them better understand their role? Without having the sponsor or someone performing a sponsor's functions, the project will suffer, wasting time and resources. Someone must serve as a protector of the project and its priorities so long as the project continues to meet the organization's strategic goals.

The Role of the Product Manager There are usually multiple projects over the course of a product's life cycle. In an agile environment, the product manager is typically the lead of the product owners and is ultimately accountable for the product value and benefits. But the term product manager is not limited to agile environments and its exact meaning may depend on organizational culture. While you are not likely to see a specific question about this on the exam you may see the term used, so it's helpful to understand it in the agile context.

The Role of the Project Team The project team is a group of people, including the project manager, who will complete the work of the project. Team members can change throughout the project as people are added to and released from the project. An agile environment may include the concept of keeping stable teams within an organization and bringing projects to the team, while more traditional approaches tend to assemble teams as new projects are initiated.

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Generally, it is the team's role to help plan what needs to be done by creating the WBS or backlog and estimates for their work packages or activities. Team members complete activities to produce the deliverables or outcomes represented as work packages or features and help look for deviations from the project management plan during project executing and monitoring and controlling. In agile environments, team members are responsible for clarifying user stories with the customer so that they can estimate and plan the releases and iterations, hold reviews and retrospectives, and update the project information using tools like Kanban boards and burndown charts.

On large projects, there may be too much project management work for one person to perform. Therefore, the project manager may select team members to help perform project management activities. The *PMBOK® Guide* refers to these people as the project management team. Members of this team must have project management training. For the exam the term "project management team" refers to this subset of the team or project team, and it includes the project manager.

The Role of the Stakeholders A stakeholder is anyone who will be impacted by the project or can positively or negatively influence the project. This includes the customer or end user, the project manager and team, the project's sponsor, program and portfolio managers, the project management office, functional or operational managers within the organization, other departments or groups within the organization (such as business analysis, marketing, procurement, quality, or legal), and external sellers that provide services or materials for the project. Questions about the role of stakeholders and how they or their work should be managed appear throughout the exam.

The stakeholders' role on a project is determined by the project manager and the stakeholders themselves. Stakeholders should be involved in planning the project and managing it more extensively than many people are used to on their projects. For example, project managers should involve the customer in planning and controlling a project. Customer representation is built into agile environments through the role of product owner or value management team, and this is increasingly so on hybrid and traditional projects. The product owner role can be filled by someone from the business who is responsible for working with the team to prioritize features.

The Role of the Functional or Resource Manager A functional or resource manager is responsible for the human and physical resources in a specific department, such as IT, engineering, public relations, marketing, etc., and for working with the project manager to meet the needs of the project. As managers of people, facilities, or equipment, functional or resource managers maintain a calendar indicating availability of these resources for projects and organizational work. This might involve negotiation if people, facilities, or equipment are needed by more than one project at the same time. If there are issues with resources provided by the functional manager, project managers collaborate with them to resolve them.

Earlier in this chapter we discussed different organizational structures. The degree that functional managers are involved in a project depends on whether the organization has a matrix, project-oriented, or functional organizational structure. To avoid conflict, the project manager and functional managers must balance their respective needs regarding the use of resources to complete project and operational work. It is generally the responsibility of the project manager to manage this relationship by using clear communication and interpersonal and team skills, such as conflict management and emotional intelligence.

The Role of the Program Manager The program manager is responsible for managing a group of related projects, combined into programs to provide coordinated control, support, and guidance. The program manager provides oversight to meet both project and program goals.

The Role of the Portfolio Manager The portfolio manager is responsible for governance at an executive level of the programs, projects, and operational work that make up a portfolio. A project is included in a portfolio based on its association with other projects, programs, and operations that support the same organizational strategic goals and other factors critical to organizational success.

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2.5 Exercise The following lists contain the responsibilities for each of the roles discussed in this chapter. If you come across a responsibility that is unfamiliar to you, write it down in your Exercise Notebook. Completing this exercise will help you identify gaps so you can pay particular attention to understanding those responsibilities as you read the rest of this book.

Note: Each of these lists should give you a good sense of the respective role, but they are not all-inclusive or presented in a particular order and may not be exclusive to traditional or agile approaches.

Project Manager Responsibilities List

Responsibility	Responsibility
Is assigned to the project no later than project initiating	Is in charge of the project but not necessarily the resources
Helps write the project charter	Builds, develops, and empowers team
Applies project management knowledge and personal and leadership skills to achieve project success	Uses rewards and recognition
Assists the team and other stakeholders during project executing	Identifies and delivers required levels of quality
Identifies and analyzes constraints and assumptions	Identifies stakeholders, supports stakeholder engagement, and manages stakeholder expectations throughout the project
Leads and directs project planning with the team or product owner	Manages project knowledge, including sharing lessons learned
Selects appropriate processes for the project (with the team)	Solves problems
Helps identify dependencies between activities	Makes decisions
Takes action to produce a realistic schedule	Demonstrates ethics and leadership
Develops time and cost reserves for the project (with the team)	Manages and controls resources
Understands and fosters professional and social responsibility	Controls the project by measuring performance and determining variances from the plan
Coordinates interactions between the project team and key stakeholders	Monitors risk, communications, and stakeholder engagement to ensure they're in conformance with expectations
Integrates the project components into a cohesive whole that meets the customer's needs	Determines the need for change requests, including recommended corrective and preventive actions and defect repair
Finalizes and gains approval of the project management plan	With the team, approves or rejects changes as authorized, manages change control, and sits on the change control board (this is the product owner in agile)

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Responsibility	Responsibility
Influences the project team and the environment by promoting good communication, insulating the team from impediments, enhancing the positive aspects of cultural differences, and resolving team issues	Uses metrics to identify variances and trends in project work, and is responsible for analyzing the impact of these variances and trends
Spends more time being proactive than dealing with problems	Works with team members to resolve variances from the project management plan
Understands how cultural differences may impact the project, including global teams, virtual teams, or projects involving multiple organizations	Keeps the team members focused on risk management and risk responses
Ensures professional interactions between the team and other stakeholders	Performs project closing at the end of each phase and/or for the project as a whole

Project Sponsor Responsibilities List

Responsibility	Responsibility
During or Prior to Initiating, the Sponsor:	
Provides high-level requirements	Provides funding
Guides the process to get the project approved and formalized	Provides information regarding the initial scope of the project
Participates in developing the business case for the project	May (with the customer) dictate milestones, key events, or the project end date
Helps to define the measurable objectives	Determines priorities between the constraints (if not done by the customer)
Advocates for or champions the project	Provides information that helps develop the project charter and approves the charter
Serves as a voice of the project or spokesperson to those who do not know about the project, including upper management	Gives the project manager authority as outlined in the project charter
Maintains support for the project	Sets priorities between projects
Ensures buy-in throughout the organization	Encourages the finalization of high-level requirements and scope by stakeholders
During Planning, the Sponsor:	
Provides the project team with time to plan	Determines the reports needed by management to oversee the project
May review the WBS	Helps evaluate trade-offs during crashing, fast tracking, and re-estimating
Identifies risks	Approves the final project management plan
During Executing and Monitoring & Controlling, the Sponsor:	
Supports the efforts of the project manager	Resolves conflicts that extend beyond the project manager's control

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Responsibility	Responsibility
Protects the project from outside influences and changes	Approves, rejects, or defers changes, or authorizes a change control board to do so
Enforces quality policies	May direct that a quality review be performed
Provides expert judgment	Clarifies scope questions
Helps evaluate trade-offs during crashing, fast tracking, and re-estimating	Works with the project manager to monitor progress
During Closing, the Sponsor:	
Provides formal acceptance of the deliverables (if they are the customer)	Supports the collection of historical records from the project
Enables an efficient and integrated transfer of deliverables to the customer	

Team Responsibilities List

Responsibility	Responsibility
Help identify and involve stakeholders	Comply with quality and communications plans
Identify requirements	Enforce ground rules or team charter
Identify constraints and assumptions	Execute the project management plan to accomplish the project scope
Create the WBS or product backlog	Attend project team meetings
Decompose work packages into activities, or decompose stories into tasks	Recommend project changes, including corrective and preventive actions
Identify dependencies between activities	Implement approved changes
Provide schedule and cost estimates	Share new knowledge
Participate in the risk management process	Contribute to the lessons learned knowledge base

Stakeholders Responsibilities List

Responsibility to Help	Responsibility to Help
Create the project charter and the project scope statement	Identify constraints and assumptions
Develop the project management plan or backlog and release roadmap	Identify requirements
Approve project changes	Manage risk
Attend reviews and accept or reject deliverables presented; provide feedback	Identify issues
Be a risk owner	Document lessons learned
Participate in phase gate reviews	Provide expert judgment
Be involved with governance	Participate as a member of the change control board

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Functional or Resource Manager Responsibilities List

Responsibility	Responsibility
Assign specific individuals to the team and negotiate with the project manager regarding team and physical resources	Manage activities within their functional area
Inform the project manager of other projects or departmental work demands that may impact the project	Assist with issues related to team or physical resources under their control
Participate in project planning until work packages or activities are assigned	Improve resource utilization
Provide subject matter expertise	Participate in rewards and recognition of team members
Approve the final schedule during schedule development when it involves team or physical resources under their control	Participate in risk identification
Approve the final project management plan or backlog/release roadmap when it involves team or physical resources under their control	Participate in quality management
Recommend project changes including preventive and corrective actions	Sit on the change control board

Program Manager Responsibilities List

Responsibility	Responsibility
Manage related projects to achieve results not obtainable by managing them separately	Provide oversight to adjust projects for the program's benefit
Ensure projects selected support strategic goals of the organization	Guide and support individual project managers' efforts

Portfolio Manager Responsibilities List

Responsibility	Responsibility
Manage projects or programs that may be largely unrelated	Work with senior executives to gather support for individual projects
Ensure selected projects provide value to the organization	Get the best return from resources invested

Business Environment (ECO Domain III)

Having an understanding of the business environment within which a project operates allows a project manager to deliver the benefits and value for which it was selected. Do you consider the business environment when managing a project? Do you understand how a business environment may impact and is impacted by a project?

ECO
Domain: III
Task: 1, 2, 3, 4

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The term "business environment" can mean many things. The following should help you understand the tasks associated with the Business Environment domain within the *Examination Content Outline* (ECO).

ECO Domain III: Business Environment
Task 1: Plan and Manage Project Compliance
Task 2: Evaluate and Deliver Project Benefits and Value
Task 3: Evaluate and Address External Business Environment Changes for Impact on Scope
Task 4: Support Organizational Change

The first task addresses project compliance as it relates to security, health and safety, regulatory and other policy-related requirements internal or external to the organization. It's important for a project manager to elicit all compliance-related requirements and ensure that all project-related work remains in compliance with those requirements. The second task is specifically for delivering the project's benefits and value. The last two tasks involve managing change: the third is about addressing external business environment changes as they may impact scope, and the fourth task is about supporting (internal) organizational change.

Although PMI states that this domain makes up approximately 8% of exam questions, a question may be on any project management-related topic and require an understanding of the business environment in order to answer it correctly. In other words, a good project manager will understand the needs of their project in the context of the business environment.

Environmental Factors Internal and external factors influence projects and operations of any given organization. These factors include the EEFs and OPAs as introduced earlier in this book as well as customers, stakeholders, regulations, technology, and the marketplace, among others. The business environment is always changing, so it's important to consistently assess and adapt to changes in the business environment that may affect the project. Essentially, your goals in operating within any business context is to deliver the project's benefits and value to the organization while ensuring compliance with internal (such as governance) and external (such as regulatory) environmental needs and supporting change management.

In a predictive environment the challenge is to continually ensure the benefits agreed to during initiating and planning remain valid and that the potential solution will deliver those benefits. Small changes to the business environment may simply require a reprioritization of the project backlog or a reassessment of project scope. This may include changes to the schedule, budget, or other project constraints. One way that agile projects adapt in a changing environment is to use the concept of building a Minimally Viable Product (MVP)—a package of functionality that is complete enough to be useful to the market yet small enough that it doesn't represent the entire product. This allows the project team to learn the most about the customer and business environment with the least possible effort, incrementally. The MVP allows you to see how the increment of the product appeals to the customer and how the customer uses the product. The team then uses feedback to update the product to increase its capabilities or even cancel the project entirely as necessary.

Organizational Culture Projects are impacted by, and have an impact on internal cultural norms, and organizational management policies and procedures. These factors are increasingly important in global organizations in which team members are often located in different offices and in multiple countries. Organizations may have employees from many different cultures and multiple organizational cultures will exist among various branches of the organization. Project managers should be able to adapt their approach to leading the project by understanding these cultures and their impacts within the organization and the project.

It is important to consider organizational culture not only when initiating a project, but throughout its life cycle. Why? Imagine you've planned a project and uncovered key requirements the supporting organization didn't initially disclose. The plan will most certainly need to change to adhere to these new

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requirements. Was it an oversight or was there a specific reason the requirements remained unexposed? How will the organizational culture be affected by these changes? Likewise, how will these changes affect organizational culture? Will the team support the necessary changes to the project? Will the customer support the changes?

Managing Change We have organized how change is managed into three main categories: project change, transitional change, and environmental change. While these are not terms you will find on the exam, these categories may help you understand how change is managed on a project.

The first category is project change: those changes within a project that affect the success of the project. The second category is brought about by the solution. We will call this second category transitional change: those positive changes your project is meant to bring to your organization and its associated stakeholders (e.g., customers, communities, government, sellers). The third category represents environmental changes (external to the project) that will potentially affect the first two categories of change.

While these categories make for a convenient way to articulate different qualities of change, they are not mutually exclusive. Different types of change overlap and are often interdependent. Like project constraints, you cannot evaluate change in one category without thinking about its effects on the others.

Project Change Project change management is discussed in further detail in the "Integration" chapter, but here we list some examples of how good project management practices help to manage changes within a project.

- Iterative and rolling wave planning support the understanding within traditional project management that as a project progresses new information will become available and some information will change and plans will need to be updated periodically.
- In traditional project management, the progression from rough order of magnitude (ROM) estimating for project selection and initiation is followed by more definitive estimating using tools like scope decomposition, network diagramming, and three-point estimating during planning.
- Phase-gate systems for projects allow the team and stakeholders to pause, evaluate, and approve what has happened so far on the project and then make a decision to move on to the next phase. Changes may be made to policies and procedures at these milestones.
- Integrated change control is the process of managing changes within the project, ensuring that changes to the project are necessary and carried out systematically.
- Agile project management supports a continual state of project change through iterative and incremental planning and execution. Delivery of successive MVP increments and fine tuning of development work can be done with tools such as high-level release planning, experimental spikes for exploring uncertainty, and cycles of time-boxed iterations.

Transitional Change Why do we do projects in the first place? A project is undertaken for the express purpose of filling a business need to bring about positive change of a specific nature. So, before a project starts its stakeholders are in a situation called a current state. The project is meant to bring the stakeholders to a future state defined by the project objectives and requirements. Project management is geared toward building the end result but also toward helping stakeholders make the transition from current to future state. By their very nature, projects are about managing change.

However positive a new solution is, people need help making the transition to it. Following are some examples of how that might be managed:

- A simple change to an already existing software product automatically downloads on stakeholder devices and a pop up summarizes the changes.
- A new software rollout will completely change the way processes are completed in the organization. The project is part of a coordinated program that includes a communications director managing a carefully planned communications project while a training director manages an implementation and training project.

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- An already excellent product is being updated, so included in the new product rollout is a trade-in and rebate program that gives customers incentives to buy the new product.

Environmental Change Think of this category as twofold. Changes to the external business environment that may impact your project and organizational change that may impact (or be impacted by) your project. Let's say a project has already started and is going well. The project manager has a plan to address changes and can easily take change requests within the project into consideration. But, for example, what happens when something changes within the supporting organization? Now what?

Organizational changes may require changes to the project team, rework, schedule changes, and more. Understanding organizational culture, politics, and governance will enable you to make needed changes in ways that minimize negative effects and keep the project moving forward. What about the external business environment? The industry you are working in, technology, regulations, geopolitical factors, and marketplace sectors can all experience change that will impact your project.

Consider these examples of environmental change:

- Your major project is to develop battery technology for electric cars. A competitor releases a battery to the market with a capacity marginally exceeding the one you are set to achieve with your project. You will need to lead a project change effort within your organization, which you know is very averse to change on major projects.
- Your organization has merged with another company and you will lead efforts to evaluate the continued viability of your project within the new organization.
- A natural disaster affecting the region from which your project is being managed will affect your project. Risk management planning has to take this into account.
- A regulation governing your product has changed so that your project can begin closing sooner than expected, having accomplished all work that still aligns with the project charter. You can transition the product as-is to the marketplace.

How do you consider facilitating change? Regardless of the type of changes taking place on your project or in your environment, the process is the same!

1. Have a high level of sophistication about your products and services, your organization, and your environment.
2. Maintain awareness and monitor the possibility of change of any kind.
3. As potential changes are identified, evaluate the changes and their impacts.
4. Plan your response.
5. Lead the team in operating within the organization and the project to support your planned response.

Make sure you are comfortable with all the concepts in this chapter before reading further. These concepts provide a basis for understanding much of the material presented in the remainder of this book.

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Practice Exam

1. A project team is discussing the benefits and drawbacks of working on projects within their organization now that it has become project oriented. They can agree on many advantages for the team and for the organization, but also agree there are some drawbacks relative to the strong matrix structure the organization used to have. In a project-oriented organization, the project team:
   A. Reports to many managers
   B. Has no loyalty to the project
   C. Reports to the functional manager
   D. Will not always have a "home"

2. A project manager is trying to complete a software development project, but cannot get enough attention for the project. Resources are focused on completing process-related work, and the project manager has little authority to assign resources. What form of organization must the project manager be working in?
   A. Functional
   B. Matrix
   C. Expediter
   D. Coordinator

3. You are managing a project to develop an online course in teaching English as a second language. The project charter includes a requirement that the course include complex interactive games, like the courses offered by your competitors. Since your organization's current learning management system will not support these features, one team member is researching new learning platforms while the others start work on the course outline and learning goals. What kind of project is this?
   A. This is a hybrid project since the team members need to both adopt a new technology and deliver a new product.
   B. This is a change-driven project since the technology and the product scope are emerging as the work is being done.
   C. This is a hybrid project since the team already knows how to build an online course and only the technology will be new.
   D. This is a change-driven project since the organization must change their approach to keep up with their competition.

4. A project manager has little project experience, but she has been assigned as the project manager of a new project. Because she will be working in a matrix organization to complete her project, she can expect communications to be:
   A. Simple
   B. Open and accurate
   C. Complex
   D. Hard to automate

5. A project team member is talking to another team member and complaining that many people are asking him to do things. If he works in a functional organization, who has the power to give direction to the team member?
   A. The project manager
   B. The functional manager
   C. The team
   D. The PMO

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6. A plan-driven organization is trying to move toward a more agile approach. As part of this process, you have been asked to manage the organization's first hybrid project. What can you expect?
   A. You will plan the project with the usual predictive process, then the team will use agile practices to implement the plan.
   B. The team will be using both agile and predictive practices in each iteration.
   C. For each part of the project, you will need to choose either agile practices or plan-driven practices.
   D. You will need to design the best balance of agile and plan-driven practices based on the needs of the project and the organization.

7. Two project managers have just realized that they are in a weak matrix organization and that their power as project managers is quite limited. One figures out that he is really a project expediter, and the other realizes she is really a project coordinator. How is a project expediter different from a project coordinator?
   A. The project expediter cannot make decisions.
   B. The project expediter can make more decisions.
   C. The project expediter reports to a higher-level manager.
   D. The project expediter has some authority.

8. All the following are characteristics of a project except:
   A. It is temporary.
   B. It has a definite beginning and end.
   C. It has interrelated activities.
   D. It repeats itself every month.

9. A framework for keeping an organization focused on its overall strategy is:
   A. Organizational project management
   B. The *PMBOK® Guide*
   C. Project governance
   D. Portfolio management

10. A project manager's primary responsibility is to deliver the product of the project within project constraints. Actions taken and changes made to the benefit of one constraint could negatively affect another. Which of the following best describes the major constraints on a project?
    A. Scope, number of resources, and cost
    B. Scope, cost, and schedule
    C. Scope, schedule, cost, quality, risk, resources, and customer satisfaction
    D. Schedule, cost, and number of changes

11. Your corporate compliance office has just issued a new requirement that a complex security checklist must be submitted before the release of every high-criticality product. Since this form wasn't originally required, you didn't make plans for completing it. Your release date is approaching and the checklist is due soon. What should you do?
    A. Ensure that the checklist is filled out accurately and submitted on time.
    B. Delegate the task of completing and submitting the checklist to the business analyst for your project.
    C. Complete the checklist yourself, based on historical records.
    D. Ask the PMO to complete the checklist.

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12. Your project involves redesigning an online training portal in order to enhance the learner experience. The project performance will be measured based on customer feedback surveys. The redesign is being delivered incrementally, over multiple releases. What will be the best way to measure the business value delivered over the course of the project?
    A. Once all the releases are completed, compare pre-project revenue to post-project revenue.
    B. Divide the expected improved satisfaction by the number of releases, and monitor whether each release delivers its share of the improvement.
    C. Analyze customer satisfaction improvement after all releases have been delivered.
    D. Analyze the customer feedback after each release, comparing the results to predefined targets.

13. If a project manager is concerned with gathering, integrating, and disseminating the outputs of all project management processes, she should concentrate on improving the:
    A. Work breakdown structure (WBS)
    B. Communications management plan
    C. Project management information system (PMIS)
    D. Scope management plan

14. A project manager is managing his second project. It started one month after the first one did, and both projects are still in process. Though his first project is small, the new project seems to be quickly growing in size. As each day passes, the project manager is feeling more and more in need of help. The project manager has recently heard that there was another project in the company last year that was similar to his second project. What should he do?
    A. Contact the project manager for the other project, and ask for assistance.
    B. Obtain historical records and guidance from the project management office (PMO).
    C. Wait to see if the project is impacted by the growth in scope.
    D. Make sure the scope of the project is agreed to by all the stakeholders.

15. To obtain support for the project throughout the performing organization, it's best if the project manager:
    A. Ensures there is a communications management plan
    B. Correlates the need for the project to the organization's strategic plan
    C. Connects the project to the personal objectives of the sponsor
    D. Confirms that the management plan includes the management of team members

16. Your management team has decided that all orders will be treated as projects and that project managers will be used to update orders daily, to resolve issues, and to ensure the customer formally accepts the product within 30 days of completion. Revenue from the individual orders can vary from $100 to $150,000. The project manager will not be required to perform planning or provide documentation other than daily status. How would you define this situation?
    A. Because each individual order is a "temporary endeavor," each order is a project.
    B. This is program management since there are multiple projects involved.
    C. This is a recurring process.
    D. Orders incurring revenue over $100,000 would be considered projects and would involve project management.

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17. A project team is working on manufacturing a new product, but they are having difficulty creating a project charter. What is the best description of the real problem?
    A. They have not identified the project objectives.
    B. They are working on a process and not a project.
    C. The end date has not been set.
    D. They have not identified the product of the project.

18. One of your team members informs you that he does not know which of the many projects he is working on is the most important. Who should determine the priorities between projects in a company?
    A. The project manager
    B. The project management team
    C. The project management office (PMO)
    D. The project team

19. The difference between a project, program, and portfolio is:
    A. A project is a temporary endeavor with a beginning and an end, a program may include other nonproject work, and a portfolio is all the projects in a given department or division.
    B. A project is a lengthy endeavor with a beginning and an end, a program combines two or more unrelated projects, and a portfolio combines two or more programs.
    C. A project is a temporary endeavor with a beginning and an end, a program is a group of related projects, and a portfolio is a group of projects and programs related to a specific strategic organizational objective.
    D. A project is a contracted endeavor with a beginning and an end, a portfolio is a group of projects with more open-ended completion dates, and a program combines two or more portfolios.

20. A complex aerospace engineering project is nearing completion. Because the work was highly technical and new to the organization, the product of the project was released two months later than planned. Despite the late delivery, management is appreciative of the effort expended and believes that this product will generate additional opportunities for the organization. Management also thinks that the experience of this team will provide great value for teams working on similar projects in the future. The sponsor requests that lessons learned be thoroughly documented. Lessons learned are best completed by:
    A. The project manager
    B. The team
    C. The sponsor
    D. The stakeholders

21. Project A has an internal rate of return (IRR) of 21 percent. Project B has an IRR of 7 percent. Project C has an IRR of 31 percent. Project D has an IRR of 19 percent. Which of these would be the best project?
    A. Project A
    B. Project B
    C. Project C
    D. Project D

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22. Consideration of ongoing operations and maintenance is crucially important to products of projects. Ongoing operations and maintenance should:
    A. Be included as activities to be performed during project closure
    B. Be a separate phase in the project life cycle because a large portion of life cycle costs is devoted to maintenance and operations
    C. Not be viewed as part of a project
    D. Be viewed as a separate project

23. What is a program?
    A. An initiative set up by management
    B. A means to gain benefits and control of related projects
    C. A group of unrelated projects managed in a coordinated way
    D. A government regulation

24. A company is making an effort to improve its project performance and create historical records of past projects. What is the best way to accomplish this?
    A. Create project management plans.
    B. Create lessons learned.
    C. Create network diagrams.
    D. Create status reports.

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Answers

1. **Answer** D
   Explanation The main drawback of a project-oriented organization is that at the end of the project when the team is dispersed, they do not have a functional department ("home") to which to return. They need to be assigned to another project or get a job with a different employer.

2. **Answer** A
   Explanation In a functional organization, the project manager has the least support for the project and has little authority to assign resources. Project expediter and project coordinator are roles in a weak matrix organization.

3. **Answer** B
   Explanation This is an example of a change-driven project that cannot be planned up front since there is a high level of uncertainty about the technology and the product scope. While the team may already know how to build an online course, they haven't developed interactive games before, and they don't know which platform they will be using yet. The choice of a platform will affect how the content is built and the features available to the developers. Change-driven teams are often faced with coming up with a unique solution that has never been built before. If this were a hybrid project, the team would be using both predictive and agile approaches in a customized way. However, the scenario doesn't mention using any predictive methods, and that approach would require a higher level of certainty than described here.

4. **Answer** C
   Explanation Because a project done in a matrix organization involves people from across the organization, communications are more complex.

5. **Answer** B
   Explanation In a functional organization, the team members report to the functional manager. The project manager probably reports to the functional manager as well.

6. **Answer** D
   Explanation A hybrid approach to project management uses both predictive and agile approaches, but that doesn't mean both approaches are used in every iteration. It also doesn't mean that upfront planning is done predictively while implementation is done in an agile way. Although it's possible that every part of the project will use either agile or hybrid practices, a hybrid of the two approaches may be used instead. There is no set definition of how to do a "hybrid" project. Each hybrid project must be customized based on the needs of the project and the organization.

7. **Answer** A
   Explanation The project coordinator reports to a higher-level manager and has authority to make some decisions. The project expediter has no authority to make decisions.

8. **Answer** D
   Explanation "It repeats itself every month" implies that the whole project repeats every month. Generally, the only things that might repeat in a project are some activities. The whole project does not repeat. This is more likely a characteristic of ongoing business operations.

9. **Answer** A
   Explanation Organizational project management (OPM) provides a framework and direction for how projects, programs, portfolios, and organizational work should be done to meet the organization's strategic goals.

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10. **Answer** C
Explanation "Scope, schedule, cost, quality, risk, resources, and customer satisfaction" is the most accurate list of constraints, or competing demands, that a project manager must deal with.

11. **Answer** A
Explanation It is the project manager's responsibility to ensure that compliance requirements are met. In this scenario, that will mean finding the appropriate person to complete the form and ensure that it is submitted on time. The person who completes this form must have the necessary expertise, and based on the information provided, we can't tell who that would be. We don't know whether the project manager, business analyst, or PMO have enough knowledge of the security requirements to complete the form. We can only say that the project manager needs to determine who is best qualified to fill out the form, and ensure that it is filled out accurately and submitted on time

12. **Answer** D
Explanation The scenario says that the business goal is enhanced customer experience as measured by feedback surveys, not revenue enhancement. Therefore, comparing pre- and post-project revenue won't measure the value delivered. Also, it won't be helpful to divide the expected improvement by the number of releases, since each release will include different features. Assessing the results after all the releases are done will not measure the value being delivered incrementally throughout the project. So the best option is to review the metrics against predefined targets (documented in the quality management plan) after each release. This allows you to monitor value delivery throughout the project.

13. **Answer** C
Explanation The scope management plan and the WBS focus on project scope. The communications management plan addresses who will be communicated with, when, and in what format. The only choice that addresses gathering, integrating, and disseminating information is the PMIS.

14. **Answer** B
Explanation There are many things the project manager could do. Asking the other project manager for assistance is not the best choice, as the other project manager might not be an experienced mentor. Her advice might not be adequate to help this project manager. Waiting to assess the impact on the project is reactive; a project manager should be proactive. Gaining agreement of all the stakeholders on the project scope is also not the best choice. It would be helpful, but does not specifically address the issue in this situation. By contacting the PMO, the project manager can access the knowledge of many project managers, historical information from many projects, and the assistance of someone whose job it is to help.

15. **Answer** B
Explanation Connecting the project to the sponsor's objectives might be a good idea, but it does not address the issue of obtaining support throughout the performing organization. Neither ensuring there is a communications management plan nor confirming that the management plan includes the management of team members directly addresses the need to obtain support for the project. Correlating the need for the project to the organization's strategic plan is the best way to gain support for the project.

16. **Answer** C
Explanation Because orders are numerous and of short duration, this situation is a recurring process, not a project.

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17. **Answer** B
Explanation Manufacturing a product is an ongoing process; it is operational work, not project work. Therefore, the manufacturing team would have no reason to create a project charter and would have difficulty doing so if they tried because of the ongoing nature of the work. If the question referred to a team developing a new product, however, that would qualify as a project.

18. **Answer** C
Explanation Because the question talks about priorities between projects, this cannot be the role of the project manager, the project management team, or the project team. Determining priorities between projects is a role of the PMO.

19. **Answer** C
Explanation A project is a temporary endeavor with a beginning and an end, a program is a group of related projects, and a portfolio is a group of projects and programs related to a specific strategic organizational objective. Remember to use the process of elimination, ruling out any answer that is not completely correct.

20. **Answer** D
Explanation The best answer is stakeholders, as their input is critical for collecting all the lessons learned on each project. The term "stakeholders" includes all the groups mentioned in the other answer options.

21. **Answer** C
Explanation Remember, the internal rate of return is similar to the interest rate you get from the bank. The higher the rate, the better the return.

22. **Answer** C
Explanation Remember the definition of a project: temporary and unique. Operations and maintenance are considered ongoing activities, not temporary. Therefore, such work is not considered a project or part of a project.

23. **Answer** B
Explanation Did you select "a group of unrelated projects managed in a coordinated way"? If so, you missed the word "unrelated." Programs are groups of related projects.

24. **Answer** B
Explanation Lessons learned help to avoid future pitfalls and use the good ideas of past projects. This leads to improvements in future projects. The organization benefits from creating a lessons learned repository.

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Processes and Domains

THREE

In this chapter, we will discuss project development life cycles, which are important to any development approach: predictive, agile, or hybrid. We will also discuss the project management process from the viewpoint of the following five process groups: initiating, planning, executing, monitoring and controlling, and closing. We'll also discuss the domains within which projects occur: People, Process, and Business Environment. It is important to know that although the exam is reported to be based solely on PMI's *Examination Content Outline* (ECO), the five process groups continue to be foundational to project management work, and understanding them is critical to passing the exam.

QUICKTEST

- What is done during each of the project management process groups
  - Initiating
  - Planning
  - Executing
  - Monitoring and controlling
  - Closing
- ECO Domains
  - People
  - Process
  - Business Environment
- What you should do during each of the project management process groups
- What is a project life cycle
- What is a development life cycle
- Plan-driven
- Change-driven

The Project Life Cycle[1] PAGE 19*

The project life cycle is how you organize doing the work of the project, and the project management process is how you organize managing that work. Both are necessary to complete a project. This section will cover both concepts.

The Life Cycle and Development Approach A life cycle is a progression through a series of developmental stages. The project development life cycle[2] reflects the performing organization's methodology for managing a project. It is a logical breakdown of what you need to do to produce the project deliverables, and is selected based on factors such as the type of product being developed, the industry, the organization's preferences, and the development approach.

A project life cycle can use a plan-driven or change-driven development approach, or a hybrid of the two. There are generally one or more phases, although the term "phases" will be qualified later in reference to change-driven projects. An example of a life cycle for new product development might include the following phases: research, design, build, test, and implement.

Plan-Driven Project Life Cycle Plan-driven projects have predictive development (also referred to as traditional, predictive, or waterfall) life cycles that require scope, schedule, and cost to be determined in detail early in the life of a project—before the work begins to produce the project deliverables. For example, a construction project would typically be managed using a predictive life cycle.

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Change-Driven Project Life Cycle Change-driven projects use iterative and incremental (also referred to as agile or adaptive) development life cycles, and have varying levels of early planning for scope, schedule, and cost. Incremental and iterative life cycles involve early planning of high-level scope sufficient enough to allow for preliminary estimates of time and cost; scope is developed a little more with each iteration.

An incremental development life cycle delivers a complete, usable portion of the product for each iteration. For example, a project to build a website using an incremental life cycle would involve prioritizing requirements into iterations that deliver a fully functioning portion of the website at the end of each iteration.

With an iterative development life cycle, the complete concept is built in successive levels of detail to create the end result. To build the website mentioned in the previous paragraph using an iterative life cycle, planning for the first iteration would focus on planning to create a prototype of the entire website. After the basic skeleton of the site is built, each successive iteration would be planned to add more detail until a complete and fully functioning site is achieved.

Adaptive development life cycles involve a fixed schedule as well as fixed costs. Scope is broadly defined with the understanding that it will be refined throughout the life of the project. The customer's requirements are documented and prioritized in a backlog, which can be adjusted as the project progresses. Work is planned in short increments to allow the customer to change and reprioritize requirements within the time and cost constraints. A new software development project may follow an adaptive approach, using stages that might include high-level feasibility, design, and planning followed by short, iterative stages of detailed design, coding, testing, and release.

Hybrid Development Approach A hybrid life cycle is a combination of a predictive and an adaptive development approach. With such an approach, a predictive life cycle is used to manage the project requirements that are well defined, while an adaptive life cycle is used to manage the requirements that are less clear.

TRICKS OF THE TRADE Think in terms of tailoring the processes and tools discussed in this book based on the nature of the project, the characteristics of the organization, industry, type of product and other factors, including development life cycles. It's important to think in terms of a plan-driven project life cycle for the exam, but you will have to understand how change-driven projects occur as well. Remember that many of the same processes and tools and techniques can be used on projects using various development life cycles.

Project Management Process Groups

There are a number of ways to successfully manage a project, as long as it is managed with the disciplined application of good practices. Using and tailoring project management processes is connected to managing a project based on project constraints, the business environment, and the chosen development life cycle.

Understanding the relationship of the business environment to your project is connected to why your project was selected and the value it promises if succefully completed. Project constraints are what limitations you have on a project in terms of scope, schedule, cost, quality, resources, risk, and customer satisfaction.

For the exam, you need to understand project management from two different but corresponding viewpoints. The overall project management process can be managed through the structure of the five process groups: Initiating, Planning, Executing, Monitoring and Controlling, and Closing. The other structural viewpoint is the three domains: People, Process, and Business Environment (described later in this chapter).

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The overall process of project management may include managing a project using five process groups. These process groups are presented in Figures 3.1 through 3.5. Figure 3.1 shows how the project management process groups interact.

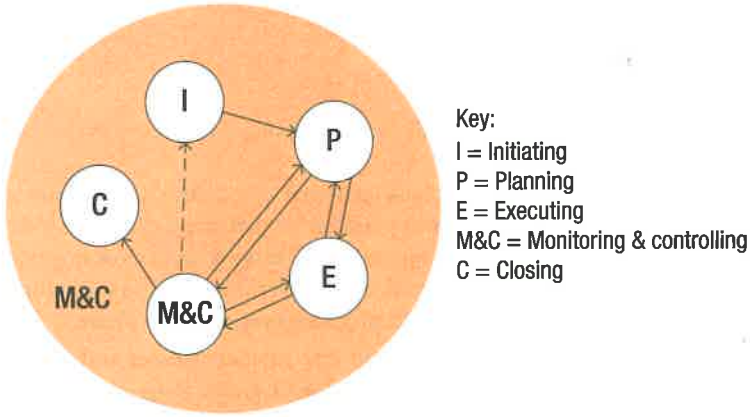

FIGURE 3.1 *Project management process*

The overall process of project management interacts with the project life cycle. For small projects following a plan-driven (or predictive) life cycle, you may go through the overall project management process (initiating through closing) once for the entire project, although portions of the process may be iterated or repeated throughout the project life cycle as shown in figure 3.2.

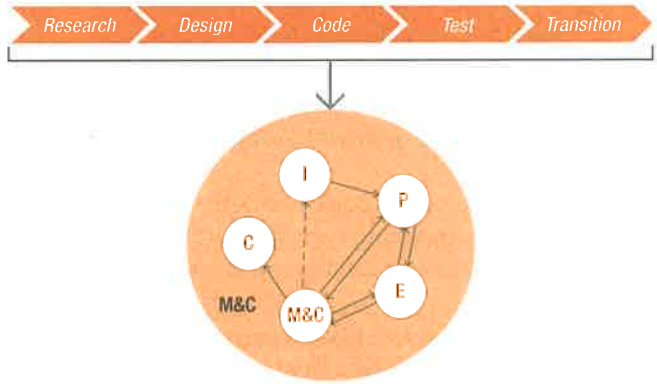

FIGURE 3.2 *Small project with a predictive life cycle*

Large projects often require each life cycle phase to be managed through the project management process groups. The example illustrated in figure 3.3 is for a large construction project. In this project, the development life cycle phases of feasibility, planning, design, production, turnover, and start-up are all extensive, requiring separate planning and management of each phase. This means there would be an overall initiating effort in which the project manager would help create a charter and do high-level planning for the entire project to get charter approval. Then, a separate initiating process for the feasibility phase would take place, followed by a planning effort for that phase, the execution and control of that work, and, finally, a closeout of the phase, which typically includes a handoff of deliverables – in this case, the results of the feasibility analysis. This would then be repeated for each life cycle phase.

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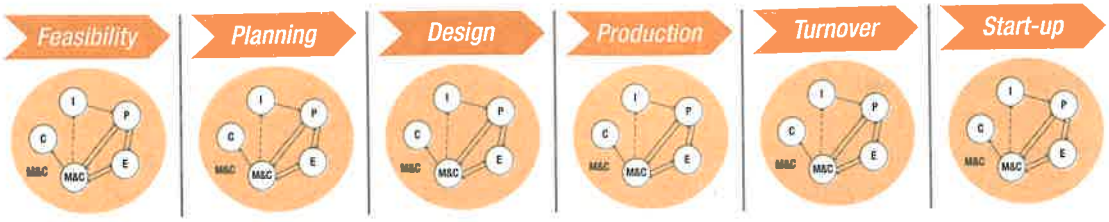

FIGURE 3.3 *Large project with a predictive life cycle with phase gates (indicated by the vertical bars)*

At the end of each phase, an event called a phase gate[3] may take place. A phase gate involves analyzing the results of the completed phase against what was planned for that phase. Based on that analysis, options may include redoing the same phase, moving forward with the next phase, or choosing not to continue with the project. If the decision is made to move forward, the project would begin initiating work on the next phase and progress through the project management process groups for that phase.

Projects may also be broken into phases and then into smaller releases and iterations within those phases. The project management processes of initiating, planning, executing, monitoring and controlling, and closing are done for each phase. The level of detail and the time spent on each process group may vary, but the entire project management process is typically followed, as indicated in figure 3.4, which depicts the traditional process groups with an adaptive life cycle.

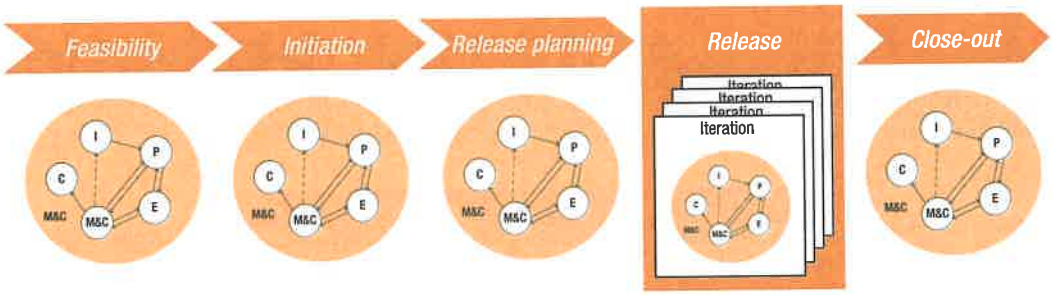

FIGURE 3.4 *Large project with an adaptive life cycle*

It's important to know that agile approaches don't include the use of the term "phase" as the traditional "phase gate" approach is different from an adaptive environment in which iterations tend to be short in nature and include retrospectives. Also be aware that the overall process is usually more flexible and evolves throughout the life of a project.

This may all seem somewhat complicated. Don't worry! For the exam, understand that there is a project life cycle and a project management process. Read exam questions carefully to determine whether the project life cycle or project management process is being discussed.

Some people think they need to understand a variety of industries to pass this exam. Although some questions may refer to specific types of projects and industries (for example, "You are building a bridge" or "You are creating a new system for your company"), that is background information. The exam will not ask you to select the "correct" project life cycle for a specific type of project, nor will it ask how to do work on an IT, construction, or engineering project. The questions are general and can be answered without an understanding of the industry—if you know project management.

You may, however, see questions that require you to understand how the project life cycle (plan-driven, change-driven, or hybrid) is being used in a given scenario. The process groups do not change, although there are variations in the level of attention and formality given to each, depending on the life cycle.

The illustration that appeared in figure 3.1 is shown again here in figure 3.5 for your reference as you read the rest of this section and think about the project management process in terms of the process groups.

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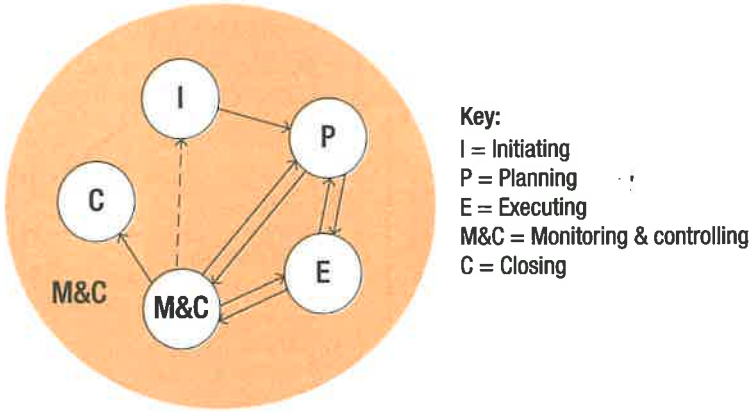

FIGURE 3.5 *Project management process*

Take time to fully understand Figure 3.5 before continuing. Consider the following hints and trick:

- Arrows moving clockwise from initiating indicate the process moving generally in order from initiating through planning, executing, monitoring and controlling, and closing.
- Double arrows between the planning, executing, and controlling process groups illustrate that you often move back and forth between them depending on events taking place. New information that becomes available while executing could bring you back into planning. For example, while a process like Integrated Change Control (ICC) is a controlling process it addresses change requests made during executing. You return to executing upon its completion to carry out approved changes and to communicate ICC results.
- The single dotted arrow returning from monitoring and controlling to initiating indicates that, under certain limited circumstances, you may enter initiating once you leave it (see figure 3.6).
- Have you noticed the shaded circle labeled M&C enclosing the rest of the figure? Monitoring and Controlling is being carried out from start to finish on the project. Work in all other process groups takes place in the context of ongoing monitoring and controlling. This is an important concept to remember for the exam.

TRICKS OF THE TRADE One of the most important aspects of understanding the project management process groups is that while they are mainly classified as going in sequence, in reality there is a lot of overlap between the process groups at any given time. It is true that project management may occur in a certain order, but at the same time project management is very dynamic, which means that managing a project is not linear.

Figure 3.6 illustrates the reasons for entering project initiating. Figure 3.7 shows the reasons for entering project planning.

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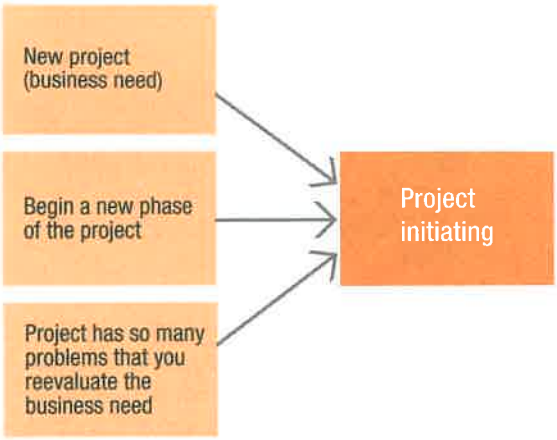

FIGURE 3.6 *Reasons for entering project initiating*

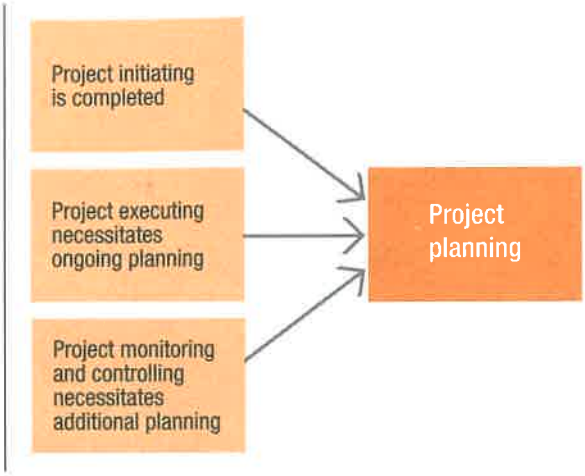

FIGURE 3.7 *Reasons for entering project planning*

Figure 3.8 illustrates the reasons for entering project executing. Figure 3.9 illustrates the reasons a project may enter the closing process group.

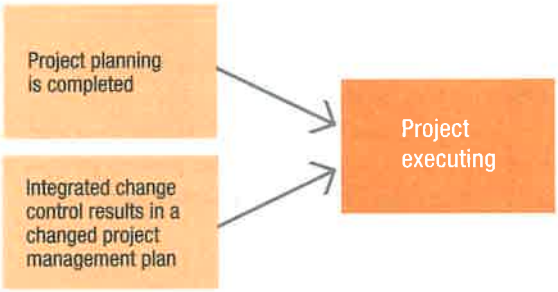

FIGURE 3.8 *Reasons for entering project executing*

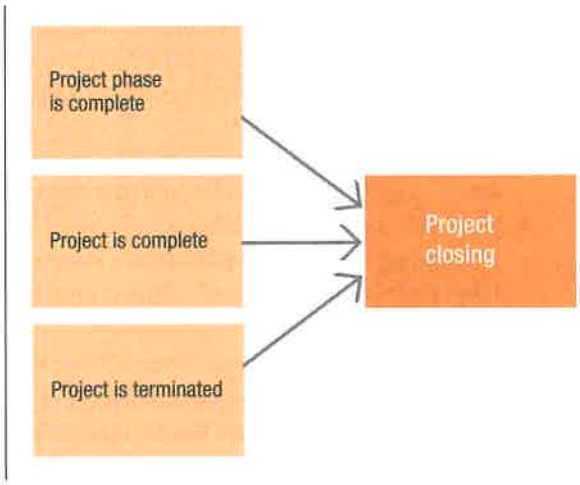

FIGURE 3.9 *Reasons for entering project closing*

The traditional approach to execution is to "go do the items identified in the project plan" and update the baseline if changes occur. These changes may be necessary due to changes in activity durations and resource productivity or availability based on unanticipated risks and issues. There is an assumption that to a certain extent planned activities are fully understood prior to starting work and are completed according to the plan.

Agile methods employ a more dynamic execution approach in which additional efforts may be made to replan some or all of a project. This is due to the complex nature of some projects that may require a lot of change. This could occur because of a technical uncertainty or a change within a requirement, for example. It is assumed that all aspects of work are not known in advance and learning with adaptation will be necessary to complete these tasks.

Execution on an agile project occurs through multiple iterations. Each iteration is a short and focused time period to undertake work followed by an interation review (including a product demo with the customer) and a team retrospective. The retrospective allows any issues with execution or scope changes to

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be discussed in a timely fashion. It also acts as a review point to check progress against the plan and determine if any changes to the project execution process, scope, or schedule are necessary.

Figure 3.10 illustrates key project outcomes that trigger a focus on monitoring and controlling. It also shows that you might go from monitoring and controlling to other process groups depending on the needs of the project.

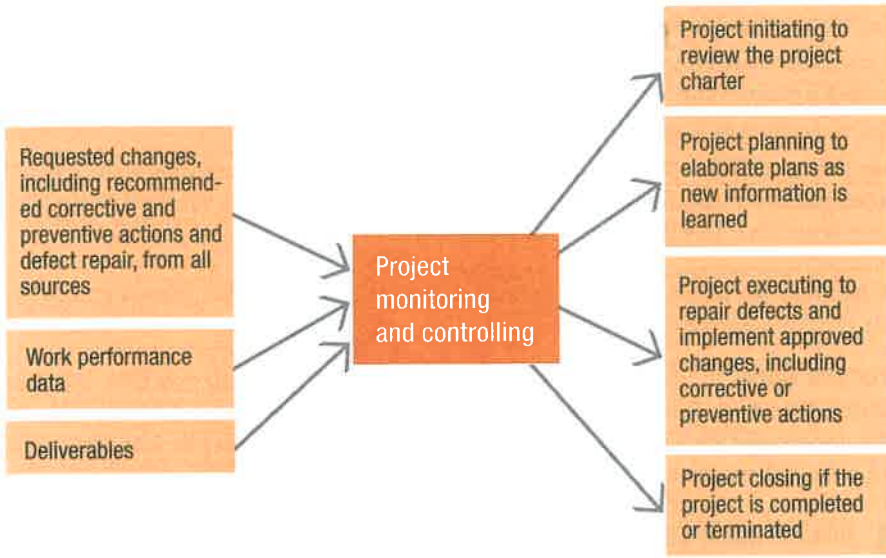

FIGURE 3.10 *Key outputs that trigger project monitoring and controlling, and potential next steps*

Test takers often find project monitoring and controlling to be particularly challenging on the exam. One reason for this is that you are expected to know how to observe, measure, evaluate, and analyze a project in a more complete and systematic way than many project managers have experience with.

Monitoring and controlling applies to change-driven and plan-driven projects, but it is useful to think in terms of plan-driven projects to understand the work of this process group and to answer questions on the exam. High-change environments often handle evaluating and approving project changes differently through the product owner role. By putting the product owner in charge of the backlog, agile approaches delegate the authority for local decision making to this embedded team member to streamline the process.

The overall view of Monitoring and Controlling within the five process groups is similar to a thermostat model. Once the plan is made, measurements are used to determine if adjustments during execution are necessary when feedback indicates acceptable tolerances have been exceeded. Agile approaches use different techniques for monitoring, with more demos and feedback rather than tests to specification. These demos and business discussions are more subjective, but eventual success is often a subjective measure.

In addition to the thermostat model of feedback, experimentation and learning are a key part of the process for change-driven projects. The iteration review and the retrospective that follow an agile iteration are visible components of an experimentation and learning model in play. Iterations can be created to try new technology or test new process changes in addition to building new functionality. These short cycles provide important feedback on what is working and what needs further tuning.

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TRICKS OF THE TRADE

For the exam, assume you are using a plan-driven approach:

- You have a formal project management plan that is realistic and complete to the level appropriate for the type of project.
- You have plans already in place for how and when you will measure schedule, cost, and scope performance against the performance measurement baseline.
- You are accountable for meeting the performance measurement baseline.
- You also measure against the other metrics included in the project management plan to see how the project is performing.
- You take action to correct any variances that warrant action.
- Any deviations from the plan should be made up, rather than requesting a change to the project to accommodate them. Submitting a change request should be the very last resort and only used if there is no other way to make up the deviation.

Now let's look at the project management process within these five process groups in more detail, using Rita's Process Chart™.

Rita's Process Chart™ Since the first edition of this book, people all over the world have used Rita's Process Chart™ as a trick to learn the project management process in more detail, quickly and effectively. It helps you understand what should be done when. This chart was created by Rita Mulcahy and is unique to RMC's books and products.

TRICKS OF THE TRADE

Rita's Process Chart™ Understanding the overall process of project management is integral to learning the terms and concepts presented throughout this book and for passing the exam. Because it can seem like a lot to absorb and comprehend, this chapter and the remaining chapters, along with the Tricks of the Trade that we've included, will help you gain the knowledge you need to fully grasp the material included in this book.

Rita's Process Chart™ is not intended to map to other project management resources; instead, its function is to state, simply and directly, the efforts that are involved in managing a project. Understanding these efforts will provide the project management context you need for the exam.

How to Use Rita's Process Chart™ As you review Rita's Process Chart™, make sure you:

- Understand the overall project management process (a PMI-ism).
- Find terms you do not know, and learn what they are by looking them up in this book.
- Know why each item is in the column (process group) it falls into.
- Understand the project management process groups of initiating through closing, including when each effort should be done on projects. The exam asks questions that present a situation and require you to know which process group the project is in.
- Are able to replicate the specific order of the planning activities by understanding what happens when, how previous work supports what comes next, and why; knowing Rita's Planning column in this order can help you get a large number of questions right on the exam because the exam often asks what should be done next. The work in the other process groups does not have a set order. Use Rita's Process Chart™ Game (discussed later in this chapter) for this.
- Understand that project planning is an iterative process. Consider how you might go back and redo (iterate) some of the items in the Planning column to refine the plan for a large project. Or think about how rolling wave planning would be used on a large project to refine and detail plans for each phase as you move through the life cycle of a project.
- Complete Rita's Process Chart™ Game at least three times. Going through the game will solidify your understanding of the overall project management process and help you find gaps in your knowledge. Focus your study on those gap areas so you understand the processes before taking the exam.

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INITIATING

- Select project manager
- Determine company culture and existing systems
- Collect processes, procedures, and historical information
- Divide large projects into phases or smaller projects
- Understand business case and benefits management plan
- Uncover initial requirements, assumptions, risks, constraints, and existing agreements
- Assess project and product feasibility within the given constraints
- Create measurable objectives and success criteria
- Develop project charter
- Identify stakeholders and determine their expectations, interest, influence, and impact
- Request changes
- Develop assumption log
- Develop stakeholder register

PLANNING
(This is the only process group with a set order.)

- Determine development approach, life cycle, and how you will plan for each knowledge area
- Define and prioritize requirements
- Create project scope statement
- Assess what to purchase and create procurement documents
- Determine planning team
- Create WBS and WBS dictionary
- Create activity list
- Create network diagram
- Estimate resource requirements
- Estimate activity durations and costs
- Determine critical path
- Develop schedule
- Develop budget
- Determine quality standards, processes, and metrics
- Determine team charter and all roles and responsibilities
- Plan communications and stakeholder engagement
- Perform risk identification, qualitative and quantitative risk analysis, and risk response planning
- Go back—iterations
- Finalize procurement strategy and documents
- Create change and configuration management plans
- Finalize all management plans
- Develop realistic and sufficient project management plan and baselines
- Gain formal approval of the plan
- Hold kickoff meeting
- Request changes

EXECUTING

- Execute work according to the project management plan
- Produce product deliverables (product scope)
- Gather work performance data
- Request changes
- Implement only approved changes
- Continuously improve; perform progressive elaboration
- Follow processes
- Determine whether quality plan and processes are correct and effective
- Perform quality audits and issue quality reports
- Acquire final team and physical resources
- Manage people
- Evaluate team and individual performance; provide training
- Hold team-building activities
- Give recognition and rewards
- Use issue logs
- Facilitate conflict resolution
- Release resources as work is completed
- Send and receive information, and solicit feedback
- Report on project performance
- Facilitate stakeholder engagement and manage expectations
- Hold meetings
- Evaluate sellers; negotiate and contract with sellers
- Use and share project knowledge
- Execute contingency plans
- Update project management plan and project documents

MONITORING & CONTROLLING

- Take action to monitor and control the project
- Measure performance against performance measurement baseline
- Measure performance against other metrics in the project management plan
- Analyze and evaluate data and performance
- Determine if variances warrant a corrective action or other change request(s)
- Influence factors that cause change
- Request changes
- Perform integrated change control
- Approve or reject changes
- Update project management plan and project documents
- Inform stakeholders of all change request results
- Monitor stakeholder engagement
- Confirm configuration compliance
- Create forecasts
- Gain customer's acceptance of interim deliverables
- Perform quality control
- Perform risk reviews, reassessments, and audits
- Manage reserves
- Manage, evaluate, and close procurements
- Evaluate use of physical resources

CLOSING

- Confirm work is done to requirements
- Complete final procurement closure
- Gain final acceptance of product
- Complete financial closure
- Hand off completed product
- Solicit customer's feedback about the project
- Complete final performance reporting
- Index and archive records
- Gather final lessons learned and update knowledge bases

Rita's Process Chart™
Where are we in the project management process?

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Notes on the Chart

Initiating

- Do you remember the project selection process from the "Framework" chapter? Do you know why your project was selected? Does it matter? It will influence how the project is planned, what kinds of changes are allowed, and how the project scope is defined. The business case and the benefits management plan are inputs to developing the charter. (See the "Develop Project Charter" discussion in the "Integration" chapter for more about the importance of project business documents.)
- Notice the phrase "Understand business case and benefits management plan." This could be read as "Understand the reason the project is being done and what benefits the organization expects to gain as a result of it." These business documents will guide all project management activities to ensure the project is worth the investment and that it will return the expected benefits to the organization. This is a major concept on the exam that many project managers miss.
- As the project manager, you should understand why your project was selected and what benefits it is expected to deliver. Is the project being done so the organization can enter a new market? Is it intended to meet a regulatory requirement? Is it the result of a customer request? Is it just a priority project for a company executive? Is it expected to dramatically improve the future of the company? If you lose sight of the objectives, the project may finish on schedule and on budget but still fail because it does not achieve those objectives or does not deliver the expected benefits.
- Team building, risk identification, stakeholder identification, risk response planning, and many other activities primarily occur in the process groups in which they are placed on the chart, but these activities can start in initiating and continue until closing.
- Identifying and analyzing stakeholders help to align their expectations about the project and assess their potential involvement and influence on the project.
- The project manager determines whether the project objectives can be achieved and if it is likely to be completed within the given constraints. High-level planning is summarized in a project charter, which documents high-level estimates, measurable objectives, success criteria, milestones, and an initial budget. Initial planning may also include creating a high-level WBS and doing high-level risk identification.
- The charter, once formally approved by the sponsor, gives the project manager the authority to continue the project beyond initiating. It also provides a guiding vision of the project's business case and benefits management plan (the project's reason for being), and the organization's strategic objectives.
- Besides an approved charter, an outcome of initiating is the stakeholder register.

Planning

- After the project charter has been approved, detailed planning begins. In the Planning column, note the first box: "Determine development approach, life cycle, and how you will plan for each knowledge area." Each knowledge area (scope, schedule, cost, etc.) requires management plans as well as additional plans for configuration, change, and requirements management. The first thing you need to do as you start planning is figure out how you are going to plan, execute, and control for each knowledge area. This will guide the rest of your planning efforts.
- The project manager and team perform a more detailed analysis of whether the objectives in the project charter and the expected business benefits can be achieved. They determine what processes are appropriate for the needs of the project and tailor processes to those needs.
- Notice the phrase "Determine team charter and all roles and responsibilities." Determining roles and responsibilities involves determining who is going to do which product-related work activities but also who will provide reports, attend meetings, help with risk identification, work with the quality department, etc. All roles and responsibilities should be defined. They may be documented as part of the resource management plan, in project job descriptions, and in the management plans for each

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knowledge area. This item also includes developing a responsibility assignment matrix and a rewards and recognition system.

- Some projects may be organized by phases where detailed planning for the next phase is started as the previous phase nears completion. In adaptive planning only the first part of the project may be fully planned, while the later portions are planned at a high level and then progressively elaborated when more is known about the project.
- Remember when we said project management seems linear but is more dynamic? The Planning column has a reminder that planning is the only process group with a set order. However, a planning process may require an input that won't be available yet. The risk register, for example, is an input to several processes leading to the creation of the schedule. Initial risks are uncovered during initiating, so although the risk register will by no means be complete by the time you're creating the schedule, known risks can be factored into your planning. Then, after performing risk management activities, you'll have a more complete risk register that you can use to refine your schedule.
- Look at the phrase "Go back—iterations." This is an important concept. Planning is iterative. When planning a project, the project manager and the team complete each item listed above this point to the best of their ability. But even a plan-driven project will evolve as the project progresses and earlier planning work will need to be modified. For example, it is only after completing the risk management planning efforts that the WBS and the other items can be finalized. A risk response strategy may be used to avoid a portion or all of a threat (see the "Risk" chapter). This will require adjusting the WBS for added scope, the network diagram to determine the order of the work, the budget for added cost, and so on. The project manager might also work with discretionary dependencies to change the network diagram and thereby decrease some risk (see the "Schedule" chapter).
- Notice the term "procurement strategy and documents" in the Planning column. Note also the placement of "Finalize procurement strategy and documents" after "Go back—iterations." The risk management process may generate risk response strategies involving contracts; through iterations the procurement documents can be created, refined, and finalized.
- The important thing to remember is that planning should lead to a realistic, bought-into, approved, and formal project management plan that is updated throughout the project to reflect approved changes. Iterations help you create and maintain such a plan.
- The distinction between predictive and adaptive approaches is worth thinking about here. The *PMBOK® Guide* planning processes describes all the traditional activities performed to define the total scope, objectives, and course of action for a project. It assumes that with sufficient analysis these are knowable, and development is then largely the execution of this course of action. Progressive elaboration and rolling wave planning are effective mechanisms to tune plans to emerging details, and they act as accepted extensions to generally detailed initial planning.
- The process of continually refining estimates and scope definition is called progressive elaboration.[4] Although the project management plan is finalized in planning, items such as detailed estimates and project scope and product scope descriptions may be clarified as the work is being done during the executing and monitoring and controlling processes.
- The technique of rolling wave planning[5] is a form of progressive elaboration. The earliest parts of the project are planned in sufficient detail for work to begin. Later phases of project work are planned at a high level. As the project progresses, and more information impacting the work becomes available, plans are elaborated in sufficient detail to accomplish the work.

Adaptive approaches to planning are deliberately more incremental and recommend a process that iterates to discover and refine scope. Rolling wave planning and progressive elaboration, for example, can be made to exist within the traditional framework of project management. This approach makes agile concepts a more central theme rather than a supporting process.

When describing an agile project in a traditional environment it is important to explain that initial plans will be deliberately light and progressively enriched as early iterations clarify understandings and provide additional information. It is also useful to know that planning ownership

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shifts from project manager as primary planner to the team as primary planner. Agile methods encourage shifting much of the planning responsibilities to the team (including business representation), which takes the form of release and iteration planning and backlog prioritization.

- The project management plan and documents (project artifacts) resulting from planning will guide the execution and control of the project. After the plan is iterated and includes the appropriate detail for the project life cycle and development approach, the sponsor approves it.

Executing

- With an approved project management plan, the project moves into executing, where the team completes the work according to the plan. The project manager's focus is on leading and managing the project, including engaging stakeholders, working with the team, following processes, and communicating according to the plan. For the exam, get your mind around the critical difference extensive planning makes. Assume the project was properly planned before work began, unless the question indicates otherwise.
- The purpose of project executing is to complete the project work as defined in the plan, to produce the project deliverables (the product scope) at agreed quality levels, within the project's approved budget and schedule. This achieves the expected business value and agreed-upon benefits.
- Team members can be released at any time once their work is approved and accepted and they have completed activities that pertain to their work. For example, the electricians on a project to build a house may test their work, get acceptance of their work, document lessons learned, suggest process improvements, and turn the work over. They are released while other team members doing drywall are still working. Some team members remain on the project to its end to assist the project manager in creating the final lessons learned, archiving final records, and producing the final report.
- As executing progresses, the project manager may determine that a change is needed. The same could happen while the project manager is monitoring and controlling the work, or in planning as a result of rolling wave planning that occurs after the plan has been approved and work has started. Change requests are evaluated and approved or rejected as part of the Perform Integrated Change Control process (see the "Integration Management" chapter).

Monitoring & Controlling

- Do the project management process groups occur sequentially? No; they overlap. For example, you could be using monitoring and controlling processes to control stakeholder identification, adherence to organizational requirements for project planning, or the creation of baselines and project documents. Defects could be identified in executing that require work in executing to fix them, as well as work in monitoring and controlling to decide if the defects require a change to the plan to prevent future rework and delays. Controlling procurements and the closure of procurements can occur simultaneously on projects because some sellers will complete their contractual obligations to the project while others are still producing deliverables. Look again at Rita's Process Chart™, and think about the overall focus of each process group, but also about how the work can overlap at various points in time.
- While the work is being done, work results (or data) are fed into monitoring and controlling to make sure the project is advancing according to the established baselines. This requires attention to how the project is progressing, evaluating hard data on how the project is conforming to the plan, and taking action to address variances that are outside of acceptable limits. The project manager and team are also assessing how stakeholders are participating, communicating, and feeling about the project and the work, and addressing uncertainties (or risks) that have been identified.
- The project management plan includes monitoring activities, such as observing, communicating, and evaluating. It also specifies control activities to be used on the project, along with a plan for how variations from planned metrics will be addressed.

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- Outcomes of monitoring and controlling include recommending changes to the way the work is being done or possibly requesting adjustments to baselines to reflect more achievable outcomes. Change requests are evaluated in Integrated Change Control to determine their impact on the project, identify the best options for dealing with them, and decide whether they should be approved, rejected, or deferred.
- Approved changes that require adjustments to baselines and other plan elements require replanning before the team starts working (in executing). If the project gets so far off the baselines that it requires an analysis of whether it should continue at all, or if significant changes are suggested that are outside the project charter, it may move back into initiating while that decision is made.
- Make sure you understand the difference between executing and monitoring and controlling actions, because they continually overlap while the work of the project is going on. The focus of executing is leading people, and managing physical resources and work to accomplish the project as planned. The focus of monitoring and controlling is ensuring the project is progressing according to plan and approving necessary changes to the plan to meet the organization's strategic objectives and deliver the expected benefits.

Closing

- The closing effort includes administrative activities such as collecting and finalizing all the documentation needed to complete the project, and technical work to confirm that the final product of the project is acceptable. It will also include any work needed to transfer the completed project to those who will use it and to solicit feedback from the customer about the product and the project.
- While lessons learned should be collected on an ongoing basis on traditional projects, they are finalized at closing. On an agile project lessons learned are collected as the project progresses after every iteration. In both cases they should be put to use right away and after closing be made available to future projects.
- Work on an agile project is prioritized to undertake the highest business value items first, so if the Closing process group is exercised to prematurely close a project or phase on an agile project there is a high chance that some useful business value will already have been generated.
- In many real-world situations, projects never seem to officially finish. Keep in mind that all projects must complete the required closing activities.

TRICKS OF THE TRADE

Rita's Process Chart™ Game Rita's Process Chart™ Game has helped many students solidify their understanding of the overall process of project management. There are two formats you can use to practice this game. One way is to access our online version of Rita's Process Chart™ Game using the following web address: rmcls.com/process-chart-game-v9. As an alternative, you can download a printable version of the game. This version is available on our PMP Exam Prep Resource page: rmcls.com/extras. When practicing Rita's Process Chart™ Game, put each item from Rita's Process Chart™ into the correct process group. When you think the items are sorted into the correct process groups, put the planning efforts in order. Check your answers using Rita's Process Chart™. Play this game at least three times to ensure you understand the efforts involved in the project management processes that are discussed throughout this chapter and book.

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The What-Comes-Before Game Here is another game to help you understand the overall project management process. Playing this game after you have completed Rita's Process Chart™ Game at least three times will help solidify your understanding of these concepts.

3.1 EXERCISE In your Exercise Notebook, name the planning effort that comes before each of the following items on Rita's Process Chart™.

	Planning
1.	Create network diagram
2.	Finalize procurement strategy and documents
3.	Create project scope statement
4.	Create WBS and WBS dictionary
5.	Determine critical path
6.	Develop budget
7.	Estimate activity durations and costs
8.	Gain formal approval of the plan
9.	Hold kickoff meeting
10.	Determine quality standards, processes, and metrics
11.	Assess what to purchase and create procurement documents
12.	Plan communications and stakeholder engagement
13.	Go back—iterations
14.	Determine team charter and all roles and responsibilities
15.	Develop realistic and sufficient project management plan and baselines
16.	Perform risk identification, qualitative and quantitative risk analysis, and risk response planning
17.	Estimate resource requirements
18.	Create activity list

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Answer

	What Comes Before?
1.	Create activity list
2.	Go back—iterations
3.	Define and prioritize requirements
4.	Determine planning team
5.	Estimate activity durations and costs
6.	Develop schedule
7.	Estimate resource requirements
8.	Develop realistic and sufficient project management plan and baselines
9.	Gain formal approval of the plan
10.	Develop budget
11.	Create project scope statement
12.	Determine team charter and all roles and responsibilities
13.	Perform risk identification, qualitative and quantitative risk analysis, and risk response planning
14.	Determine quality standards, processes, and metrics
15.	Finalize all management plans
16.	Plan communications and stakeholder management
17.	Create network diagram
18.	Create WBS and WBS dictionary

Process Group Review For many people, this chapter uncovers the most gaps in their knowledge. We created these exercises based on which gaps are most common. Trust us to help you; carefully follow along and try to complete each of the following exercises. Look for gaps in your knowledge and note your gaps in your Exercise Notebook. Do not simply skip to the answers.

Stay focused while working through the long lists as they contain a lot of information that will help you understand this material for the rest of this book and when answering exam questions. Then spend some time making sure you research each knowledge gap either in this chapter or as you read the rest of the book.

TRICKS OF THE TRADE Remember, many questions on the exam will include common errors in project management. You will be required to know the activities that should be done during each part of the project management process. The only way to check your knowledge is to first determine what your knowledge is and then compare it to what it should be. The following exercises are designed to help you do just that.

3.2 Exercise Initiating Actions What are the specific actions required to complete project initiating? Write the answer in your Exercise Notebook.

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Answer The following table provides a list of the actions involved in project initiating. Since what needs to be done varies based on the specific project, it may not be practical to do all these actions on every project. Note that the items in the list are not in any particular order.

	Actions Involved in Project Initiating
1.	Sponsor(s) selects the project manager.
2.	Sponsor(s) determines the authority of the project manager.
3.	Collect historical information.
4.	Divide large projects into phases. Use project governance rules and apply them to the project.
5.	Identify stakeholders, and determine their influence, expectations, and impact. Document that information in a stakeholder register.
6.	Determine high-level requirements, constraints, assumptions, and risks.
7.	Turn high-level stakeholder needs, wants, and expectations into requirements.
8.	Make sure the business case and the analysis supporting the need for the project are documented and understood.
9.	Use the benefits management plan to understand the benefits that the project is expected to deliver to the business.
10.	Ensure the high-level product scope is documented with as much detail as is practical.
11.	Understand how the project supports the organization's strategic objectives.
12.	Collect and use any relevant, existing agreements (including contracts) that might be generating the project or that will be required during the project.
13.	Determine success criteria and measurable project and product objectives.
14.	Facilitate the resolution of conflicting objectives.
15.	Become familiar with the company culture and structure as they relate to the project.
16.	Find existing processes, standards, and compliance requirements that affect the project.
17.	Understand how the organization does business (business knowledge) and what governance, procedures, and policies are already in place to use on the project.
18.	Do planning on a high-level basis.
19.	Perform high-level estimating for the project schedule and budget.
20.	Use the high-level planning and estimating data to determine whether the project objectives can be achieved within the given constraints and whether the expected benefits can be realized.
21.	Determine what form the project charter will take, including its level of detail.
22.	Coordinate project initiating efforts with stakeholders, including the customer.
23.	Work with the customer and others to determine high-level acceptance criteria and clarify what is and is not in the project.
24.	Determine the initial project organization.
25.	Identify any inherent or required milestones on the project.
26.	Finalize the project charter.
27.	Obtain formal approval of the project charter.
28.	Define the exit criteria for the project (when and why the project or phase should be closed).

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	Actions Involved in Project Initiating
29.	Involve subject matter experts in developing the project charter and identifying stakeholders.
30.	Develop project documents such as the risk register, the stakeholder register, and the assumption log, including data on identified risks and stakeholders.
31.	Use stakeholder mapping to analyze data on identified stakeholders to understand their power, interest, and influence.

3.3 Exercise Planning Actions What are the specific actions to complete during planning? Write the answer in your Exercise Notebook.

Answer Although all the following actions are done during project planning, the level of detail to which each action is performed will vary based on the particular project and approach.

	Actions Involved in Project Planning
1.	Determine how you will plan the planning, executing, and monitoring and controlling efforts for stakeholders, requirements, scope, schedule, cost, quality, resources, communications, risk, procurement, changes, and configuration, and put that information into the beginnings of management plans.
2.	Refine the high-level requirements from project initiating so they are more specific and detailed, and look for additional requirements, being sure to consider any internal or external analysis, reports, or regulations; analyze and prioritize requirements.
3.	Expand on the assumptions identified in project initiating, looking for new assumptions and documenting the details of the assumptions.
4.	Refine the high-level constraints (such as resources, schedule, and cost) from project initiating so they are more specific and detailed.
5.	Create a description of the project deliverables, the work required to complete those deliverables, and their acceptance criteria (project scope statement).
6.	Use the project scope statement to gain approval of the "final" scope from stakeholders before further planning is done.
7.	Assess what may need to be purchased on the project. Identify any pieces of work that may be outside the organization's abilities to complete, and determine if new equipment or technology is needed to perform the project work.
8.	Select the procurement strategy for each contract. Create a draft of the procurement documents for necessary contracts, including bid documents, procurement statements of work, source selection criteria, and contract provisions.
9.	Determine what subject matter experts you will need on the project team to help with project planning.
10.	Engage a business representative as a product owner.
11.	Break down the deliverables into smaller, more manageable pieces into a WBS (Work Breakdown Structure) (or for agile, create a product backlog).
12.	Create descriptions of each WBS entity in a WBS dictionary so that the work can be understood and produced without gold plating.
13.	Break down the work packages from the WBS into lists of activities to produce them.

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	Actions Involved in Project Planning
14.	Sequence activities and determine predecessors and successors in the network diagram.
15.	Estimate resource requirements (such as staff, facilities, equipment, and materials).
16.	Meet with managers to gain resource commitments.
17.	Decide what level of accuracy is needed for estimates.
18.	Use historical data to support estimating time and cost.
19.	Involve experts or those who will work on activities (or stories) to estimate (time and cost).
20.	Determine how long the project will take without compressing the schedule (determine critical path).
21.	Develop a schedule model, evaluate it against the schedule constraint in the project charter, and use schedule compression techniques to reconcile the two to come up with a final schedule for the project management plan.
22.	Develop a preliminary budget and compare it to the budget constraint in the project charter. Then, develop options to reconcile the two to come up with the final budget for the project management plan.
23.	Determine quality policies, practices, and standards, and then determine metrics to measure quality performance.
24.	Determine processes to fulfill quality requirements and conform to organizational standards and policies.
25.	Determine how you will improve the processes in use on the project.
26.	Create a system for recognizing and rewarding the efforts of project team members to help keep them motivated and engaged in project efforts.
27.	Plan for acquisition, team building, training, assessment, and release of team members. Plan for physical resources requirements, including acquisition and logistics.
28.	Clearly determine all roles and responsibilities so team members and stakeholders know their roles on the project and what work they will need to do.
29.	Work with the project team to develop a team charter defining their commitments and interactions with each other, including ground rules for meetings, conflict resolution processes, etc.
30.	Determine what information you need from other projects and what information you will share with the organization and other projects.
31.	Plan what will be communicated on the project; to whom, by whom, when, and how.
32.	Plan how to involve stakeholders and manage their expectations during the project.
33.	Complete detailed risk identification, subjectively analyze risks (qualitative risk analysis), perform quantitative risk analysis as necessary, and do risk response planning.
34.	Iterations—go back and update project plans and documents as necessary to work toward a project management plan that is bought into, approved, realistic, and formal.
35.	Finalize the procurement statement of work and other bid documents for each contract.
36.	Look for potential positive and negative interactions with other projects that could affect the project.
37.	Determine the processes that will be used to request, approve, and manage changes on the project.
38.	Develop the configuration management plan, outlining naming conventions and processes for document versioning, storage, and retrieval.

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	Actions Involved in Project Planning
39.	Plan ways to measure project performance, including determining the measurements to be used, when they will be taken, and how the results will be evaluated.
40.	Determine what meetings, reports, and other activities you will use to control the project to the project management plan.
41.	Finalize the "execute" and "monitor and control" aspects of all management plans. Document closing requirements and actions.
42.	Develop the final project management plan, project documents, and performance measurement baseline by performing schedule network analysis, looking for options, and confirming that project objectives can be met.
43.	Gain formal approval of the project management plan from the sponsor, team, and managers of resources.
44.	Hold a kickoff meeting with key stakeholders, team members, managers of team members, and the customer to make sure everyone is on the same page and to gain buy-in.
45.	Throughout the project, return to the planning processes to do rolling wave planning (progressive elaboration or iteration) as more information becomes available. Results will likely require change requests and updates to the project management plan and project documents.

3.4 Exercise Executing Actions What are the specific actions to complete during executing? Write the answer in your Exercise Notebook.

Answer The following actions are done during project executing. As with project planning, be aware that the level of detail to which each action is performed will vary.

NOTE: This is another long list. Keep focused and think through these actions. Also, be aware that this list is not sequential.

	Actions Involved in Project Executing
1.	Communicate your expectations for stakeholders and the project, and manage the involvement and needs of all stakeholders throughout the project to ensure everyone has a common understanding of the work.
2.	Implement the most up-to-date version of the project management plan, including revisions made as a result of control activities.
3.	Complete work packages.
4.	Collect, document, and share lessons learned.
5.	Establish and manage communication channels.
6.	Evaluate how effectively the team members function as a team.
7.	Implement approved changes, including corrective actions, preventive actions, and defect repair.
8.	Confirm that practices and procedures are being followed and are still appropriate for the project.
9.	Produce and distribute reports on project performance.
10.	Hold team-building activities.

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	Actions Involved in Project Executing
11.	Use the team charter for guidance on team interactions. Follow ground rules at team meetings.
12.	Obtain needed training for team members.
13.	Exchange information about the project according to the plan, and solicit feedback to ensure communication needs are being met.
14.	Remove roadblocks.
15.	Achieve work results that meet requirements.
16.	Meet with managers to reconfirm resource commitments.
17.	Keep managers apprised of when their resources will be needed on the project.
18.	Commit, manage, and release physical and team resources in accordance with the project management plan.
19.	Guide, assist, communicate, lead, negotiate, facilitate, and coach.
20.	Use your technical knowledge.
21.	Hold meetings to identify and address issues, assess risks, and keep the project work moving forward.
22.	Manage stakeholder engagement and expectations, increase project support, and prevent possible problems.
23.	Focus on preventing problems rather than just dealing with them as they arise.
24.	Make sure all team members have the skills, information, and equipment needed to complete their work.
25.	Look for exceptions to the approved project management plan in team members' performance, rather than checking up on every person's work.
26.	Recommend changes to be evaluated in the Perform Integrated Change Control process.
27.	Follow organizational policies, processes, and procedures.
28.	Increase the effectiveness of processes.
29.	Make updates to the project management plan and project documents to reflect current information about the project.
30.	Create recommendations for the performing organization to increase its effectiveness.
31.	Ensure continued agreement from the stakeholders to the project management plan.
32.	Keep everyone focused on completing the project to the project charter and project management plan.
33.	Keep the project's business case and benefits management plan in mind while managing the project, especially when problems occur.
34.	Solve problems.
35.	Determine where project changes are coming from and what you can do to eliminate the root cause of the need for change.
36.	Determine final team members and other resources, and bring them on to the project as needed.
37.	Recognize and reward the team and individuals for their work and performance on the project.
38.	Gather initial measurements and details about activities of project work (work performance data).
39.	Implement approved process improvements.

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Actions Involved in Project Executing
40. Use an issue log to record project issues and details about their resolution, including who is responsible for resolving each issue and the expected timeline.
41. Obtain seller responses to bid documents.
42. Review proposals, bids, and quotes; negotiate contract terms with prospective sellers; and manage the evaluation and selection of sellers.
43. Manage the integration of sellers' work and deliverables into the overall work and deliverables of the project; manage any seller-related conflicts or challenges.
44. Expend and manage project funds.
45. Facilitate conflict resolution using conflict resolution techniques.
46. Assess individual team member performance.
47. Update human resource records of team members to reflect new skills acquired while working on the project.
48. Carry out contingency plans in response to risk triggers.

Notice that "solves problems" is only one of 48 items on the list of actions to be done during executing. As a project manager, you should be focused on preventing problems so you do not have to deal with them. With proper project management, problems occur less often, and should not have a major impact on the project. Assume risk management efforts have identified and evaluated risks, and that contingency plans are in place to deal with risks that have high probability or impact ratings. Instead of handling risk events, you can spend your time engaging stakeholders and encouraging team members.

Did you list meetings? Effective agile teams, for example, have focused daily stand-up meetings to keep the team on track to complete their work for an iteration. The occasions when the team gets together are too important to just focus on collecting status. How about reviewing risk triggers and upcoming contingency plans during meetings?

TRICKS OF THE TRADE

Keep the following in mind as a way to summarize executing activities: work according to the plan; lead, guide, and engage; and remove impediments.

3.5 Exercise Monitoring and Controlling Actions What are the specific actions to complete during monitoring and controlling? Write the answer in your Exercise Notebook.

Answer The following actions are done during monitoring and controlling. If you included actions not listed here, make sure those actions are part of monitoring and controlling.

NOTE: Because this is one of the most challenging process groups on the exam, you should spend considerable time here. Do not lose focus as you read. Take a break in the middle of the list if you need to, and remember this list is not sequential.

Actions Involved in Project Monitoring and Controlling
1. Measure project performance according to the planned measures in the management plans.
2. Measure against the performance measurement baseline.
3. Analyze and evaluate work performance data.
4. Determine variances.

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Actions Involved in Project Monitoring and Controlling
5. Use your judgment to determine what variances are important and if they warrant recommending a change or corrective action.
6. Recommend changes, including defect repair and preventive and corrective actions. Do not just wait for others to recommend them.
7. Make or obtain a decision in integrated change control about whether changes should be approved, rejected, or deferred.
8. Track and evaluate naming conventions, version control processes, the storage and retrieval system (configuration management), and the use of the PMIS. This ensures everyone knows which version of the project or product documentation is the latest version.
9. Control scope, schedule, and cost to their baselines.
10. Perform procurement inspections and reviews of seller performance to the contract.
11. Refine control limits as needed.
12. Identify the root causes of problems with the help of techniques such as process analysis (for example, Lean, Kanban, and Six Sigma).
13. Obtain formal acceptance of interim deliverables from the customer.
14. Identify the need for replanning.
15. Replan and make updates to the project management plan and project documents to reflect approved changes and updates to the project.
16. Evaluate stakeholder relationships and involvement to determine if they require improvement.
17. Manage the schedule and cost reserves.
18. Recalculate how much the project will cost and how long it will take, and create forecasts.
19. Obtain additional funding if needed.
20. Prepare work performance reports from the analyzed data and measurements.
21. Hold periodic quality inspections.
22. Make decisions to accept or reject completed deliverables.
23. Evaluate the effectiveness of implemented corrective actions.
24. Assess the effectiveness of project control systems.
25. Spend time trying to improve quality.
26. Determine if project controls need to be updated.
27. Identify and analyze trends.
28. Evaluate the effectiveness of risk responses in a risk review.
29. Look for newly arising risks.
30. Reanalyze identified risks.
31. Use milestones as a project control tool.
32. Observe and analyze.
33. Use variance reports to help correct small problems before they become serious.
34. Calculate estimate to complete.
35. Use and interpret earned value calculations.
36. Use quality control tools such as inspections, histograms, performance reviews, and cause-and-effect diagrams.

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Actions Involved in Project Monitoring and Controlling	
37.	Influence any factors that could result in the project's change control and configuration management measures being bypassed.
38.	Control changes.
39.	Control to make sure that only approved changes are implemented.
40.	Work with the change control board.
41.	Evaluate stakeholder satisfaction.
42.	Control procurements through actions such as reviewing, approving, and paying invoices, administering claims, and performing inspections and audits.
43.	Validate defect repair.
44.	Determine where project changes are coming from and what you can do to eliminate the root cause of the need for change.
45.	Consider the project's business case and the organization's strategic objectives when analyzing change requests.
46.	Use active listening, inquiry, and data gathering to confirm that communications and stakeholder engagement efforts are effective and working as planned. Make or recommend needed adjustments.
47.	Evaluate the use, cost, and other aspects of physical resources. Make appropriate changes and adjustments.
48.	Close procurements after final deliverables are accepted.
49.	Update the risk report to keep key stakeholders informed about the status of overall project risk and the highest-ranked individual risks.

When a project has been planned appropriately, most control efforts result in information that shows work is being done according to the plan and that scope is being produced to the agreed-upon standards and metrics. Results of measurements and outcomes of other monitoring and controlling efforts are added to the project management plan and project documents as updates. In fact, project artifact updates (to the project management plan and project documents) are outcomes of every monitoring and controlling process. Records of the work, measurements, and lessons learned are used for reference and comparison throughout the life of the project. In addition to identifying variances, measurements can be useful in trend analysis, forecasting, and estimating the remaining work.

Since monitoring and controlling is so challenging, let's look at this another way. We have included the following information by knowledge area (or constraint) to help you develop a better overall understanding of project monitoring and controlling.

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Monitoring and Controlling Activities by Knowledge Area

Control Scope, Control Schedule, and Control Cost	Control Quality
• Measure performance against the performance measurement baseline. • Request changes. • Follow the change management plan. • Influence factors that cause changes. • Control changes and their impacts. • Analyze work performance data and variances. • Update the baseline and other project artifacts (including requirements documentation) with approved changes. • Validate changes to make sure they do not over- or under-correct problems. • Manage reserves. • Use earned value analysis to recalculate estimates at completion and other forecasts. • Document lessons learned.	• Hold inspections. • Ensure deliverables are meeting quality standards. • Influence factors that cause changes. • Request changes or improvements to work and processes. • Make decisions to accept or reject work. • Assess the effectiveness of project quality control systems. • Analyze work performance data and variances. • Update the quality management plan, as well as quality- and process-related documentation. • Validate changes to make sure they do not over- or under-correct problems. • Document lessons learned.
Control Resources	**Monitor Communications**
• Confirm the type and quantity of resources used are consistent with what was planned. • Evaluate the effectiveness of physical resources. • Analyze work performance data and variances. • Request changes. • Validate changes to make sure they do not over- or under-correct problems. • Update the resource management plan, as well as resource-related documentation. • Document lessons learned.	• Ensure information is being communicated to the appropriate people in the right way and at the right time. • Analyze work performance data and variances. • Request changes. • Analyze information about communications to make sure they are meeting stakeholder needs. • Validate changes to make sure they do not over- or under-correct problems. • Document lessons learned.
Monitor Risks	**Control Procurements**
• Reassess risks, planned responses, and reserves. • Identify new risks. • Watch for the occurrence of risk triggers. • Create and implement workarounds. • Perform risk audits to evaluate the effectiveness of risk management processes. Analyze work performance data, work performance reports, and variances. • Request changes.	• Monitor performance to make sure both parties to the contract meet contractual obligations. • Inspect and verify the contract deliverables. • Protect your legal rights. • Follow the defined procurement management procedures, including the contract change control system. • Analyze work performance data, seller work performance reports, and variances.

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Monitor Risks	Control Procurements
• Evaluate the effectiveness of implemented risk response plans. • Document lessons learned.	• Request and manage changes. • Authorize contract-related work. • Issue and review claims. • Maintain comprehensive records. • Report on seller performance compared to contract. • Review invoices and make payments. • Update the project management plan and procurement documentation. • Validate contract changes, control contracts to updated versions, and evaluate effectiveness of changes.
Monitor Stakeholder Engagement	
• Analyze work performance data and variances. • Evaluate stakeholder engagement, stakeholder relationships, and look for opportunities for improvement. • Assess whether stakeholders' expectations are aligned with the project. • Resolve conflicts. • Maintain an issue log. • Request changes. • Update the stakeholder management plan and the stakeholder register. • Validate success of changes to stakeholder engagement strategy. • Document lessons learned.	

3.6 Exercise Closing Actions What are the specific actions required to complete the Close Project or Phase process? Write the answer in your Exercise Notebook.

Answer When the work is done (or the project is terminated), the phase or project moves into closing. Project closing, where the project is finished, is one of the most ignored parts of the project management process. However, if you take time now to understand the concepts from this section, the questions on the exam about closing should be easy.

NOTE: Close Project or Phase is the only process in the Closing process group, but there may be many activities associated with it.

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Actions Involved in Project Closing
1. Confirm that all project requirements have been met.
2. Verify and document that the project, or project phase, meets completion or exit criteria set in place during project planning.
3. Obtain formal (legal) sign-off and final acceptance of the product of the project from the customer.
4. If any issues prevent final acceptance by the customer, negotiate a settlement or other resolution.
5. If the project was terminated before completion, document the reasons for termination and the status of the project and deliverables.
6. Make final payments, and complete cost records.
7. Gather final lessons learned and share with the organization.
8. Update project records.
9. Ensure all the project management processes are complete.
10. Update corporate processes, procedures, and templates based on lessons learned.
11. Complete project (or phase) closure.
12. Analyze and document the success and effectiveness of the project.
13. Create and distribute a final report of project (or phase) performance.
14. Index and archive project records.
15. Evaluate customer satisfaction regarding the project and the deliverables.
16. Hand off the completed project deliverables to the appropriate stakeholders (the customer, operations and maintenance, etc.).
17. Confirm all contracts have been formally closed; update and archive records.
18. Celebrate!

Because many organizations do not require formal closure procedures, let's take a moment to discuss some of the key actions listed in the previous table that many people miss.

Confirming that all the requirements have been met may seem unimportant; however, most studies show that many requirements are not met on projects. This confirmation needs to take place and can be done by reviewing the project management plan and accepted deliverables.

What about handing off the completed project deliverables to operations and maintenance? Work involved in completing such a transfer is considered part of the project. The work could include meetings to explain the project nuances, training, documentation for maintenance, and other activities as needed.

Now let's think about formal sign-off and acceptance. These are important because they confirm that the customer considers the project completed and accepts the whole project. Without that acceptance, you cannot be sure the project was finished.

Measuring customer satisfaction is another important part of project closing. Have you ever had a customer accept your work although they were not happy with the project? Just like lessons learned, measuring customer satisfaction should be ongoing throughout the project, but it must occur during project closing.

In the first chapter of this book, we noted that historical records are a PMI-ism. For the exam, make sure you understand the value of these records and the project manager's and team's responsibility for creating them. Historical information is collected throughout the project, but it is during project closing that the final versions of the lessons learned are compiled and archived in the lessons learned repository.

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Some project managers consider completing the final project performance report and holding an end-of-the-project celebration to be unimportant. However, the final report communicates to all stakeholders and the entire organization benefits achieved by the team members' efforts on the project.

Project Management by Domains

For the exam, you should know the following three domains: People, Process, and Business Environment. These domains and their processes (or tasks) support and are supported by one another. So think about them in terms of an integrated whole. Together they reflect the evolving nature of project management as these domains are more inclusive of all project management approaches, from predictive to change-driven and hybrid. As such, the project management concepts presented within these domains are more open to interpretation than one may find within the traditional five process groups. It's important to know that the knowledge areas are still covered within these domains, but they are not organized in the same way as they occur within the five process groups as listed in the *PMBOK® Guide*.

This does not mean that the order in which a project occurs has changed; it simply means that a project manager can and should apply and adapt their project management approach to fit the needs of any given project. Managing the knowledge areas (many of which are project constraints) is the main focus of the Process domain. People domain tasks and the skills they require relate to and enable the tasks within the Process domain, and contribute to their overall success. The Business Environment domain and its associated tasks relate to the environment in which projects exist. A solid understanding of the Business Environment domain along with the interpersonal and team skills, like those relating to the People domain, support the technical project management skills in the Process domain.

Domain I: People The People domain relates to several tools and techniques along with a unique set of skills that may include the following: leadership, team building, motivation, and conflict management. This domain also relates to the ability to interact with and support the needs of project stakeholders. This can mean from the sponsor to the project team and the performing organization, and from the customer to the larger community in which all stakeholders work together. Stakeholder engagement is as much about managing expectations as it is about meeting them. To build and maintain a shared understanding, you must deliver the overall value of the project within scope while simultaneously managing expectations.

Note that while PMI states that 42% of the exam is based on the People domain, the associated tasks and skills are not only needed for project communications, they are inherent in your work as a project manager. They are also needed in order to carry out the project management processes and successfully navigate the business environment within the context of a project. A project manager needs a unique set of soft skills, abilities, and personal attributes to carry out the tasks within this domain and to support the Process and Business Environment domains. They are covered directly or indirectly throughout this book, but especially in the "Resources," "Communications," and "Stakeholders" chapters. The following list is a good representation of the skills, abilities, and attributes needed to manage a project:

- Active listening
- Adaptive leadership
- Coaching and mentoring
- Collaboration
- Conflict resolution
- Emotional intelligence
- Facilitation
- Negotiation
- Participatory decision making
- Personal integrity and trust building
- Rewards and recognition systems
- Team and individual performance evaluation
- Team building and development
- Understanding of motivation

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3.7 Exercise For each scenario list three skills (from the previous list) based on the activity given. Write the answer in your Exercise Notebook (an answer is provided for the first scenario as an example).

NOTE: There are often many skills that apply to any given scenario, so your responses may be different but still correct, based on the needs of the project.

Scenario	Activity	Skills Needed
1. A new transit hub is to be built near an existing highway overpass	Public meeting to get feedback from the community	Active listening, negotiation, personal integrity, and trust building
2. A new team is meeting to decompose the defined scope	Brainstorming meeting to create a WBS	
3. The team is breaking down stories for the next release	Story breakdown and estimation meeting	
4. Contracting for a procurement with a new single source	Customize a standard contract with the seller	
5. A stakeholder group is concerned the new product implementation will slow their work in progress	Post-training floor support during product transition	

Answer

1.	For the meeting to be successful, active listening and negotiation are tools that may be used to build confidence and understanding. On a public project like this, exhibiting personal integrity and the ability to build trust are important attributes and you must be sure to address issues as they are brought to your attention.
2.	Facilitation, coaching, and mentoring skills will help you lead the team in creating the WBS and WBS dictionary for a plan-driven project. Creating a WBS is also an important team-building exercise.
3.	This scenario is likely to be taking place on a change-driven project. Active listening, participatory decision making, and conflict resolution are all likely to be used. Remember that conflict resolution is more likely to be about project priorities and constraints, technical considerations, and differences of expert opinions than about personalities.
4.	Personal integrity and trust building are important as you establish a good relationship with the seller. Collaboration and negotiation are important to obtaining a fair and equitable price and conditions of the contract. Did you automatically think of conflict resolution? That would not have been wrong either. Conflict is possible during any human interaction on a project.
5.	Using emotional intelligence and understanding human motivation will help you appreciate the need to help stakeholders manage their transition to the new product. With conflict resolution you can help them navigate changes to their ways of working.

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Domain II: Process The Process domain includes the technical project management skills and activities needed to manage a project with the overall goal to deliver the benefits for which the project was undertaken. The project manager and project team work together in this effort, so, as you would expect, you are using the skills needed from the People domain. You lead the development and organization of the project with these skills and a deep and balanced understanding of the business environment in which you and the team continually deliver value.

The project management tasks within this domain include not only the management of stakeholder engagement, resources, and communications but scope, schedule, cost, quality, risk, and procurement management, all of which are covered in the following chapters of this book. You are also primarily responsible for keeping the project's many aspects integrated, as in managing the project planning and artifacts. Managing the project governance structure, changes, issues, and the transfer of lessons learned and other knowledge, as well as the product turnover are all part of this domain. Remember that a key measure of success beyond turnover is the continuation of the project's resulting value and benefits (which is also a domain III task).

3.8 Exercise Think about each scenario and identify an activity related to domain II: Process. Write the answer in your Exercise Notebook. Skills associated with domain I: People that apply to the scenario are provided. The first answer is given as an example.

Note: Remember that there are interactions between activities related to knowledge areas and project constraints, and there can be many supporting skills for any given scenario.

Scenario	Activity	Skills from Domain I: People
1. Learning and documenting what is and is not in scope	Stakeholder engagement Requirements documentation Scope definition	Facilitation Build shared understanding Negotiation
2. Adjusting a deliverable before approval, due to customer feedback		Collaboration Negotiation Conflict resolution
3. Helping the team achieve superior performance		Adaptive leadership Coaching and mentoring Understanding of motivation
4. Analyze and resolve a difficult scheduling issue with the customer		Facilitation Emotional intelligence Participatory decision making
5. Balance labor expenses against task proficiency		Performance evaluation Performance support Ensuring adequate training

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Answer As you read these answers, note the skills from domain I: People. You may think of others that apply as well.

1. Requirements documentation is needed for scope definition, and stakeholder engagement is integral to successfully completing both. Creating a product backlog or WBS could also be involved depending on where we are in the project management process.
2. You are meeting with the customer to gain approval for a deliverable. That is validate scope. Change management activities are needed to adjust the deliverable as a result of customer feedback. You and the project team would verify product quality before first presenting it for approval and again after making the requested adjustments.
3. The project team should always be engaged in the project (the process of stakeholder engagement). The team leadership and communications management processes help you lead them adaptively through the process of becoming a performing team.
4. Difficult scheduling issues could be serious risks on projects so there must be a risk assessment (and possibly a risk response plan if it cannot be immediately resolved). You will have had to identify and analyze stakeholders to understand how you might help resolve their scheduling issue. How related communications take place is a communications management issue.
5. Balancing labor expenses against task proficiency is the balancing of the processes of cost, schedule, and quality management. The most proficient team resource choice is likely to have the most experience and their labor will cost more, but that could increase the quality of the work and also help to compress the schedule. Note that if we were looking at an external resource, the procurement process would be involved.

Domain III: Business Environment Projects occur within the larger organization and business environment. Let's say you have the skills associated with domain I and you have the knowledge of and experience with the project management processes of domain II. You would still need a solid understanding of the business environment within which the project occurs. It is likely that you already understand this, but you may not have thought about it as a separate factor in your success. The presentation of the business environment as a separate domain helps you understand how critical this is to accomplishing project objectives and delivering value. Note that one of the associated tasks within this domain specifically states that you should evaluate and deliver project benefits and value. This can only be achieved if a project manager uses the skills related to domains I and II together with a complete understanding of the business environment.

It's also important to have knowledge and understanding of project and organizational lessons learned and the importance of how they are used between projects. A project manager receives lessons learned from organizational process assets at the beginning of a project. Throughout a project, lessons learned may be collected, used, and then shared with other projects and project managers. Can you see how lessons learned become integrated back into organizational process assets for use on future projects and within the organization at large? (This is further described in the "Framework" chapter.)

Organizational and project governance (see the "Framework" chapter) are both essential to overall project success as it relates to the business environment. Organizations evaluate the external business environment during project selection (also in the "Framework" chapter). The environment is also continuously evaluated throughout the project to ensure that changes do not affect procurements, project objectives, and other project needs. Many projects have a change management component that addresses the changes to ways of doing business that are caused by the project. For example, a project whose goal it is to update the automation of a process that affects large parts of the organization requires a large communications effort before, during, and after the project is executed. There may be a separate implementation and training project to introduce the product of the project to its customers so it can be successfully used as intended.

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3.9 Exercise The exam may describe domain III: Business Environment tasks in a variety of ways. Match each scenario to the appropriate strategy. Write the answers in your Exercise Notebook.

Scenario	Strategy
1. A schedule risk is a threat to regulatory compliance.	a. Support compliance
2. You determine the development approach and life cycle to best deliver value.	b. Account for the effect of business environment changes on scope delivery
3. Building ample time between the pilot and rollout, you fix issues and misunderstandings to achieve customer satisfaction for the rollout.	c. Evaluate and select appropriate delivery options
4. You plan in a mid-project technology update to ensure no disruption to project objectives.	d. Facilitate and support organizational change management
5. Provide team training in workplace safety.	e. Compress the schedule

Answer

1. e 2. c 3. d 4. b 5. a

Structural Differences: The Process Groups and Domains

Historically, the five process groups existed long before the current domains. It is critical to understand how both describe the project management process in different ways and that they correspond to one another. In either case, you are doing the same basic things: initiating, planning, following through on your plan, measuring and analyzing your progress against measureable project objectives, adjusting plans, and making changes along the way.

It is useful to compare the two. The domains structure provides a more flexible framework than presented in the five process groups and has a number of advantages as a result. For example, it may require less adapting for a change-driven approach compared to a predictive approach.

Review the following differences between the domains and process groups to understand how the domains have been structured compared to the five groups:

- **No indication of a set order** Remember, project management is not linear. We made this statement earlier in relation to the five process groups, but the domains make this concept more clear. Since there is no indication of an order of operations within the domains, there is no false sense that all your project management activities are started and finished one after the other. In fact, there are iterations and progressive elaboration regardless of the applied methodology.
- **No definitive framework** A lack of definitive framework allows for more flexibility to select from development approaches along the continuum of predictive to hybrid to change-driven.

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- **No direction in relation to how tasks may be connected** While the structure of the five process groups provides direction related to all project management processes, the domains only describe skills and activities. This means that you need to understand how everything is interconnected and to know how to connect tasks and the overall work of a project.
- **Much is left to interpretation** Relative to the structure of the five process groups, much is left to interpretation within the domains and their associated tasks. This further allows a project manager to utilize multiple project management philosophies and methodologies, including whether or not a more adaptive approach is more appropriate to fit the needs of the project, or a more predictive approach, or a hybrid approach.

For the exam, it's important that you understand how project management processes and the tasks associated with each project management domain relate. Let's review a specific task, as an example: Domain II task 7, plan and manage quality of products/deliverables. Taken literally, you can see that this task clearly addresses the quality of the product of the project (corresponding to Control Quality in the process groups). But it doesn't address the quality of the processes, policies, and procedures for achieving that product quality (corresponding to Manage Quality in the process groups). You should be able to make the assumption that producing a deliverable (the "what" of quality management) includes using appropriate processes to get there (the "how" of quality management).

This example should help you understand that while there are many similarities, there are notable differences that you should feel comfortable with. While you will undoubtedly discover other differences between the way project management is described within the process groups and domains, you should have a solid understanding of the overall process of project management for the exam.

Final Exercise: Project Management Scramble Game

TRICKS OF THE TRADE

The following exercise is an extension of Rita's Process Chart™ Game and should help you assess how well you've understood what you've read. For each item listed in the following table, determine if it is done in initiating, planning, executing, monitoring and controlling, or closing.

3.10 Exercise For each of the following actions, list in your Exercise Notebook the correct process group: initiating, planning, executing, monitoring and controlling, or closing.

	Actions
1.	Use the project scope statement to gain approval of the "final" scope from the stakeholders before further planning is done.
2.	Determine high-level requirements, constraints, assumptions, and risks.
3.	Measure against the performance measurement baseline.
4.	Implement approved changes, including corrective actions, preventive actions, and defect repair.
5.	Reanalyze identified risks.
6.	Use high-level planning and estimating data to determine whether the product can be achieved within the given constraints.
7.	Verify and document that the project or project phase meets completion or exit criteria set in place during project planning.
8.	Conduct team-building activities.
9.	Evaluate the effectiveness of risk responses in a risk review.

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	Actions
10.	Determine how you will plan the planning, executing, and monitoring and controlling efforts for stakeholders, requirements, scope, schedule, cost, quality, resources, communications, risk, procurement, changes, and configuration, and put that information into the beginnings of management plans.
11.	Obtain formal (legal) sign-off and final acceptance of the product of the project from the customer.
12.	Increase the effectiveness of processes.
13.	Recalculate how much the project will cost and how long it will take, and create forecasts.
14.	Plan what will be communicated on the project, to whom, by whom, when, and how.
15.	Spend time trying to improve quality.
16.	Make sure the business case and the analysis supporting the need for the project are documented and understood. Also make sure the expected benefits are understood and likely to be realized through the project.
17.	Evaluate how effectively the team members function as a team.
18.	Determine how and when you will analyze processes in use on the project.
19.	Determine measurable project and product objectives.
20.	Manage schedule and cost reserves.
21.	Focus on looking for exceptions to the approved project management plan in team members' performance, rather than checking up on every person's work.
22.	Develop the final project management plan, project documents, and performance measurement baseline by performing schedule network analysis, looking for options, and confirming that project objectives can be met.
23.	Gather final lessons learned.
24.	Keep everyone focused on completing the project to the project charter and project management plan.
25.	Calculate estimate to complete.
26.	Understand how the project supports the organization's strategic objectives.
27.	Implement approved improvements to project processes.
28.	Identify stakeholders, and determine their influence, expectations, and impact.
29.	Determine variances.
30.	Meet with managers to gain resource commitments.
31.	Use and interpret earned value calculations.
32.	Ensure a high-level product scope is identified through an evaluation of a business need, and then documented in the project charter.
33.	Create and distribute a final report of project or phase performance.
34.	Use your judgment to determine what variances are important and if they warrant recommending a change or corrective action.
35.	Finalize the "execute" and "monitor and control" aspects of all management plans.
36.	Index and archive project records.
37.	Keep managers apprised of when their resources will be needed on the project.
38.	Evaluate customer satisfaction regarding the project and the deliverables.
39.	Determine who will be on the project team to help with project planning.

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	Actions
40.	During the project, share knowledge and make recommendations to increase project effectiveness throughout the organization.
41.	Perform procurement inspections.
42.	Turn high-level stakeholder needs, wants, and expectations into requirements.
43.	Look for newly arising risks.
44.	Determine what processes should be followed on the project to reduce the need to supervise work, improve quality, and make use of standards.
45.	Obtain formal acceptance of interim deliverables from the customer.
46.	Determine what specifically will constitute project success.
47.	Assess individual team member performance.
48.	Make or obtain a decision in integrated change control about whether changes should be approved, rejected, or deferred.
49.	Manage quality to ensure the defined practices and procedures are being followed and are still appropriate for the project.
50.	Evaluate the effectiveness of implemented corrective actions.
51.	Manage stakeholder engagement and expectations, increase project support, and prevent problems.
52.	Plan ways to measure project performance, including determining the measurements to be used, when they will be taken, and how they will be interpreted.
53.	Keep the project's business case in focus while managing the project, especially when problems occur.
54.	Determine the process that will be used to request, approve, and manage changes on the project.
55.	Obtain seller responses to bid documents.
56.	Implement planned risk responses as appropriate.
57.	Evaluate the use, cost, and other aspects of physical resources. Make appropriate changes and adjustments.
58.	Collect and share project information as it is discovered.
59.	Negotiate with potential sellers; sign contracts.

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Answer The Project Management Scramble Game

	Done During Which Process Group?		Done During Which Process Group
1.	Planning	31.	Monitoring and controlling
2.	Initiating	32.	Initiating
3.	Monitoring and controlling	33.	Closing
4.	Executing	34.	Monitoring and controlling
5.	Monitoring and controlling	35.	Planning
6.	Initiating	36.	Closing
7.	Closing	37.	Executing
8.	Executing	38.	Closing
9.	Monitoring and controlling	39.	Planning
10.	Planning	40.	Executing
11.	Closing	41.	Monitoring and controlling
12.	Executing	42.	Initiating
13.	Monitoring and controlling	43.	Monitoring and controlling
14.	Planning	44.	Planning
15.	Monitoring and controlling	45.	Monitoring and controlling
16.	Initiating	46.	Initiating
17.	Executing	47.	Executing
18.	Planning	48.	Monitoring and controlling
19.	Initiating	49.	Executing
20.	Monitoring and controlling	50.	Monitoring and controlling
21.	Executing	51.	Executing
22.	Planning	52.	Planning
23.	Closing	53.	Executing
24.	Executing	54.	Planning
25.	Monitoring and controlling	55.	Executing
26.	Initiating	56.	Executing
27.	Executing	57.	Monitoring and controlling
28.	Initiating	58.	Executing
29.	Monitoring and controlling	59.	Executing
30.	Planning		

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Practice Exam

1. A project manager has received some help from the team, and she needs help from them again so that she can create a detailed project budget. Which project management process group is she in?
   A. Initiating
   B. Before the project management process
   C. Planning
   D. Executing

2. The project charter is created in which project management process group?
   A. Executing
   B. Planning
   C. Closing
   D. Initiating

3. A detailed project schedule can be created only after creating the:
   A. Project budget
   B. Work breakdown structure
   C. Project management plan
   D. Detailed risk assessment

4. Which of the following is not an input to the initiating process group?
   A. Company processes
   B. Company culture
   C. Historical WBSs
   D. Project scope statement

5. Your team is building a website to provide resources for families and childcare providers who want to design their own homeschooling programs. The site will include many features. As each feature is completed, the product owner reviews it and either accepts it or tells the team what needs to be fixed. Upon acceptance, the feature is reviewed by QA and then added to the live build. Which life cycle or development approach are you using for this project?
   A. Hybrid
   B. Incremental
   C. Iterative
   D. Release-driven

6. The project sponsor has just signed the project charter. What is the next thing to do?
   A. Begin to complete work package
   B. Validate scope
   C. Start integrated change control
   D. Start to create management plans

7. The high-level project schedule constraints have just been determined. What project management process group are you in?
   A. Initiating
   B. Planning
   C. Executing
   D. Monitoring and controlling

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8. The WBS and WBS dictionary have been completed, and the project team has begun working on identifying risks. The sponsor contacts the project manager, requesting that the responsibility assignment matrix be issued. The project has a budget of $100,000 and is taking place in three countries using 14 human resources. There is little risk expected for the project, and the project manager has managed many projects similar to this one. What is the next thing to do?
   A. Understand the experience of the sponsor on similar projects.
   B. Create an activity list.
   C. Make sure the project scope is defined.
   D. Complete risk management and issue the responsibility assignment matrix.

9. A project manager does not have much time to spend on planning before the mandatory start date arrives. He therefore wants to move through planning as effectively as possible. What advice would you offer?
   A. Make sure you have a signed project charter and then start the WBS.
   B. Create an activity list before creating a network diagram.
   C. Document all the known risks before you document the high-level assumptions.
   D. Finalize the quality management plan before you determine quality metrics.

10. The best time to assign a project manager to a project is during:
   A. Integration
   B. Project selection
   C. Initiating
   D. Planning

11. Why does the agile approach plan the work continuously throughout the project?
   A. Agile methods break down the work into small chunks so the team can complete one iteration at a time.
   B. An agile product owner can't know what they really need until they see a prototype in action.
   C. Agile teams are asked to prioritize tasks that deliver value, rather than spending their time planning.
   D. Agile projects are subject to uncertainty and high rates of change that make upfront planning inefficient.

12. A project manager gets a call from a team member notifying him that there is a variance between the speed of a system on the project and the desired or planned speed. The project manager is surprised because that performance measurement was not identified in planning. If the project manager then evaluates whether the variance warrants a response, he is in which part of the project management process?
   A. Initiating
   B. Executing
   C. Monitoring and controlling
   D. Closing

13. During a team meeting, a team member asks about the measurements that will be used on the project to assess performance. The team member feels that some of the measures related to activities assigned to him are not valid measurements. The project is most likely in what part of the project management process?
   A. Closing
   B. Monitoring and controlling
   C. Executing
   D. Initiating

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14. Which of the following is a characteristic of project management processes?
    A. Iterative
    B. Unique
    C. Unnecessary
    D. Standardized

15. What does a project manager need to do to deliver value in the context of the organization and its business environment?
    A. Understand the organizational and project governance and how they may impact the project.
    B. Review the lessons learned from other projects and use them to generate organizational process assets.
    C. Use people and process skills along with understanding the organizational and business environment.
    D. Continuously monitor any changes to the external business environment, such as competitive and regulatory changes.

16. Which project management process group generally takes the most project time and resources?
    A. Planning
    B. Design
    C. Integration
    D. Executing

17. You are managing two projects and have been assigned to a third project that has just been approved. You begin the new project, and are able to manage it well along with the others you are managing. During initiating, you are focused on accomplishing a number of activities. Which of the following are you not concerned with at this time?
    A. Identifying and documenting business needs
    B. Creating a project scope statement
    C. Dividing a large project into phases
    D. Accumulating and evaluating historical information

18. Which statement about process groups and domains is accurate?
    A. Both process groups and domains recommend the best practices that should be followed on all projects.
    B. Since the process groups lack a definitive framework, they allow for more flexibility in the development approach.
    C. Compared to the process groups, the tasks involved in the domains are more open to interpretation and the project manager's judgment.
    D. The process groups and domains provide a different view of the project depending on the development approach being used.

19. The software development project has progressed according to plan. The team is very enthusiastic about the product they have created. Now they are looking ahead to finding new projects to work on. You caution them that the current project cannot be considered complete until after the closing process group. Closure includes all the following except:
    A. Determining performance measures
    B. Turning over the product of the project
    C. Documenting the degree to which each project phase was properly closed after its completion
    D. Updating the company's organizational process assets

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20. What key point about the process groups and domains is important to know in studying for the exam?
    A. Being able to correlate these two frameworks with each other will help you understand the project management process.
    B. By combining these two perspectives, you can determine the best sequence in which the work should be done.
    C. Analyzing the project characteristics from the standpoint of each of these frameworks will help you choose the best development approach to follow.
    D. Since these two frameworks should be used independently of each other, you need to be able to choose the best one for each project.

21. The first phase of your project has come to an end. What is the most important thing to ensure is done before beginning the next phase?
    A. Verify that the resources are available for the next phase.
    B. Check the project's progress compared to its baselines.
    C. Confirm that the phase has reached its objectives, and have its deliverables formally accepted.
    D. Recommend corrective action to bring the project results in line with project expectations.

22. During which process group does the team measure and analyze the work being done on the project?
    A. Initiating
    B. Executing
    C. Monitoring and controlling
    D. Closing

23. Which of the following is the most appropriate thing to do in project closing?
    A. Work with the customer to determine acceptance criteria.
    B. Confirm all the requirements in the project have been met.
    C. Collect historical information from previous projects.
    D. Gain formal approval of the management plans.

24. Which process group focuses on completing the requirements of the project?
    A. Initiating
    B. Planning
    C. Executing
    D. Closing

25. All the following occur during the planning process group except:
    A. Develop Project Charter
    B. Create WBS
    C. Estimate Costs
    D. Sequence Activities

26. A market demand, a business need, and a legal requirement are examples of:
    A. Reasons to hire a project manager
    B. Reasons projects are initiated
    C. Reasons people or businesses become stakeholders
    D. Reasons to sponsor a project

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Answers

1. **Answer** C
   Explanation Notice the use of the word "detailed." Such a budget is created during project planning.

2. **Answer** D
   Explanation The project charter is needed before planning and execution of the work can begin. Therefore, it is created and approved in project initiating.

3. **Answer** B
   Explanation In the project management process, the project budget, detailed risk assessment, and project management plan come after the schedule is created. The only answer that could be an input is the work breakdown structure.

4. **Answer** D
   Explanation Notice the question asks which is not an input to project initiating. Did you read it correctly? Companies should have processes in place for hiring resources, reporting, and managing risks on projects (to name only a few). These are inputs to project initiating, as are company culture and historical WBSs. The project scope statement is an output of project planning.

5. **Answer** B
   Explanation This scenario describes an incremental life cycle, where complete portions of the product are developed and delivered one at a time. In an iterative life cycle, the complete project would be built up progressively, in increasing levels of detail; that is not the case here. While this could be a hybrid project, the scenario doesn't mention any predictive or plan-driven methods. Since a hybrid project is one that uses both agile/adaptive and predictive methods, that isn't the best answer. The answer "release-driven" is a distractor; that is not a recognized type of life cycle or development approach.

6. **Answer** D
   Explanation To answer this type of question, look for the choice that occurs closest to the process group you are in. The project charter is created during project initiating. Completing work packages is done during project executing. Validating scope and performing integrated change control are done during project monitoring and controlling. Starting to create management plans is the best choice, as it is part of project planning.

7. **Answer** A
   Explanation High-level constraints are identified in the project charter, which is created during project initiating.

8. **Answer** B
   Explanation Look at the order of planning the project that the team has chosen. Although understanding the experience of the sponsor might sound like a good idea, the sponsor is a stakeholder, and understanding the stakeholders is part of stakeholder analysis. That should have occurred before the creation of a WBS. Project scope must be defined before a WBS can be created. Completing risk management and issuing the responsibility assignment matrix cannot be best, as that work does not come next in the process. Other work must be done before risk management can effectively be completed. Creating an activity list comes next after the WBS and WBS dictionary.

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9. **Answer** B
Explanation This question is asking which of the choices is the most effective way to move through project planning. Starting the WBS immediately after obtaining a project charter skips the important steps of defining the scope and other activities. High-level assumptions are determined in project initiating. Quality metrics are determined as part of the quality management plan, not after it. The activity list is created before the network diagram, so that is the best option.

10. **Answer** C
Explanation The project manager should be assigned during project initiating.

11. **Answer** D
Explanation It is true that agile methods break down the work into small chunks, but so do predictive or plan-driven methods and this is not why planning continues throughout the project. Since every project begins with a recognized need or problem, an agile sponsor or product owner knows what they need—they just might not know what a feasible solution will look like until they see a prototype in action. While agile teams do prioritize tasks that deliver value, agile teams continuously plan the work throughout the project because these projects are inherently subject to uncertainty and high rates of change that make upfront planning inefficient or impossible.

12. **Answer** C
Explanation Even though the measurement was not identified in planning, the project manager would still have to investigate the variance and determine if it is important. The project manager is in project monitoring and controlling.

13. **Answer** C
Explanation This situation does not describe an actual measurement (a monitoring and controlling activity) but rather a meeting occurring during project executing.

14. **Answer** A
Explanation As the project life cycle progresses, more information becomes available, allowing the team to manage the project to a more detailed level.

15. **Answer** C
Explanation This is a tricky question, since all of these answers are accurate to some degree. In this case, the best answer is that you need to use people and process skills along with understanding the business environment. This answer is the most comprehensive—it includes the tasks described in the other three answer options. In addition, this is the only answer that mentions the people and process domains, and to deliver value successfully (in any context) a project manager needs to apply skills from all three domains.

16. **Answer** D
Explanation Did you notice that planning and executing are the only process groups offered as choices? Therefore, design and integration can be eliminated as options. Doing the actual work (in executing) will generally take the most project time and resources.

17. **Answer** B
Explanation A project scope statement is created during project planning.

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18. **Answer** C
Explanation In comparison to the process groups, the domain tasks are more open to interpretation and the project manager's judgment. While both the process groups and domains provide guidance for the project management process, they do not recommend the best practices that should be followed on all projects. The project manager determines the best practices that are appropriate for each project. The domains provide for more flexibility in practice, not the process groups. While the development approach being used might affect how the project manager will use the process groups and domains, they don't inherently reflect a different view of the project.

19. **Answer** A
Explanation Performance measures are determined earlier in the project so they can be used to measure progress during the project, determining performance measures is the only correct answer to this question.

20. **Answer** A
Explanation It is important to be able to correlate the process groups and domains with each other to prepare for the exam. Since they describe the project management process in different ways, this dual perspective will deepen your understanding of the process. So it isn't correct to say that they should be used independently of each other, or that you should only choose one perspective for a project. Neither of these perspectives define a specific order of operations for the work, since project management is not linear. It is true that the best development approach should be based on understanding the needs and characteristics of the project, the team, and the organization, but you would use other tools to analyze that, not the process groups and domains.

21. **Answer** C
Explanation A phase or project must be formally closed and accepted.

22. **Answer** C
Explanation During monitoring and controlling, project performance is measured and needed changes are identified and approved.

23. **Answer** B
Explanation Collecting historical information and determining high-level acceptance criteria are done in project initiating. Gaining approval of management plans is part of project planning. Confirming that project requirements have been met occurs in project closing.

24. **Answer** C
Explanation Project executing is where work is done to produce the product of the project.

25. **Answer** A
Explanation Develop Project Charter occurs in project initiating.

26. **Answer** B
Explanation These are all reasons projects are initiated.

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Integration

FOUR

How would you respond if you were asked, "What is a project manager's primary role?" The correct answer is: to perform integration management[1]—to pull all the pieces of a project together into a cohesive whole. This is so much a part of a project manager's job that it is arguably the reason for the project manager's existence in an organization and on a project.

While the work of the project is being done, the team members are concentrating on completing the work packages, and the project sponsor is protecting the project from changes and loss of resources. The project manager is responsible for integration—putting all the pieces of the project together into one cohesive whole that gets the project done faster, cheaper, and with fewer resources, while meeting the project objectives.

TRICKS OF THE TRADE® Think about integration as balancing all the processes and tasks with each other. Project management activities do not happen independently of one another. To complete a cost estimate, for example, factors such as the number of resources on the project, the scope being estimated, and risk reserves should be taken into account.

QUICKTEST

- Integration management process
- Integrated change control
- Process for making changes
- Project management plan
  - Project life cycle
  - Development approach
  - Management reviews
  - Tailoring
  - Individual management plans
  - Baselines
  - Requirements management plan
  - Change management plan
  - Configuration management plan
- Project charter
- Knowledge management
- Types of knowledge
  - Tacit
  - Explicit
- Project documents
- Assumption log
- Change requests
- Corrective action
- Preventive action
- Defect repair
- Constraints and assumptions
- Configuration management system
- Change control system
- Change control board
- Work authorization system
- Lessons learned
- Agile change management
- Kickoff meeting

The other chapters in this book explain the detailed work of a project manager. This chapter, however, is about the high-level work a project manager needs to do. Read this chapter carefully. Integration management can be a difficult area as it entails assimilating all tasks or processes that may be involved in a given situation.

The following tables should help you understand how each part of integration management fits into the overall project management process.

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The Integration Management Process	Done During
Develop Project Charter	Initiating process group
Develop Project Management Plan	Planning process group
Direct and Manage Project Work	Executing process group
Manage Project Knowledge	Executing process group
Monitor and Control Project Work	Monitoring and controlling process group
Perform Integrated Change Control	Monitoring and controlling process group
Close Project or Phase	Closing process group

ECO Domain II: Process
Task 1: Execute Project with the Urgency Required to Deliver Business Value
Task 9: Integrate Project Planning Activities
Task 10: Manage Project Changes
Task 12: Manage Project Artifacts
Task 13: Determine Appropriate Project Methodology/Methods and Practices
Task 16: Ensure Knowledge Transfer for Project Continuity
Task 17: Plan and Manage Project/Phase Closure or Transitions

These tables illustrate that the integration management process from the *PMBOK® Guide* can map to several *Examination Content Outline* (ECO) tasks. Some tasks and processes appear to be very closely related. For example, the Develop Project Management Plan process is for the establishment of the initial project life cycle, development approach, and performance measurement baseline, as well as the integration of all outputs from the planning processes of each management area. This process directly relates to the integrate project planning activities task found in domain II of the ECO. And have you considered that Manage Project Changes from the ECO is similar to what is known as Integrated Change Control in the *PMBOK® Guide*?

The Manage Project Artifacts task from the ECO, on the other hand, relates to both the Develop Project Management Plan and Integrated Change Control processes from the *PMBOK® Guide*. In fact, it's likely to be involved in all the integration management processes found within the *PMBOK® Guide*. Integration management cannot be understood without a solid understanding of project management. Therefore, if you have limited project management training or experience, you might want to do a high-level review of this chapter now, read the rest of this book, and then come back and read this chapter again. It will make more sense the second time. Remember that integration management is the primary role of a project manager.

Figure 4.1 shows the relationship between knowledge areas and process groups as they are described in the *PMBOK® Guide*. With it you can easily see where a project manager's activities are focused for each knowledge area. For example, all knowledge areas include processes that occur in planning and monitoring and controlling. Scope, Schedule, and Cost show no project management activity for the project manager because it is the team that is executing the work to build the product of the project while the project manager monitors and controls. And did you notice that Integration is the only area that has processes occurring in all process groups? The project manager is always integrating.

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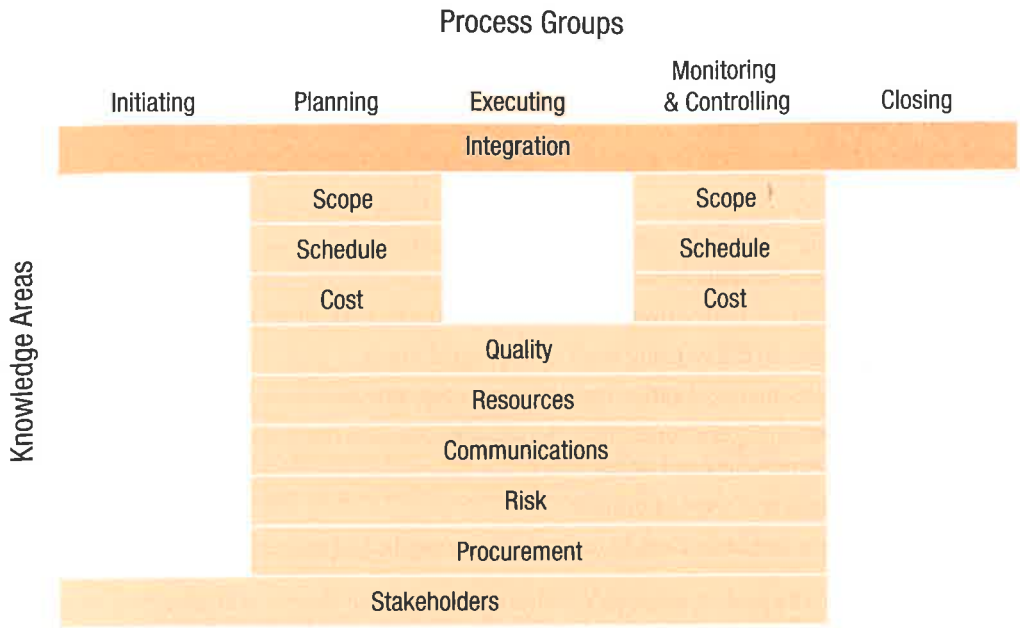

FIGURE 4.1 *The relationship between the knowledge areas and process groups*

Develop Project Charter PAGE 75

The Develop Project Charter process includes using all the information known about a project from the project selection process to achieve an approved (signed) project charter, which authorizes the project to continue. This process also includes the creation of an assumption log, which is an outcome of developing the project charter as initial assumptions and constraints are gathered and documented in the charter. It's also important to note that the assumption log is updated throughout the project as assumptions and constraints may change and new assumptions are uncovered.

PMBOK® Guide
PG: Initiating
Process: Develop Project Charter

ECO
Domain: II
Task: 1, 10, 12, 13, 16

Creating a project charter[2] involves planning a project at a high level to assess whether it is feasible within the given constraints. Detailed planning does not happen until after the charter is signed. In project initiating, you may meet with key stakeholders to define the high-level objectives, requirements, scope, risks, assumptions, and other constraints in an effort to assess the feasibility of the project. Then, you will use all the information gathered to confirm the project is realistic, aligns with the organization's strategic goals, and is likely to deliver the anticipated value. Additional resources (time and money) are spent only after the project is officially authorized by the project charter.

The project manager may create the project charter, but it is issued (signed off on) by the sponsor as part of project initiating. The project charter should be broad enough that it does not need to change as the project progresses. (Any change to the project charter should call into question whether the project should continue.)

Projects that include hybrid or agile approaches may tailor charter documents. For example, a project charter may contain less information if there is more uncertainty about requirements or the product deliverables at the beginning of the project. It's also important to note that the description of the governance of the project may contain different information. For instance, instead of a formal change control board, a project's product owner may be assigned and given the authority to make decisions relating to change requests and be able to further prioritize requirements. While the detail and approach may vary, the basics of the charter remain.

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4.1 Exercise Test yourself! In your Exercise Notebook, write the answers to the following questions.

What does the project charter do for the project and the organization?

Why is it so necessary?

Answer The project charter is your target for the project and serves as a definition of how success will be measured. Know the following for the exam.

The charter at a minimum does the following :

- Formally recognizes (authorizes) the existence of the project, or establishes the project
- Links the project to the ongoing work of the organization
- Gives the project manager authority to commit corporate resources to the project*
- Clarifies and encourages a common understanding between the sponsor and project manager of the major deliverables and milestones
- Defines key roles and responsibilities
- Provides the project objectives, high-level requirements, and success criteria

*On the exam, the project manager's authority through the charter is an assumed benefit or use of the project charter. In many project situations in a corportate structure, the project team does not report to the project manager, which can lead to cooperation and performance issues. The project charter helps prevent these issues.

The process of creating the charter uncovers the assumptions recorded as the start of the assumption log. These assumptions will later be updated or addressed in the detailed requirements gathering, scope definition, and risk management efforts. Can you see that the creation of a project charter should address and influence all the project management constraints? Aside from the assumption log and the charter, you should have the following documented in their respective project artifacts:

- Identified and analyzed stakeholders
- Defined project objectives, constraints, and success criteria
- Confirmed high-level requirements
- Preliminary product scope definition
- Documented initial risks and issues

Some of the tools and techniques that can be used during this process include data gathering (interviews, brainstorming, focus groups, etc.), conflict management, and meeting management. During meetings with the sponsor and key stakeholders, the project manager can obtain needed information and work with experts to understand and address organizational strategy and develop measurable project objectives.

NOTE: The following charter example is not an exact template as a charter should be tailored to meet the needs of the business and project. This example is meant to show you the types of sections that may be included and what those sections may summarize. Also note that this charter refers to attached documents that are not included in this example.

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Project Charter

Project Title and Description *(What is the project?)* **Upgrade the Payroll Systems**

We're a large, multinational organization with more than 20,000 employees, so human resource management is critical to our success. To more efficiently compensate our employees, we want to replace or upgrade the employee payroll systems to better reflect the changing nature of our workforce. Employees now work in various locations (offices and homes) around the world, work simultaneously for multiple business units, and have more varied work schedules than ever before. Current geographically focused payroll systems are not integrated, are inflexible, and require significant clerical time to maintain them manually. With the existing systems, consolidated corporate reporting and analysis is expensive and inefficient.

Project Manager Assigned and Authority Level *(Who is given authority to lead the project, and can they determine, manage, and approve changes to budget, schedule, staffing, etc.?)*

Isaiah Higgins will be the project manager for this project. He may request any team members he sees fit and will work with resource managers to secure the needed resources. He has signature authority up to $10,000. Ashley Chan is assigned as assistant project manager.

Business Case *(Why is the project being done? On what financial or other basis can we justify doing this project?)*

Administering payroll currently costs $2.4 million annually along with the unmeasured costs of procedural inefficiencies. The industry average payroll processing costs for a global company our size is $100 per employee per year, or $2 million overall per year. Anticipated savings of $400,000 per year (assuming a three-year payback period) justifies the approval of this project. See the detailed business case attached to this charter.

Resources Preassigned *(How many or which resources will be provided?)*

The corporate payroll processing group will be closely involved in this project, along with the payroll specialists who work in our local offices. A senior team of business analysts, enterprise architects, and software designers has been identified for the initial research and analysis phase. Procurement and legal representatives will be involved in seller contract processes, including development of RFPs and contracts when deemed necessary. English will be the primary project language; local language experts will be involved to ensure country-specific regulations and laws are understood. Other required resources must be identified and negotiated for by the project manager.

Key Stakeholder List *(Who will affect or be affected by the project [influence the project], as known to date?)*

Attached is a list of stakeholder groups that will be impacted by this project. It includes all employees, divided into payees, corporate management, legal, procurement, and payroll administrators. It also includes outside representatives of government taxing authorities, benefit providers, and suppliers of payroll-processing solutions.

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Stakeholder Requirements as Known *(Requirements related to both project and product scope.)*

Req. Number	High-Level Requirements
R1	Pay employees based on the agreed-upon rate/salary on the agreed-upon schedule.
R2	Adhere to country-specific government requirements related to tax withholding and payment schedules.
R3	Adhere to state, province, county, or other local government requirements related to tax withholding and payment schedules.
R4	Allow the company to provide benefits for employees as approved by the Board of Directors.
R5	Allow the company to collect benefit premium payments from employee pay as agreed to by each employee.
R6	Keep all employee data confidential, secure, and archived as required by law in each jurisdiction.

High Level Product Description/Key Deliverables *(What are the key product deliverables that are wanted and what will be the end result of the project?)*

The result of this project should be one or more systems that support payroll processing for all employees, at or below the industry average cost. Specific desired features include:

- The systems should allow direct deposit of employee pay into any financial institution in the world, along with notification of deposit via email or text message to any device.
- Workers should be able to change their address, number of dependents, tax withholding parameters, and benefit characteristics via a website at any time from any location.
- The systems must support consolidated management and reporting of corporate payroll processing, plus government mandated reporting and payments.

High-Level Assumptions *(What is believed to be true or reliable in the situation? What do we believe to be the case but do not have proof or data for? See details in the assumption log.)*

- There are payroll applications available that support the countries in which our employees are located.
- The average cost of $100 per employee per year is accurate for our industry.
- Each employee reports their primary residence in just one country for tax reporting purposes.
- We have internal resources available to evaluate and do the work assigned.

High-Level Constraints *(What factors may limit our ability to deliver? What boundaries or parameters will the project have to function within?)*

- The system must be able to comply with all international payroll rules and perform direct deposits globally.
- The solution and the supporting systems must be able to maintain organizational information security standards that meet or exceed individual country standards.
- Year-end tax reporting must be completed by the new system in the year of the implementation (payroll data must be converted).
- Summary milestone schedule: Due no later than October 6, 20XX
- Preapproved financial resources: $1,200,000

Measurable Project Objectives *(How does the project tie into the organization's strategic goals? What project objectives support those goals? The objectives need to be measurable and will depend on the defined priority of the project constraints.)*

The main objective of this project is to decrease costs by at least $400,000 annually. A second objective, which supports the first, is to increase productivity for new employees and payroll processing employees.

- Decrease payroll processing costs by 15 percent in two years by decreasing manual clerical processes.
- Decrease the duration of the new worker onboarding process from an average of 5 business days to 2 business days within 18 months.

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Project Approval Requirements *(What items need to be approved for the project, and who will have sign-off authority? What designates success?)*

Approvals for this project include:

- Decision to purchase application software to support the payroll systems (VP of Operations)
- Choice of seller application package (Director of HR)
- High-level design of the new systems (Director of HR)
- Global transition plan for new systems rollout (VP of Operations)

Overall Project Risks *(Overall potential threats and opportunities for the project)*

- Because of the complexity of employee pay calculations and the large number of employees, we may have errors in employee payroll during implementation of the new systems. (High impact)
- Because of the number of localities supported and differing regulations, we may have errors in government tax payments and regulatory compliance during implementation of the new systems. (High impact)
- Because of the volatility in the software application marketplace, we may select an unreliable seller for delivery of the payroll-processing applications. (High impact)

Project Exit Criteria *(What needs must be met so that the project manager will be able to close or terminate the project or phase?)*

- A new payroll processing system that meets the project objectives and requirements and incorporates all key deliverables described herein will be delivered within defined cost and budget constraints.
- *Or,* if it is determined that the project objectives of cost saving cannot be met, the project manager will recommend termination of the project.
- *Or,* if it is determined that another solution will better meet the organizational needs, the sponsor should be notified for closing approval, and a business case will be developed for the new solution.

Project Sponsors Authorizing This Project

Muhammad Chauhan, Executive Vice President	Jessica Bouchard, Director of Human Resources

Develop Project Management Plan PAGE 82

Project managers must plan before they act. Let's first look at what management plans are, and then move on to discuss the project management plan.

PMBOK® Guide
PG: Planning
Process: Develop Project Management Plan

ECO
Domain: II
Task: 1, 9, 10, 12, 13, 16, 17

Management Plans Management plans document the strategy and approach for managing the project and the processes related to scope, schedule, cost, quality, resources, communications, risk, procurement, and stakeholder management. These plans are in essence a set of documents with processes, procedures, practices, and standards the team will follow to ensure consistent results. When creating a management plan, you ask yourself, "How will I define, plan, manage (execute), and control scope (or schedule, cost, quality, etc.) for the project?" "How will closing phases be performed, if that's part of the overall project?" You think ahead, and document how you will plan and manage for each management area based on its particular needs. This effort should cover all aspects of the project management process. Management plans are unique to each project, including the format and level of detail needed at each stage of planning.

If you don't create management plans for your projects this area of the exam may be difficult for you. Let's consider an example of how you would address cost management. In the planning portion of our cost example, the following questions may be addressed: "How will we make sure all costs are identified and estimated?" "Who will be involved in estimating costs?" "What methods of estimating costs will we use?"

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"What historical records, processes, and organizational requirements will need to be used or met?" "What estimating tools and techniques will we employ?" "What level of accuracy is appropriate?" "How will funding and cost constraints be considered when establishing the budget?" "What data, metrics, and measurements do we need for planning cost?"

Agile and hybrid environments may not have any or all of these plans documented as separate deliverables. However, this does not mean the planning of these attributes is absent. Rather, they are incorporated into other artifacts. Scope, schedule, and risk management plans are often incorporated in the product backlog and the release roadmaps, for example. These deliverables show the plan for project work, inclusive of risk response decisions and when things are planned for delivery.

The executing portion of a management plan focuses on the processes and procedures for doing the work. Some management areas, such as cost management, won't have separate executing processes for the project manager. The work performance data related to the management area is gathered as part of Direct and Manage Project Work and must still be planned for. The executing component of a cost management plan answers questions such as: "What cost data is needed?" "Who is responsible for gathering it?" "Where will we capture the raw data that will later be used in monitoring and controlling?"

The monitoring and controlling component of a management plan defines the processes and procedures to measure project progress, compares actual project results to what was planned, and determines how to handle variances that require a change.

Before you read further, spend some time imagining what management plans for scope, schedule, quality, resources, communications, risk, procurement, and stakeholder management might contain. Many project managers don't realize how big their knowledge gap is regarding management plans until it finds them on the exam. Don't let this happen to you!

TRICKS OF THE TRADE

Here is a trick to understanding management plans for the exam. Know that management plans look forward in time and that there are management plans for all the project management areas. There are also the following management plans:

- Change management plan
- Configuration management plan
- Requirements management plan

When taking the exam, assume the project manager has created each of these management plans. If a question refers to a problem on a project, the answer might be for the project manager to look at the management plan for that aspect of the project to see how the plan says such a problem will be handled. Or when the work is being done, the project manager might refer to the cost management plan to see how costs are to be measured and evaluated.

Project Management Plan[3] The project management plan integrates all the individual management plans into a cohesive whole, creating a centralized document to describe what is involved in the project. The overall project management plan also includes the baselines for the project. Do you remember the discussion in the "Processes and Domains" chapter about how the iterations in project planning lead to a realistic project management plan? This means a project management plan is a set of plans and baselines, not just a schedule. The key components of the project management plan are discussed in the following sections. Remember the agile and hybrid differences we discussed in the previous section, and think through how an adaptive approach may tailor any of the following plans and project management components.

Project Life Cycle The project life cycle describes the phases of work on a project required to produce the deliverables (for example, requirements, design, code, test, implement). Project life cycles range from plan-driven to change-driven.

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Development Approach Development approaches to produce the project deliverables range from plan-driven to change-driven.

Management Reviews Milestones will be built into the project management plan, indicating times when management and stakeholders will compare project progress to what was planned and identify needed changes to any of the management plans.

Tailoring Think about the science of project management for a moment. Would you want to use everything in the *PMBOK® Guide* to the same extent on every project? No! A project manager should determine the extent to which processes need to be used, based on the needs of the project. Tailoring the process to be followed is part of developing the project management plan.

Individual Management Plans These are the management plans for scope, schedule, cost, quality, resources, communications, risk, procurement, and stakeholders. (The individual management plans are discussed in more detail in chapters 5 through 13 of this book.)

Baselines[4] (Performance Measurement Baseline) The project management plan includes scope, schedule, and cost baselines, against which the project manager will report project performance. These baselines are created during planning. They are a record of what the project had planned, scheduled, and budgeted for in terms of scope, schedule, and cost performance, and are used to compare the project's actual performance against planned performance. The following are the elements included in each baseline:

- **Scope baseline** The project scope statement, work breakdown structure (WBS), and WBS dictionary
- **Schedule baseline** The agreed-upon schedule, including the start and stop dates for each activity, and scheduled milestones
- **Cost baseline** The time-phased cost budget (the spending plan indicating how much money is approved for the project and when the funds are required and will be available)

The project manager and team will watch for deviations from the baselines while the work is being done. If a deviation is discovered, they will assess whether adjustments can be made to the project to deal with the problem. These adjustments might involve submitting a change request for corrective or preventive action or defect repair.

If minor adjustments will not correct a deviation a request to change the baselines might be necessary. A substantial part of managing a project beyond planning is making sure the baselines are achieved, which in turn helps ensure the sponsor and the organization get the complete benefits of the project they chartered. Therefore, as a project manager, your ability to not only plan a project but also to control the project and get it completed as planned is very important.

Requested changes to the baselines are evaluated and approved in the Perform Integrated Change Control process. Baseline changes are so serious that the evolution of the baselines should be documented to show when and why changes were made. Baselines are mentioned frequently on the exam. Make sure you understand the concepts described here, including what the project manager's attitude should be regarding the project's baselines and any changes to those baselines.

TRICKS OF THE TRADE The exam tests you at an expert level. Understand that deviations from baselines are often due to incomplete risk identification and risk management. Therefore, if the exam asks what to do when a project deviates significantly from established baselines, the correct answer is likely the one about reviewing the project's risk management process. Many project managers do not understand that such an effort should be done. Does it make sense to you now that we've pointed it out?

Requirements Management Plan Part of the scope management process (described in the next chapter) involves defining and planning for stakeholders' needs, wants, expectations, and assumptions to determine the requirements for the project. The requirements management plan defines how requirements will be

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gathered, analyzed, prioritized, evaluated, and documented, as well as how the requirements will be managed and controlled throughout the project.

Change Management Plan Controlling a project to the baselines and the rest of the project management plan is so important that the project manager needs to think in advance about where there might be changes and what to do to limit the negative effects of changes. Are you this focused on change management on your projects? You need to plan the project in a way that minimizes the need for changes and prevents unnecessary changes. You also need to proactively look for needed changes, thereby solving problems before they have a major negative impact on the project. Because making changes is much more costly than including the work from the beginning, changes should not be undertaken lightly.

The change management plan describes how changes will be managed and controlled, and may include:

- An outline of how changes will be managed and controlled
- Change control procedures (how and who)
- Approval levels for authorizing changes
- The creation of a change control board (described later in this chapter) to approve changes, as well as the roles and responsibilities of those on the board
- Who should attend meetings regarding changes
- The organizational tools to use to track and control changes
- Information on reporting the outcome of change requests
- The emergency change process

Note that a change management plan will often have a separate process for addressing each of the knowledge areas, taking into account the project-specific needs within each area.

Configuration Management Plan It is essential to have a plan for making sure everyone knows what versions of the project management plan components are the latest version. The configuration management plan defines the naming conventions, version control system, and document storage and retrieval system. It details how you will manage changes to the documentation, including which organizational tools you will use in this effort.

Configuration Management System[5] Like the change control system, the configuration management system is part of the project management information system (PMIS). It contains the organization's standardized configuration management tools, processes, and procedures that are used to track and control the evolution of the project documentation.

TRICKS OF THE TRADE® The project management information system (PMIS) includes standardized forms, reports, processes, procedures, and software for storage and retrieval of project artifacts. It is part of an organization's enterprise environmental factors and it is here where you will store all project artifacts, including the change control and configuration management systems to track and control project changes and artifact versioning.

Putting the Project Management Plan Together The project management plan, including the individual management plans and the scope, schedule, and cost baselines, is created by completing the activities described in the Planning column of Rita's Process Chart™(discussed in chapter 3). Once the project management plan is complete, the sponsor or key stakeholders review and approve it. The Develop Project Management Plan process must result in a project management plan that is bought into, approved, realistic, and formal. In other words, the project management plan needs to be agreed to by those involved in the project, it needs to be formally approved; everyone needs to believe the project can be done according to the plan, and it needs to remain a formal artifact that is revised and used throughout the project. If this is a new concept to you, make sure you spend time thinking about how to accomplish this in the real world.

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Let's see how everything connects so far by looking at figure 4.2.

A need is identified: "What do I want?"

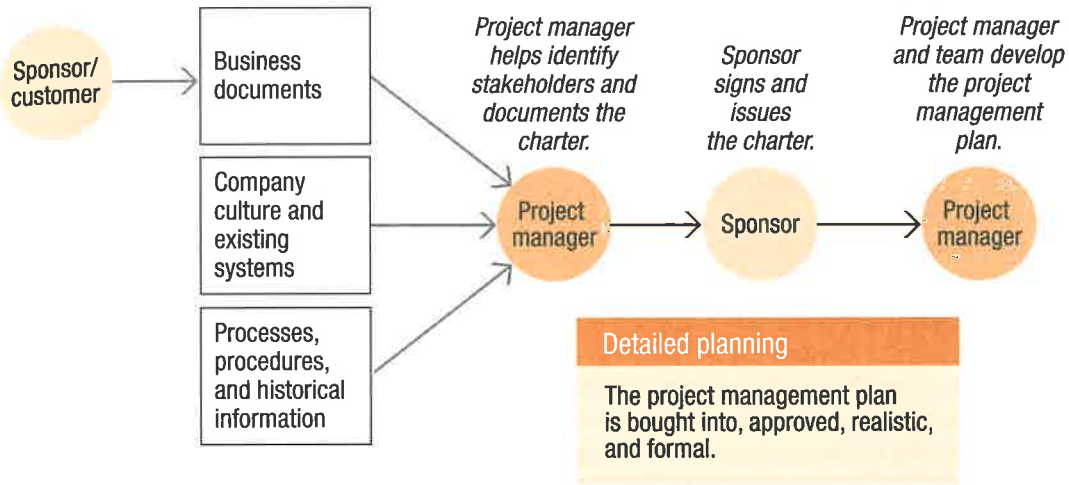

FIGURE 4.2 *Project initiating and planning*

Once the project management plan has been completed, the project manager uses it as a tool to help manage the project on a daily basis. It is not just a document created for the sponsor and other key stakeholders. Although it may evolve over the life of the project through progressive elaboration or approved changes, the project management plan is designed to be as complete as possible when project executing begins.

4.2 Exercise Test yourself! In your Exercise Notebook, make a list of the specific actions required to create a project management plan that is bought into, approved, realistic, and formal.

Answer Some of the possible answers to this exercise include:

- Select the best life cycle and development approach for the project.
- Agree on processes to report, control, incorporate changes, and communicate changes.
- Analyze the stakeholders' needs, wants, expectations, and assumptions.
- Capture the project requirements as completely as possible.
- Work with team members to estimate the project.
- Give team members a chance to approve the final schedule that converts the team's activity estimates into a calendar schedule.
- Get resource managers to approve the schedule and confirm when their resources will be used.
- Work through iterations of the plan (for example, update the work breakdown structure after you complete risk analysis).
- Create the necessary supporting project documents (for example the stakeholder register).
- Apply risk reserves to the project schedule and budget.
- Let the sponsor know if any of the project requirements that were outlined in the project charter cannot be met.

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- Perform schedule compression (crash, fast track, change scope or quality, etc.), and present options to the sponsor.
- Look for impacts on your project from other projects.
- Make sure the approach and processes are consistent with the PMO and/or program management plan, if the project is part of a program.

If you included most of the answers from the previous list, you are in good shape. But why is it so important to have a project management plan that is realistic and that everyone believes can be done? Because while the work is being done, you will need to measure progress against the project management plan to see how the project is going. The end date, end cost, and other constraints in the project must be met. There are no excuses. You will use the project management plan (including the scope, schedule, and cost baselines) as a measurement tool to make sure the project delivers within these constraints.

So when you think of the project management plan, think of all the facilitations, meetings, sign-offs, interactions with other projects, conflict resolution, negotiations, schedule compressions, etc. that will be required to bring the plan to the point of being bought into, approved, realistic, and formal. Expect questions on the exam about how to use your skills to develop the project management plan, as well as how it makes a difference as you manage work on the project and solve challenges that occur.

Project Documents The *PMBOK® Guide* uses the term "project documents" to refer to any project-related documents that are not part of the project management plan. They include the assumption and issue logs, cost and duration estimates, lessons learned register, project schedule and resource calendars, quality reports, resource requirements along with requirements documentation, and other such documentation (see page 89 in the *PMBOK® Guide* for a longer list of examples). While the sponsor and/or key stakeholders will see and approve the project management plan, most project documents (excluding some documents such as the charter, agreements, contracts, and statements of work) are created by the project manager and typically do not require sponsor approval.

Due to the iterative nature of planning and the nature of the work throughout the rest of the project, project documents must be updated frequently. Though this book will not cover these updates as an output of every process, know for the exam that project documents updates are an output of many project management activities.

Project Management Plan Approval Since the project management plan is a formal document, it typically requires formal approval by management, the sponsor, the project team, and other key stakeholders. Formal approval means sign-off (signatures). If the project manager has identified all stakeholders and their requirements and objectives, included the appropriate project and product scope in the plan, and dealt with conflicting priorities in advance, getting the project management plan approved should be relatively straightforward.

Kickoff Meeting Before the Develop Project Management Plan process can be completed and project executing can begin, a kickoff meeting should be held. This is a meeting of the key parties involved in the project to announce the start of the project, to ensure everyone is familiar with its details—including objectives and roles and responsibilities—and to ensure a commitment to the project from everyone. In addition to introducing those involved in the project, the meeting may review such items as milestones, risks, the communications management plan, and the meeting schedule.

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Direct and Manage Project Work PAGE 90

This process represents the integration aspect of project executing—the part of the project where the work is done to build the product of the project. In Direct and Manage Project Work, the project manager integrates all the executing work into one coordinated effort to accomplish the project management plan and produce the deliverables. In addition, Direct and Manage Project Work involves gathering work performance data, creating and using the issue log, requesting changes, and completing the work resulting from approved change requests.

PMBOK® Guide
PG: Executing
Process: Direct and Manage Project Work

These tasks involve managing the work and keeping people engaged. Ultimately, it's about being of service to the team to help them get the work completed, ensuring a common understanding of the project among stakeholders, and keeping everyone informed by documenting and facilitating issue resolution. The project manager also facilitates meetings and technical discussions, uses the work authorization system[6] (part of the PMIS) to keep the team and functional managers informed of upcoming work assignments and milestones, helps remove roadblocks, works on process improvement, and informs other departments within the organization how the project may affect their work.

ECO
Domain: II
Task: 1, 10, 12, 16, 17

Integration management requires project managers to keep all knowledge areas and constraints in mind at all times and to properly look at how issues relating to one knowledge area affect other knowledge areas (for example how scope management issues can affect quality and resource management).

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If you have never used a work authorization system, imagine a large construction project with hundreds of people working on the project. Can you have a plumber and an electrician show up to work in one small area at the same time? No. Remember that a project is planned to the level of detail needed for that project. To handle these types of situations, a work authorization system is put in place to make sure work is only started when a formal authorization is given. In many cases, this tool is a company-wide system and not created just for the project. The term could appear in a question on the exam or be included as an answer choice.

Depending on the needs of the project and its development approach, the use of meetings as a tool can range from informal stand-up sessions to structured meetings with an agenda that focuses on a specific aspect of the project. Other meetings may include project updates, lessons learned, upcoming project activities, and risk management or change control.

The Direct and Manage Project Work process can be illustrated as shown in figure 4.3. The primary outcomes of this process include completed deliverables along with any new work performance data and change requests. Other outputs are updates to organizational process assets and project artifacts.

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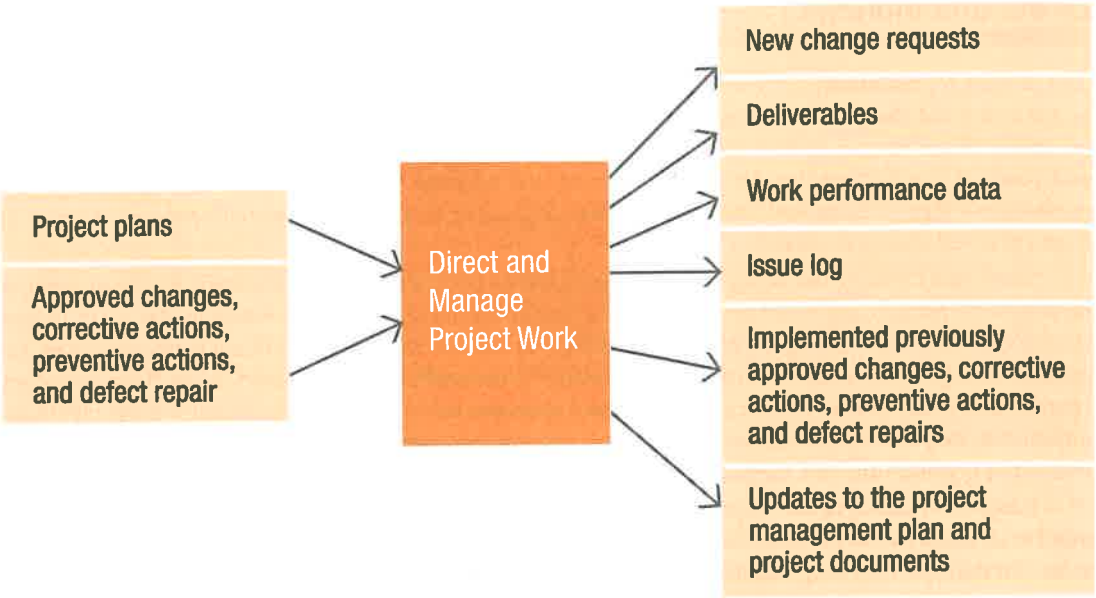

FIGURE 4.3 *Direct and Manage Project Work process*

4.3 Exercise What are some of the most likely project artifacts to be updated as an outcome of the Direct and Manage Project Work process? Write the answer in your Exercise Notebook.

Answer Project artifacts that may be updated as a part of this process include the following:

- Project management plan
- Requirements documentation
- Activity list
- Assumption and issue logs
- Lessons learned, stakeholder, and risk registers

TRICKS OF THE TRADE Keep in mind as you read the rest of this book, that for every process there are project artifacts that are likely to be updated. Be sure you know all the outputs for each project management process as you'll likely get several questions on the exam that test your knowledge and understanding of these artifact updates.

Manage Project Knowledge PAGE 98

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PG: Executing
Processe: Manage Project Knowledge

ECO
Domain: II
Task: 10, 12, 16, 17

A project doesn't—or at least shouldn't—exist in a vacuum. Think of the tremendous amount of knowledge required to properly plan and execute a project. Project managers can benefit from the knowledge base the organization has accumulated over time, particularly from the experiences and discoveries of others on past, similar projects. The Manage Project Knowledge process requires each project to actively contribute to that knowledge base. This includes sharing new processes, successes, etc., internally within the project, as well as making that knowledge accessible throughout the entire organization.

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Information and Knowledge Management Successful and consistent knowledge and information sharing contributes to a more productive work environment and increases the ability of project teams to achieve project and organizational objectives. Successful knowledge management requires an organizational culture of trust in which the project manager and stakeholders exchange knowledge without fear of judgment. The project manager needs to foster an environment that will support collaboration and knowledge sharing. As an example, discussion forums and other interactive online tools may help to facilitate this type of environment. It's also important to note that new knowledge to be shared may involve experiences that did not work out as planned. The project manager can learn from each unidentified stakeholder, each missed risk trigger, and each unrealistic schedule. Sharing such information and possibly saving another project or person from a similar issue is invaluable. This philosophy has evolved in the traditional project management world and was built into agile project management from the beginning.

Knowledge management also includes two distinct types of knowledge—explicit and tacit. Explicit knowledge is fact-based and can be easily communicated through words and symbols. Traditional lessons learned, processes and procedures, and other information repositories fall under this knowledge type. These are generated and shared as the project is ongoing and consolidated as part of project closing. Explicit knowledge, however, may need explanation or context to provide value.

Tacit knowledge, on the other hand, may provide context or explanation to explicit knowledge. It includes emotions, experience, and ability, which are difficult to communicate in words and symbols but can be learned through job shadowing or apprenticeship.

On the exam, you may encounter situational questions that test your understanding of sharing knowledge and information. You may be asked how to establish an environment that encourages the project team to share tacit and explicit knowledge. Or you may be asked how a project manager would make adjustments to an environment that isn't functioning as intended. Answers might include such actions as holding retrospective sessions and engaging in interactive communication with individual stakeholders.

You should also be aware that legal and regulatory requirements and constraints such as nondisclosure agreements may limit or impact the gathering and sharing of particular information. For example, on a project involving development of banking software, the team may have access to personal and financial information of customers of the bank for which the software is being developed. This is an obvious example of information that team members would not be permitted to share, other than in the context of the project work.

The Knowledge Management Process It's important to consider project artifacts such as the project management plan and project documents (like the lessons learned register and project team assignments, for example), along with deliverables as inputs to the Manage Project Knowledge process. Techniques for learning and sharing knowledge may include workshops, training, and observation. Simply asking, "Walk me through how you would do this task," can encourage understanding. Informal sharing occurs through the application of interpersonal and team skills, including active listening and networking. The agile concept of osmotic communication describes the phenomena of communication and knowledge sharing being facilitated and enhanced simply by team members being in proximity to one another.

You will see the topic of lessons learned mentioned often throughout this book, both as an input to and an output of many processes. As an input, they help improve the current project. As an output, they help make the organization better. They are defined as "what was done right, what was done wrong, and what would be done differently if the project could be redone." Accurately and thoroughly documenting lessons learned is a professional responsibility, and the lessons learned register is the main output of this process. Lessons learned should include an overview of each situation, what was done, the impact of actions taken, and the resulting updates to project artifacts. You should also be aware that your organization may have a template to be used for lessoned learned. Be sure to determine how to develop your lessons learned register early on in your project.

In the first chapter of this book, we described lessons learned under "General PMI-isms." Lessons learned are an essential asset to managing a project, as they are taken into account as well as created throughout a project.

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To make lessons learned as valuable as possible, use categories to ensure that all are captured. Some categories that should be captured are:

- **Technical aspects of the project** What was right and wrong about how we completed the work? What did we learn that will be useful in the future? (Examples include acceptable metrics and variance levels, new processes, improved or revised processes for particular results, and the effectiveness of particular acceptance criteria.)
- **Project management** How did we do with WBS creation, risk planning, etc.? What did we learn that will be useful in the future? (Examples include recommendations for transitioning project results to the business and operations teams, recommended changes to the organization's procurements process, and experiences working with particular sellers.)
- **Management** Lessons from communications and leadership as a project manager. What did we learn that will be useful in the future? (Examples include the results of stakeholder analysis and stakeholder engagement efforts.)

TRICKS OF THE TRADE® Many project managers do not understand the role of lessons learned on projects. Figure 4.4 helps explain their function.

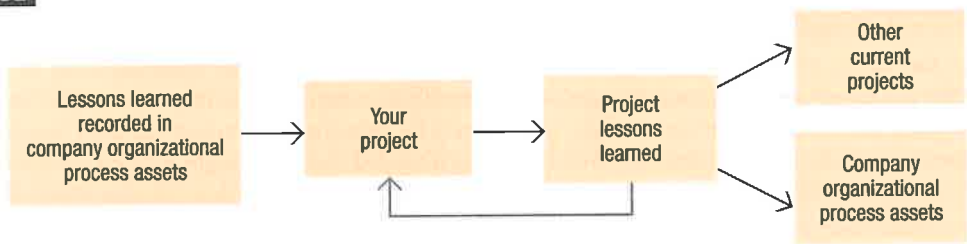

FIGURE 4.4 *Lessons learned on a project*

Monitor and Control Project Work PAGE 105

PMBOK® Guide
PG: Monitoring and Controlling
Process: Monitor and Control Project Work

ECO
Domain: II
Task: 1, 12, 13, 17

The Monitor and Control Project Work process is done from project initiating through closing and involves looking at what is happening on the project and comparing the actual and forecasted performance to what was planned. This process involves aggregating the work performance information from the project management processes relating to monitoring and controlling to evaluate and assess how their individual results are impacting plans and baselines. For example, scope may be completed but the quality may not be acceptable, or the schedule might be met but at excessive cost. This process also involves monitoring other performance requirements that were included in the project management plan.

This work encourages a holistic view of project performance and enables the project manager to take appropriate action to keep the project on track. The integration function of Monitor and Control Project Work also includes activities such as analyzing and tracking risks, performing quality control activities, assessing possible outcomes across the project using data analysis techniques (including alternatives, cost-benefit, earned value, root cause, trend, and variance analysis), and reviewing changes and corrective actions made on the project to see if they were effective.

TRICKS OF THE TRADE® If the exam talks about monitoring and controlling project work, it may not be referring to the entire monitoring and controlling process group. Instead, it may be referring to the specific integration management process: Monitor and Control Project Work. Remember that monitoring and controlling means measuring against the project management plan.

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Many project managers do not control their projects to the project management plan. If the exam asks what you should do if a work activity on the project takes longer than estimated, the answer is to request corrective action (discussed later in this section) to make up for the delay. Such action keeps the project on or close to schedule and allows the project manager to feel comfortable that the scope will be completed according to the budget and schedule agreed to.

This effort may result in change requests, work performance reports, and updates to project artifacts. The change requests from this and other processes are evaluated and approved, rejected, or deferred in the Perform Integrated Change Control process, described later in this chapter.

The following sections highlight some important concepts related to the Monitor and Control Project Work process.

Change Requests Change requests can have differing focuses, depending on which process they are generated in. Changes may involve additions to the project requested by the customer, changes to the plan that the team believes would make their work more efficient, or even changes to the policies and procedures used on the project. Needed changes are identified as you manage the execution of the project and as part of monitoring and controlling when you measure project performance against the baseline. See the "Perform Integrated Change Control" section for more about changes.

Change requests are generated from many processes. The three main categories into which they fall are corrective action, preventive action, and defect repair. Note that corrective and preventive actions should take place within the existing project baselines, should not change, and should be reviewed and approved, rejected, or deferred as part of the Perform Integrated Change Control process, as outlined in the change management plan.

Corrective Action A corrective action is any action taken to bring expected future project performance in line with the project management plan. Since corrective actions deal with actual deviations, you need a realistic performance measurement baseline and/or project management plan, including acceptable variances to determine when a variance has occurred and when corrective action is needed. Those who have serious problems with this in the real world have problems on the exam. What do you do on your projects? Do you have predetermined areas to measure, and have you identified an acceptable range in which the measurements can fall (control limits) to determine if a project is on schedule and on budget?

You cannot simply jump in and start implementing corrective actions. Instead, you need to:

- Have a realistic project management plan to measure against.
- Create metrics during project planning that cover all aspects of the project.
- Consciously focus on identifying areas that need corrective action.
- Look for problems using observation, active listening, and measurement rather than waiting for them to be brought to your attention.
- Know when the project is off track and requires corrective action.
- Find the root causes of variances.
- Measure project performance after a corrective action is implemented to evaluate the effectiveness of the corrective action.
- Determine whether there is a need to recommend further corrective action.
- Continue to measure throughout the project.

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TRICKS OF THE TRADE As you can see, a significant portion of the project manager's time while the project work is being done is spent measuring performance and implementing corrective actions as needed. You can expect questions about this on the exam. Do not expect all these questions to use the words "corrective action," however. Some questions may just describe a situation and ask you, "What is the best thing to do?" To answer those types of questions, you need to know when to look for corrective actions.

Preventive Action While taking corrective action involves dealing with actual deviations from the performance measurement baseline or other metrics, taking preventive action means dealing with anticipated or possible deviations from the baseline and other metrics. Knowing when preventive action is needed requires more experience than calculation because you are evaluating trends in the measurement analysis and anticipating that, if they continue, they could lead to deviation from the baseline or other metrics. Examples of preventive actions include:

- Adjusting the project to prevent the same problem from occurring again later in the project.
- Changing a resource because the resource's last activity nearly failed to meet its acceptance criteria.
- Arranging for team members to take training in a certain area because there is no one with the necessary skills to back up a team member who may unexpectedly get sick.

Proposed changes that would affect the baselines, policies or procedures, charter, contracts, or statements of work would likely have to go to the change control board or sponsor for approval, as outlined in the change management plan.

Defect Repair[7] Defect repair is another way of saying "rework." Defect repair may be requested when a component of the project does not meet specifications. As with corrective and preventive actions, any defect repairs should be reviewed and approved or rejected as part of Perform Integrated Change Control.

Perform Integrated Change Control PAGE 113

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PG: Monitoring and Controlling
Process: Perform Integrated Change Control

ECO
Domain: II
Task: 10, 12, 16, 17

In the previous section we introduced the three main categories of changes requested on a project. All change requests are evaluated and accepted, rejected, or deferred in the Perform Integrated Change Control process. A key focus of integrated change control[8] is to look at the impact of each change on all the project constraints, the value of which is to reduce the potential risk of not fulfilling project objectives. For example, any scope change needs to be assessed for its impact on quality, risk, schedule, cost, resources, and customer satisfaction.

Integrated change control also ensures that as changes are accepted, updates and re-planning efforts are completed, and project artifacts are updated to make sure the project team is always working with current project artifacts. The approved changes are then implemented in Direct and Manage Project Work, Control Quality, and Control Procurements.

So, do you need to go through Perform Integrated Change Control to make changes to processes or plans that haven't been finalized? No! When developing the project charter, project management plan, and baseline, changes can be made without a formal change request. But after the charter or the project management plan have been approved, requested changes need to be evaluated in the context of integrated change control.

TRICKS OF THE TRADE Read exam questions carefully to understand whether a requested change pertains to something that is still in the process of being finalized or has already been finalized. This will help you determine whether integrated change control is required.

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Integrated change control can be a difficult topic on the exam for people who do not work on projects that have formal change procedures. It can also be difficult for project managers who simply estimate the cost and/or schedule impact of a change and stop there, rather than looking for the impacts of a change on the other parts of the project. You can check your understanding of this topic with the following example:

A stakeholder wants to add scope to the project. You estimate that the change will add two weeks to the project duration. What do you do next?

Do not simply read on! Try to answer the question. Understanding the Perform Integrated Change Control process is very important. So what is your answer? Is it to look for ways to save time so the change can be accommodated? Or should you get the change approved? How about asking for an extension of time to accommodate the change?

None of the previous choices are correct. Instead, the next thing to do would be to see how the proposed change impacts project cost, quality, risk, resources, and possibly customer satisfaction. Whenever the exam mentions change, keep in mind that a change to one of the project constraints should be evaluated for impacts on all the other constraints.

Are changes bad? In plan-driven project management and in some industries this may be a controversial question. Changes can have negative effects as they may be expensive or disrupt the project. The cost of change tends to increase as the project progresses. The function of each process within monitoring and controlling is to control changes. In an agile (or change-driven) environment, however, accommodating many changes is assumed to be an ongoing part of the project management process. The definition of scope is emergent rather than defined at the beginning of the project. But even in change-driven environments change needs to be carefully planned and managed.

A project manager should work to prevent the root cause of unnecessary changes. The need for changes in a plan-driven environment may indicate that the project manager did not fully identify stakeholders and uncover their requirements, plan for risk, or properly complete other project management actions.

To control changes on a plan-driven project, the project manager should:

- Work to obtain complete and thorough requirements as soon as possible.
- Spend enough time on risk management to comprehensively identify the project's risks.
- Establish schedule and cost reserves (see the "Risk" chapter).
- Have a process in place to manage change.
- Follow the change management process.
- Have a process and templates in place for creating change requests.
- Have clear roles and responsibilities for approving changes.
- Allow only approved changes to be executed.
- Reevaluate the business case in the project charter if the number of changes becomes excessive.
- Consider terminating a project that has excessive changes and starting a new project with a more complete set of requirements.

Changes can be grouped into two broad categories—those that affect the baselines, policies and procedures, charter, or contracts, or statements of work, and those that do not. If a change does not affect these artifacts, a company's change management policies may allow the project manager to approve the change. If, on the other hand, the change does affect those key elements, the change typically needs to go to a change control board and/or sponsor for a decision.

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Change Control Board (CCB)[9] Depending on the project manager's level of authority, their role might be to facilitate decisions about certain changes, rather than actually make the decisions. Many projects have formally established change control boards responsible for reviewing change requests in accordance with the change management plan for the project. The CCB then approves, defers, or rejects the changes. The results of the decisions are documented in the project's change log. The board may include the project manager, the customer, experts, the sponsor, functional managers, and others. For the exam, assume that most projects have change control boards—with the possible exception of change-driven projects.

Summary Process for Making Changes The exam has many situational questions that deal with how to make changes. Here are two examples.

Question A functional manager wants to make a change to the project. What is the first thing a project manager should do?

Question Someone wants to make a change to the project scope. What is the best thing to do first?

TRICKS OF THE TRADE The answers are the same in either case. A trick for answering questions that ask about the process for making changes is to know that, on a high-level basis, the project manager should follow these steps:

1. **Evaluate the impact** Evaluate (assess) the impact of the change on all aspects of the project (for example, this change will add three weeks to the project length, require $20,000 additional funding, and have no effect on resources).
2. **Identify options** This can include cutting other activities, compressing the schedule by crashing or fast tracking, or looking at other options. For example, you may be able to decrease the potential effect of the change on the project by spending more time decreasing project risk, or by adding another resource to the project team.
3. **Get the change request approved internally.**
4. **Get customer buy-in** (if required).

Note in the previous steps that changes are always evaluated before any other action is taken. In most cases, evaluation involves using data analysis techniques to determine the impact of the change on all the project constraints.

Next, options to handle the change, such as crashing, fast tracking, reestimating, and using "what if" analysis are considered and evaluated. (See the "Schedule" chapter for a discussion of crashing, fast tracking, and reestimating.)

Do you remember the following question from earlier in the chapter? It is an example of the type of question you may see on the exam:

A stakeholder wants to add scope to the project. You estimate that the change will add two weeks to the project duration. What do you do next?

Notice how the following question is different:

A change in scope has been determined to have no effect on the project constraints. What is the best thing to do?

Be careful when reading these questions. Expect the right answer to depend on other details in the question. Sometimes evaluation has been done, so the best thing to do is to look for options. Sometimes evaluation and looking for options have been done, and the best thing to do is to meet with the sponsor or change control board.

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In the second question, evaluation (step 1 in the previous Trick of the Trade) has been done. The answer would be to look for options (step 2 in the Trick of the Trade), and then meet with the sponsor or change control board (step 3 in the Trick of the Trade) to discuss the change and its lack of impact on the project constraints. After informing the sponsor or change control board, the project manager may inform the customer using the process defined in the communications management plan (step 4 in the Trick of the Trade).

TRICKS OF THE TRADE

Detailed Process for Making Changes Now that you know the high-level process, let's look at a more detailed process for making changes:

1. **Prevent the root cause of changes** The project manager should not just focus on managing changes; they should proactively eliminate the need for changes.
2. **Identify the need for a change** Changes can come from the project manager, as a result of measuring against the performance measurement baseline, or from the sponsor, the team, management, the customer, or other stakeholders. The project manager should be actively looking for changes from all these sources because discovering a change early will decrease the impact of the change.
3. **Evaluate the impact of the change within the knowledge area** If it is a scope change, how will it affect the rest of the scope of the project? If it is a schedule change, how will it affect the rest of the schedule for the project?
4. **Create a change request** Changes can be made to the product scope, any part of the project management plan, contracts, charter, statements of work, policies and procedures, or even the performance measurement baseline. The process of making a change should follow the change management plan.
5. **Perform integrated change control** How will the change affect all the other project constraints?
   a. **Assess the change** Does the change fall within the project charter? If not, it should not be a change to your project; it may be an entirely different project. If the change is not beneficial to the project, it should not be approved. Also note that any change for which a reserve has been created (a previously identified risk event) would be accounted for in the project management plan as part of risk management efforts and should be handled as part of the Implement Risk Responses process rather than Perform Integrated Change Control. The techniques of alternative and cost-benefit analysis are helpful in understanding the full impact of a change request.
   b. **Identify options** Actions to decrease threats or increase opportunities include compressing the schedule through crashing or fast tracking, changing how the work is performed, adjusting quality, or cutting scope so that the effect of the change will be minimized. Sometimes it may be necessary to accept the negative consequences of a change, if the positive impact that would result from the change is more valuable to the project. It is a matter of balancing project constraints. For example, the benefits of adding new scope to the project may outweigh the negative impact of adjusting the schedule to accommodate the additional time the change would require. (See the "Schedule" chapter for a discussion of the critical path.)
   c. **Get the change approved, rejected, or deferred** Again, the project manager may be able to approve many changes. But those that affect the project management plan, baselines, charter, etc., would likely need to go to a change control board and/or the sponsor. Decision-making techniques help in this effort. The approved changes are then implemented in the Direct and Manage Project Work, Control Quality, and Control Procurements processes.

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d. **Update the status of the change in the change log** This helps everyone know the status of the change. If a change is not approved, the reasons it was rejected should be documented.

e. **Adjust the project management plan, project documents, and baselines as necessary** Some approved changes need to be incorporated into the project baselines. The changes could affect other parts of the project management plan or project documents or could affect the way the project manager will manage the project. Project documentation must be updated to reflect the changes. This means replanning must be done to incorporate the impacts of the change into the new version of the documents and plan before the team starts executing the change. For example, if there is a change in scope, the scope baseline (the WBS, WBS dictionary, and project scope statement), the project management plan, and the requirements traceability matrix should be updated. If that change in scope affects other areas of the project, the associated documentation (such as the activity list, resource management plan and other resource documentation, schedule, budget, or risk register) also needs to be updated.

6. **Manage stakeholders' expectations by communicating the change to stakeholders affected by the change** How often do you remember to do this? You could think of this, in part, as configuration management (version control to make sure everyone is working off the same project documentation).

7. **Manage the project to the revised project management plan and project documents**

Agile Change Management In agile and hybrid environments, the change control process is streamlined as there could be a dozen changes to evaluate and make decisions about every day. Waiting for a formal change control board to meet, discuss, and decide on each change would likely introduce too many delays. Instead, agile and hybrid approaches delegate much of the decision-making authority to the product owner. Changes that would not significantly alter the outcome or benefits of the project will be authorized by the product owner. This way the project team is not delayed waiting for the change control.

Note that there are some additional guidelines in relation to agile change management. For example, the product owner is typically given a description of business benefits to deliver within a firm budget and timeline. Changes that would impact the intended benefits or require more time or budget than tolerances allow still need to be escalated outside the project to a steering committee or sponsors for approval. However, everyday decisions and minor changes that come with building something new or complex are managed within the team.

4.4 Exercise Test yourself! In your Exercise Notebook, list some common changes on projects and what you would do to manage each change.

Answer Because of the wide variety of possible changes that may occur throughout the life of a project, this exercise only includes one answer, but it will help you prepare for questions related to change on the exam.

Common Change	How to Handle It
Customer wants to add scope	Make sure you know what the specific scope is and why it is necessary. Make sure all the data required in the change request is filled out. Assess the change, including whether reserves were allocated on the project to accommodate the addition of the scope. Evaluate the impact of the change. Look for options. Have the change reviewed by the change control board if necessary.

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Close Project or Phase PAGE 121

You need to understand that the Close Project or Phase process (also known as Plan and Manage Project/Phase Closure or Transitions) finalizes all activities across tasks and processes to formally close the project, phase, or transition. Plan-driven projects generally have transitions between phases and then a transition at the end, while change-driven projects are organized around more frequently occurring iteration cycles according to a product release plan. In either case, similar activities need to be completed to close a project once its phases or iterations have been completed.

PMBOK® Guide
PG: Closing
Process: Close Project or Phase

ECO
Domain: II
Task: 12, 16, 17

TRICKS OF THE TRADE Is your project really done when the technical work is done? Not if you don't close it out! The Close Project or Phase process encompasses the actions of closing as outlined in the project management plan. For example, financial and procurement closures should be completed, and you must ensure final confirmation work is done and that requirements are fulfilled. Then the product is handed off to the customer and customer feedback is solicited. Appropriate indexing and archiving of records also occurs, including final lessons learned.

There are many inputs to this process, such as all the accumulated work performance data, information and reports, communications, and updates that have been created during the project, including the following:

- The charter—to confirm that exit criteria was met
- The business case—to validate that it was fulfilled
- The benefits management plan—to evaluate and report on benefits delivery
- The project management plan—to confirm that all planned work was completed within baselines with approved changes
- Deliverables—to complete the final review for acceptance and transition to ongoing business
- The lessons learned register—to archive lessons learned in the lessons learned repository
- The risk register and the risk report, with final data on which risks occurred and how the strategies worked—to confirm that all risks were managed successfully
- The change log—to evaluate the number of changes and the impact of those changes on the project
- Agreements and procurement documentation—to confirm that all contracts are closed

The project manager will work with subject matter experts to analyze the data, including all the project artifacts, and complete the final work to close the project. Regression analysis will be done to examine the project variables—such as the schedule, budget, and risks that occurred—and how they impacted the project and its outcomes. The project manager will look at planned versus actual project results, identify variances to the plan along with their impacts, and identify additional lessons learned that can be shared or used in the organization.

A project manager must get formal acceptance of the project and its deliverables, issue a final report that shows the project has been successful, issue the final lessons learned, and index and archive all the project records. Do you understand the importance of the items in the closing process group? Make sure you are familiar with the concepts and actions listed here, and, if you do not currently do these things on your projects, imagine completing these activities in the real world. For the exam, be sure to remember that you always close out a project, no matter the circumstances under which it stops, is terminated, or is completed!

There are financial, legal, and administrative efforts involved in closing. Let's look again at the activities associated with closing.

- Confirm work is done to requirements.
- Complete final procurement closure.
- Gain final acceptance of the product.

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- Complete financial closure.
- Hand off completed product.
- Solicit customer's feedback about the project.
- Complete final performance reporting.
- Index and archive records.
- Gather final lessons learned and update knowledge base.

Note that the Close Project or Phase process involves getting the final, formal acceptance of the project or phase as a whole from the customer, whereas the Validate Scope process in scope management (a monitoring and controlling process) involves getting formal acceptance from the customer for interim deliverables. The project needs both processes.

Does it make sense to you that the Close Project or Phase process is an integration management function? If not, think of the example of final performance reporting. Can you see how you would have to report on all management areas? How about the example of indexing and archiving project records? You need to do so for records from all the areas of project mangement, such as scope, schedule, and cost.

Take some time to think about project closing and how it applies to proper project management before you take the exam.

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Practice Exam

1. You are planning communications on a new service development project. Your stakeholder list is large, but not terribly complicated. Not all stakeholders will understand the need for developing an actual communications plan, and you already have good relationships with most stakeholders on this project. What is one of the major driving forces for communication on a project?
   A. Optimization
   B. Integrity
   C. Integration
   D. Differentiation

2. The customer has accepted the completed project scope. However, the lessons learned required by the project management office have not been completed. What is the status of the project?
   A. The project is incomplete because it needs to be replanned.
   B. The project is incomplete until all project and product deliverables are complete and accepted.
   C. The project is complete because the customer has accepted the deliverables.
   D. The project is complete because it has reached its due date.

3. Your well-planned project is likely to encounter a number of change requests and approved changes during its life cycle. In the change management plan, you have outlined the processes that you and others will use to understand the impacts of changes. Getting stakeholder acceptance of the decisions related to change on this project is critical, as a failed project could impact shareholder value and the earning projections for the organization. Your attention is best focused on which of the following regarding changes on your project?
   A. Making changes
   B. Tracking and recording changes
   C. Informing the sponsor of changes
   D. Preventing unnecessary changes

4. The customer on a project tells the project manager they have run out of money to pay for the project. What should the project manager do first?
   A. Shift more of the work to later in the schedule to allow time for the customer to get the funds.
   B. Close Project or Phase.
   C. Stop work.
   D. Release part of the project team.

5. All the following are parts of an effective change management plan except:
   A. Procedures
   B. Standards for reports
   C. Meetings
   D. Lessons learned

6. A work authorization system can be used to:
   A. Manage who does each activity.
   B. Manage when and in what sequence work is done.
   C. Manage when each activity is done.
   D. Manage who does each activity and when it is done.

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7. Which of the following would be most important to include in a charter for an agile project?
   A. The roles and responsibilities of the team members assigned to the project
   B. Authorization for the product owner to prioritize features to maximize value
   C. The approvals required for specific product development milestones
   D. The preassigned resources available to the project

8. A project is plagued by requested changes to the project charter. Who has the primary responsibility to decide if these changes are necessary?
   A. The project manager
   B. The project team
   C. The sponsor
   D. The stakeholders

9. Effective project integration usually requires an emphasis on:
   A. The careers of the team members
   B. Timely updates to the project management plan
   C. Effective communication at key interface points
   D. Product control

10. The project manager's many responsibilities include being of service to the team, integrating new team members as the project progresses, and ensuring that the project meets its objectives within scope, time, budget, and other constraints. Which of the following best describes the project manager's role as an integrator?
    A. Help team members become familiar with the project.
    B. Put all the pieces of a project into a cohesive whole.
    C. Put all the pieces of a project into a program.
    D. Get all team members together into a cohesive whole.

11. Approved corrective actions are an input to which of the following processes?
    A. Validate Scope
    B. Direct and Manage Project Work
    C. Develop Project Charter
    D. Develop Schedule

12. At various points during project execution, the project manager reviews the project charter. Which of the following best describes what a project charter may be used for when the work is being completed?
    A. To make sure all the team members are rewarded
    B. To help determine if a scope change should be approved
    C. To assess the effectiveness of the change control system
    D. To make sure that all the documentation on the project is completed

13. Which of the following best describes a project management plan?
    A. A printout from project management software
    B. A bar chart
    C. Scope, risk, resource, and other management plans
    D. The project scope

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14. A project management plan should be realistic in order to be used to manage the project. Which of the following is the best method to achieve a realistic project management plan?
    A. The sponsor creates the project management plan based on input from the project manager.
    B. The functional manager creates the project management plan based on input from the project manager.
    C. The project manager creates the project management plan based on input from senior management.
    D. The project manager creates the project management plan based on input from the team.

15. You have taken over a project during project planning and have discovered that six individuals have signed the project charter. Which of the following should most concern you?
    A. Who will be a member of the change control board
    B. Spending more time on configuration management
    C. Getting a single project sponsor
    D. Determining the reporting structure

16. To manage risk for an agile project, which of the following would you be least likely to need?
    A. Risk burndown chart
    B. Risk-adjusted backlog
    C. Risk management plan
    D. Risk-based spike

17. The project manager is working to clearly describe the level of involvement expected from everyone on the project in order to prevent rework, conflict, and coordination problems. Which of the following best describes the project manager's efforts?
    A. Develop Project Management Plan and Plan Quality Management
    B. Manage Stakeholder Engagement and Direct and Manage Project Work
    C. Validate Scope and Control Quality
    D. Identify Risks and Develop Project Team

18. All the following are parts of the Direct and Manage Project Work process except:
    A. Identifying changes
    B. Using a work breakdown structure
    C. Implementing corrective actions
    D. Setting up a project control system

19. A project manager is appointed to head a highly technical project in an area with which this person has limited familiarity. The project manager delegates the processes of Develop Schedule, Estimate Costs, Define Activities, and Estimate Activity Resources to various project team members, and basically serves as an occasional referee and coordinator of activities. The results of this approach are likely to be:
    A. A team functioning throughout the project at a very high level, demonstrating creativity and commitment
    B. A team that initially experiences some amounts of confusion, but that after a period of time becomes a cohesive and effective unit
    C. A team that is not highly productive, but that stays together because of the work environment created by the project manager
    D. A team that is characterized by poor performance, low morale, high levels of conflict, and high turnover

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20. You are in the middle of leading a major modification project for an existing manufactured product when you learn that the resources promised at the beginning of the project are not available. According to your plans, these resources will be needed soon, and their unavailability will affect your timeline and possibly other aspects of the project. What is the best thing to do?
    A. Show how the resources were originally promised to your project.
    B. Replan the project without the resources.
    C. Explain the impact if the promised resources are not made available.
    D. Crash the project.

21. The project manager has just received a change request from the customer that does not affect the project schedule and is easy to complete. What should the project manager do first?
    A. Make the change happen as soon as possible.
    B. Contact the project sponsor for permission.
    C. Go to the change control board.
    D. Evaluate the impacts on other project constraints.

22. You are the project manager for an existing year-long project that must be completed. Your company just won a major new project. It will begin in three months and is valued at $2,000,000. The new project has a greater starting value and is therefore likely to have a higher priority than your project. It may affect your resources. You are concerned about how you will manage your project so that both projects can be implemented successfully. What is the first thing you should do when you hear of the new project?
    A. Ask management how the new project will use resources.
    B. Resource level your project.
    C. Crash your project.
    D. Ask management how the new project will affect your project.

23. In the middle of the project, the project manager is informed by her scheduler that the project control limits are secure. That same morning, she receives a note from a team member about a problem he is having. The note says, "This activity is driving me crazy, and the manager of the accounting department won't help me until the activity's float is in jeopardy." In addition, the project manager has emails from a minor stakeholder and 14 emails from team members. While she is reading the emails, a team member walks into the project manager's office to tell her a corrective action was implemented by a team member from the project management office, but was not documented. What should the project manager do next?
    A. Report the documentation violation to the project management office, evaluate the security of the control limits, and review the emailing rules in the communications management plan.
    B. Clarify the reasoning behind documentation being a problem, get the accounting department to assist the team member, and respond to the minor stakeholder.
    C. Add the implemented corrective action to the change log, discuss the value of documentation at the next team meeting, and smooth the team member's issue with the accounting department.
    D. Find out who caused the problem with the accounting department, respond to the minor stakeholder before responding to the other emails, and review the process in the communications management plan for reporting concerns with the team member having the documentation problem.

24. Which of the following sequences represents straight-line depreciation?
    A. $100, $100, $100
    B. $100, $120, $140
    C. $100, $120, $160
    D. $160, $140, $120

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25. For an agile project, changes are an important part of the process, allowing the product owner to maximize value delivery. As the manager of an agile project, how should you approach managing changes?
    A. Changes should be addressed as low as possible on the cost of change curve.
    B. To avoid delays and cost overruns, only changes that add measurable value should be approved.
    C. Agile tools and methods should be used to reduce the number of changes needed and their disruptive impact.
    D. There is no difference in the basis for managing changes on agile projects compared to plan-driven projects.

26. The client demands changes to the product specification that will add only two weeks to the critical path. Which of the following is the best thing for the project manager to do?
    A. Compress the schedule to recover the two weeks.
    B. Cut scope to recover the two weeks.
    C. Consult with the sponsor about options.
    D. Advise the client of the impact of the change.

27. You are asked to prepare a budget for completing a project that was started last year and then shelved for six months. All the following would be included in the project budget except:
    A. Fixed costs
    B. Sunk costs
    C. Direct costs
    D. Variable costs

28. A project is chartered to determine new ways to extend the product life of one of the company's medium-producing products. The project manager comes from the engineering department, and the team comes from the product management and marketing departments.

    The project scope statement and project planning are completed when a stakeholder notifies the team that there is a better way to complete one of the work packages. The stakeholder supplies a technical review letter from his department proving that the new way to complete the work package will actually be faster than the old way.

    The project manager has had similar experiences with this department on other projects, and was expecting this to happen on this project. What is the first thing the project manager should do?
    A. Contact the department and complain again about their missing the deadline for submission of scope.
    B. Determine how this change will impact the cost to complete the work package and the quality of the product of the work package.
    C. See if there is a way to change from a matrix organization to a functional organization so as to eliminate all the interference from other departments.
    D. Ask the department if they have any other changes.

29. The CFO is a key stakeholder on your agile project. One day he emails you, "I just saw the backlog, and we have a problem! We need to update the descriptions of stories 12.4 to 12.6 to reflect our new digital business strategy." How should you respond?
    A. The backlog has already been prioritized based on the features that will add the most business value.
    B. I noticed that and have already referred this request to the change control board for approval.
    C. The team has already made those updates, they will be included in the next backlog version.
    D. I will refer this request to the product owner, who will decide what to do about it.

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30. All the following occur during the Close Project or Phase process except:
    A. Creating lessons learned
    B. Formal acceptance
    C. Performance reporting
    D. Performing cost-benefit analysis

31. The project manager can help influence the processes that affect change on projects by creating and using the most appropriate planning strategies and tools. Assuming the project manager has created and is executing the best possible project management plan, the project sponsor should help the project manager to protect the project against unnecessary changes. Which of the following best reflects the phrase, "influencing the factors that affect change?"
    A. Telling people that changes are not allowed after planning is complete
    B. Determining the sources of changes and fixing the root causes
    C. Adding more activities to the work breakdown structure to accommodate risks
    D. Calculating the impact of changes to date on the project

32. You are managing an agile project with a high level of requirements uncertainty. What is the best way to manage changes throughout the project to ensure the project goals are met?
    A. Ask the development team to create a change management plan before the work begins.
    B. Delegate authority to the team and the product owner to manage changes as they arise.
    C. Prepare a comprehensive change management plan, and manage to the plan.
    D. Ask the product owner to refer all substantive changes to the change management team.

33. The organization is about to begin a series of similar projects. The projects will be managed consecutively. Each project involves developing an online cooking video focused on foods appropriate to the month in which they will be released. For example, the summer videos will include picnic food and cool treats, and the December video will feature holiday foods for Hanukkah, Christmas, and Kwanzaa. The project sponsor is adamant that the management plan for each project includes an emphasis on making the best possible use of the lessons learned register. He believes that other projects have not been successful because they failed to take advantage of lessons learned from previously completed projects. The lessons learned register should be updated:
    A. At the end of each project phase
    B. Throughout the project
    C. Weekly
    D. At the end of the project

34. Knowledge management is a key responsibility of the project manager. This responsibility includes managing two kinds of knowledge on a project: tacit and explicit. Which of the following definitions are correct?
    A. Tacit knowledge is fact-based and can be easily communicated through words and symbols.
    B. Tacit knowledge may need explanation or context to provide value to recipients of this information.
    C. Tacit knowledge includes emotions, experience, and abilities.
    D. Lessons learned are an example of tacit knowledge.

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Answers

1. **Answer** C
   Explanation The project manager is an integrator. This is a question about your role as an integrator and communicator.

2. **Answer** B
   Explanation Replanning is uncalled for by the situation described. Reaching the planned completion date does not mean the project is necessarily finished. A project is complete when all work, including all project management work, is complete, and the product of the project and all project deliverables are accepted. The lessons learned are project management deliverables, and therefore must be completed for the project to be complete.

3. **Answer** D
   Explanation Project managers should be proactive. The only proactive answer here is preventing unnecessary changes.

4. **Answer** B
   Explanation Every project must be closed, as closure provides benefit to the performing organization. This means simply stopping work is not the best choice. Shifting work and releasing team members will only postpone dealing with the problem, not solve it. The best thing for the project manager to do is begin the Close Project or Phase process.

5. **Answer** D
   Explanation A change management plan includes the processes and procedures that allow smooth evaluation and tracking of changes. Lessons learned are reviews of the processes and procedures after the fact—to improve them on future projects.

6. **Answer** B
   Explanation Who does each activity is managed with the responsibility assignment matrix. When each activity is done is managed with the project schedule. A work authorization system is used to coordinate when and in what order the work is performed so that work and people may properly interface with other work and other people.

7. Answer B
   Explanation Agile project charters tend to be high-level documents that contain less detailed information than charters for plan-driven projects. To manage the higher level of uncertainty and emergent nature of change-driven requirements, teams rely on established agile processes and tools that (among other things) define the team members' working relationships and responsibilities. So it isn't necessary to include that information in the charter. Of the options listed, the most important one to include in an agile charter would be authorization for the product owner to prioritize features to maximize value. It would then be up to the product owner to gain any approvals that are needed for the development milestones. While the preassigned resources available to the project could be listed in the charter, that would be less important than giving the product owner authority.

8. **Answer** C
   Explanation The sponsor issues the project charter, so they should help the project manager control changes to the charter. The primary responsibility lies with the sponsor. Remember that any change to the project charter should call into question whether the project should continue.

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9. **Answer** C
Explanation This question is asking for the most important of the choices. Think about what is involved in integration: project management plan development, project management plan execution, and integrated change control. Updates and product control are parts of project monitoring and controlling, while integration includes more than control. Advancing the careers of team members falls under project executing (the Develop Project Team process). To integrate the project components into a cohesive whole, communication is key whenever one activity will interface with another or one team member will interface with another, and when any other form of interfacing will occur.

10. **Answer** B
Explanation Integration refers to combining activities, not team members.

11. **Answer** B
Explanation Direct and Manage Project Work is the only correct response.

12. **Answer** B
Explanation One way to decide if a change should be approved is to determine whether the work falls within the project charter. If not, it should be rejected, assigned to a more appropriate project, or addressed as a project of its own.

13. **Answer** C
Explanation The project management plan includes more than just a bar chart and the project manager's plan for completing the work. It includes all the management plans for the project.

14. **Answer** D
Explanation To narrow down the answer options, this question could be rephrased to ask, "Who creates the project management plan?" The best answer is that the project management plan is created by the project manager but requires input from the team.

15. **Answer** B
Explanation Determining who will be on the change control board and determining the reporting structure may have already been done. In any case, these choices are not directly impacted by the number of sponsors who have signed the charter. Having a single project sponsor is not necessary. This situation implies that there are six areas concerned with this project. In addition to focusing on the added communications requirements, you should be concerned with competing needs and requirements impacting your efforts on configuration management.

16. **Answer** C
Explanation As the manager of an agile project, you might not need to document the management plans as separate deliverables; instead, you can rely on agile tools and methods to manage emergent threats and scope and maximize value delivery. The agile tools for managing risk include a risk burndown chart, risk-adjusted backlog, and risk-based spikes. These tools can replace a formal risk management plan, so that is the least likely option.

17. **Answer** A
Explanation Notice that this question uses the words "working to clearly describe" and "prevent." Taken together, they should tell you the project is in project planning. This eliminates all choices except Develop Project Management Plan and Plan Quality Management. Coordination and conflict prevention relate to Develop Project Management Plan, and preventing rework is part of Plan Quality Management.

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18. **Answer** D
Explanation A WBS is created in project planning, but can be used to help manage the project during project executing. The wording in the question was not "creating a WBS," but "using a WBS." A project control system is set up during project planning, not during project executing, and therefore is the exception.

19. **Answer** D
Explanation A project manager must manage and integrate all aspects of a project. If all activities are delegated, chaos ensues, and team members will spend more time jockeying for position than completing activities.

20. **Answer** C
Explanation Crashing and replanning are essentially delaying the problem. Instead, the project manager should try to prevent it by showing the consequences if the resources are not available. This is a more effective strategy than saying, "But you gave those resources to me."

21. **Answer** D
Explanation The other impacts to the project should be evaluated first. The change could impact scope, cost, quality, risk, resources, and/or customer satisfaction. Once these are evaluated, the change control board, if one exists, can approve or deny the change.

22. **Answer** D
Explanation You do not have enough information to consider resource leveling or crashing this project. As you work on any project, you need to constantly reevaluate the project objectives and how the project relates to other concurrent projects. Is your project still in line with corporate objectives? If the other project will impact yours, you need to be proactive and work on options now.

23. **Answer** C
Explanation Notice how much information is thrown at you in this question. It is important to practice reading through questions to discover what is important and what is simply background information. In this question, the only thing relevant was the corrective action taken. Once you discover what the primary issue is, look at the choices to find out which is best for addressing that issue. What is the primary issue here? Did you realize the team member's note is about a non-critical path activity? ("Until the project float is in jeopardy" means there is float; thus, the activity is not on the critical path.) So, is the issue the non-critical path activity or the documentation? You might disagree with the logic, but in this case the answer is the documentation. In the real world, problems often repeat. Without a record of what was done, there is no opportunity to consider the same solution for future problems. Documentation is critical to projects. Because the change log becomes part of the historical records database, it is best to first record the corrective action taken, then discuss the value of documentation at the next team meeting, and, finally, smooth the team member's issue with the accounting department.

24. **Answer** A
Explanation Straight-line depreciation uses the same amount each time period.

25. **Answer** A
Explanation On any project, we want to identify and address changes as low as possible on the cost of change curve. This is important for agile projects that rely on emergent scope and incremental development. While agile expects and welcomes changes for the current and future increments in development, once an increment has been built and approved, rework should be avoided if at all possible.

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An agile backlog is subject to continuous changes and tweaks, large and small, by both the product owner and the team members. While their ultimate goal is to maximize value delivery, they don't stop to analyze and measure the impact of each change. Agile tools don't limit the number of changes needed, in fact they make it possible for changes to be made freely as needed.

The approach to managing changes for plan-driven projects does differ from change-driven projects. Since there is less uncertainty about the requirements on a plan-driven project, we can better define the scope upfront—plan the work, and then work the plan.

26. **Answer** C
Explanation Do you remember what to do when there is a change? Evaluate first. You wouldn't take action before getting approval, so compressing the schedule or cutting scope would happen after consulting the sponsor and/or advising the client of the impact of the change. You would not go to the customer before going to your internal management, so advising the client is not the correct thing to do next. The next step is to discuss options with the sponsor.

27. **Answer** B
Explanation Sunk costs are expended costs. The rule is that they should not be considered when deciding whether to continue with a troubled project.

28. **Answer** B
Explanation Complaining about the missed deadline could be done, but it is not proactive. It would be helpful to get to the root cause of why this department always comes up with such ideas or changes after the project begins. However, this is not the immediate problem; the change is the immediate problem, and therefore complaining is not best. The type of project organization described is a matrix organization. There is not anything inherently wrong with such an organization, nor is there anything in this particular situation that would require it to be changed. So, changing the way the company is organized cannot be best. The department's history indicates that asking if the department has other changes is something that should definitely be done, but the proposed change needs more immediate attention. Looking at impacts of the change begins integrated change control.

29. **Answer** D
Explanation Agile projects welcome changes, so you wouldn't tell the CFO that the backlog is already prioritized, implying that no changes can be made. You also wouldn't handle the change yourself since agile project changes are managed by the product owner and the team. Either of the remaining answer options might be plausible, but this doesn't sound like the type of everyday change that the team would handle on their own without a discussion with the product owner. Also, agile backlogs typically don't have "versions"; they are dynamic documents that are continuously being edited and updated. So the best answer is to say that you will refer this request to the product owner, who will decide what to do about it.

30. **Answer** D
Explanation Cost-benefit analysis is done earlier in the project to help select between alternatives. All the other choices are done during the Close Project or Phase process. Therefore, performing cost-benefit analysis must be the best answer.

31. **Answer** B
Explanation A project manager should be looking at where changes are coming from and doing whatever is necessary to limit the negative effects of change on the project. They need to find the root cause, so future changes may be avoided.

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32. **Answer** B
Explanation On a change-driven project with a high level of requirements uncertainty, it won't be helpful to prepare a change management plan to manage changes, regardless of whether the team or the project manager is doing this. Instead, agile projects delegate change management to the team or the project owner, depending on the nature of the change. Agile projects would not benefit from referring changes to a "change management team"; to avoid delaying the work, most changes need to be resolved as they arise.

33. **Answer** B
Explanation The lessons learned register is a living document. It should be updated throughout the project, for the benefit of the current project, future, similar projects, and the organization as whole. The communications management plan documents how new lessons learned should be shared.

34. **Answer** C
Explanation Tacit knowledge includes emotions, experience, and ability. Sharing this type of knowledge requires an atmosphere of trust within the team or organization. The other choices relate to explicit knowledge.

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Scope

FIVE

When managing scope, a project manager must define what work is required and then ensure all of that work—and only that work—is completed. This is generally an easy topic, but we all have gaps in our knowledge. See if the following list helps you uncover gaps in your knowledge.

TRICKS OF THE TRADE® Things to Know about Scope Management for the Exam

- You must plan how you will determine the scope, as well as how you will manage and control scope. This is part of your scope management plan.
- Scope must be clearly defined and formally approved before work starts. If using an adaptive approach, this may be done at a higher, less formal level with a summarized agreement.
- Requirements are elicited from all stakeholders, not just the person who assigned the project.
- Requirements elicitation[1] can take a substantial amount of time, especially on large projects.
- Requirements must be evaluated against the business case, ranked, and prioritized to determine what is in and out of scope.
- A work breakdown structure (WBS)[2] is utilized on all projects that use a predictive approach. Using this tool enables you to clarify identified scope as well as find additional scope.
- A backlog, mindmap, or list, all alternatives to a traditional WBS, may be utilized on projects using adaptive approaches. For example, using a backlog creates visibility into the scope as well as the overall priorities of the project.

QUICKTEST

- Product scope
- Project scope
- Scope management process
- Scope management plan
- Requirements management plan
- Data-gathering techniques
  - Brainstorming
  - Interviews
  - Feature workshops
  - Epics, feature, user stories, tasks
  - Focus groups
  - Questionnaires and surveys
  - Benchmarking
- Requirements documentation
- Project scope statement
- Work breakdown structure (WBS)
  - Decomposition
  - Control account
  - Work package
  - Activity
  - How to create a WBS
  - Benefits of using a WBS
  - Uses for a WBS
- WBS dictionary
- Product backlog
- Product roadmap
- Timeboxing
- Scope baseline
- Group Decision Making
  - Voting
  - Multicriteria decision analysis
- Data representation
  - Affinity diagrams
  - Mind maps
- Requirements categories
  - Business
  - Stakeholder
  - Solution
    - » Functional
    - » Nonfunctional
  - Transition
  - Project
  - Quality
  - Technical
- Interpersonal and team skills
  - Nominal group technique
  - Observation
  - Facilitation
    - » Consensus
    - » User stories
- Context diagrams
- Prototypes
- Acceptance criteria
- Requirements traceability matrix
- Product analysis
- Deliverables
  - Verified
  - Accepted

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- While the project is being completed, you must check to make sure you are doing all the work included in the project management plan—and only that work.
- Gold plating a project (adding unnecessary extras) is not allowed.
- Any change to scope must be evaluated for its effect on time, cost, risk, quality, resources, and customer satisfaction.
- Changes to scope require approval; scope changes should not be approved if they relate to work that does not fit within the project charter.
- The project manager and the project team should continuously determine what is and is not included in the project scope.
- Internal verification followed by customer acceptance of deliverables happens throughout the project.

Note that in a predictive environment, creating a WBS is a required part of project management. If you have never created one or do not currently use a WBS on your projects, this chapter will help you understand how beneficial this tool is and what it can do for you. Remember, the exam asks questions at an expert level and assumes you have experience using various tools.

For the exam, you need to understand the scope management process in the *PMBOK® Guide*, and the Plan and Manage Scope task within domain II (Process) in the ECO. The following should help you understand how the *PMBOK® Guide* and the *Examination Content Outline* (ECO) relate to the process of managing scope.

The Scope Management Process	Done During
Plan Scope Management	Planning process group
Collect Requirements	Planning process group
Define Scope	Planning process group
Create WBS	Planning process group
Validate Scope	Monitoring and controlling process group
Control Scope	Monitoring and controlling process group

ECO Domain II: Process
Task 8: Plan and Manage Scope

These tables show that domain II (Process) task 8: Plan and Manage Scope maps directly to all the Scope Management processes in the *PMBOK® Guide*. Note that for a predictive project life cycle you will definitely need a WBS, while in a more change-driven life cycle you may have a WBS, the product backlog may take its place, or you may have both. Look for evidence in exam questions that tells you which type of life cycle you are dealing with.

Scope Management Fundamentals

You should understand the following concepts for the exam.

Product Scope Product scope is another way to say "requirements that relate to the product, service, or result of the project." It can also be defined as the product deliverables with their associated features and functions. It answers the question, "What end result is needed?" There may be a separate, preliminary

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project to determine product scope, or you may define the requirements as part of your project, depending on the needs of the project and the organization.

Let's look at an example of product scope. On a project to build a new train terminal, the product scope is "a new train terminal that meets these technical specifications." To determine if the project successfully achieved the product scope, the resulting product (the new train terminal) is compared to the product requirements, which were recorded in the requirements documentation and the project scope statement for the project.

Project Scope The project scope is the work the project team will do to deliver the product of the project; it encompasses the product scope. In the train terminal example, the project scope will be "a new train terminal that meets these technical specifications," plus all the work needed to deliver the train terminal. In other words, project scope includes the planning, coordination, and management activities (such as meetings and reports) that ensure the product scope is achieved. These efforts become part of the scope baseline and scope management plan, which are parts of the project management plan. To determine whether the project scope has been successfully completed, the work accomplished is measured against the scope baseline.

The Scope Management Process To avoid the risk that you will read the rest of this chapter and miss an important concept, let's make this point clear right away: There are a lot of acceptable ways to manage scope. If you do it differently than described here, you are not necessarily wrong; you may just be managing scope differently based on the needs of your project. Think of the scope management process as including the following steps when using a predictive project management approach:

1. Develop a plan for how you will plan, validate, and control scope and requirements on the project.
2. Determine requirements, making sure all requirements support the project's business case as described in the project charter.
3. Sort and balance the needs of stakeholders to determine scope.
4. Create a WBS to break the scope down to smaller, more manageable pieces, and define each piece in the WBS dictionary.
5. Obtain validation (signed acceptance) that the completed scope of work is acceptable to the customer or sponsor.
6. Measure scope performance, and adjust as needed.

This means that no one can request or add work that is not related to the reason for initiating the project. Yet, in your real world, do people want work done and try to attach it to any project they can to get that work accomplished? Do you see scope on projects that doesn't support the company's business objectives? It happens all the time. To prevent it, a project manager must be assertive in protecting the project. When you take the exam, assume you have the authority to say no when someone tries to add unrelated scope to your project. Assume you can and do say, "That sounds like it is a separate project. It should go through the project approval process, instead of being added to my project."

On change-driven projects, requirements are identified and documented at a sufficient level of detail so they can be prioritized and estimated at a high level. The work is broken into releases and iterations, and the work of each release or iteration is defined in more detail just before the work is done. Product scope is typically more flexible than for plan-driven projects. For example, as essential product features are delivered in early releases, more optional features may be deferred, sometimes indefinitely.

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Scope Management Planning PAGE 134

PMBOK® Guide
PG: Planning
Process: Plan Scope Management

ECO
Domain: II
Task: 8

Together, the scope and requirements management plans, both of which are part of the project management plan, provide direction on how the project and product scope will be defined, managed, and controlled. The project charter, project life cycle description, and organizational process assets are all inputs to the process of planning scope management. In addition, every project has a development approach. This approach could be plan-driven (predictive or waterfall), change-driven (iterative, adaptive, or agile), or a combination (hybrid). The development approach influences how requirements will be elicited as well as how the scope statement and WBS will be developed (for the entire project at once, or at a high level for the overall project, and then in more detail for each release).

Scope Management Plan The scope management plan, which is a primary output of the Plan Scope Management process, is part of the project management plan, and the project manager uses it to guide the project until closing. The scope management plan essentially contains three parts, which detail how scope will be planned, executed, and controlled. It describes how to do the following:

- Achieve the overall project scope
- Create the WBS or product backlog and stories
- Manage and control scope to the project management plan
- Obtain acceptance of deliverables

Each project's scope management plan is unique, but it may cover topics that can be standardized for the company or for the type of project. Therefore, companies can often utilize templates, forms, and standards for scope management. These are valuable assets to have on a project.

The scope and requirements management plans can be developed in stages or iterated during project planning. The first step is to plan how scope will be defined. The project manager and the team will have enough information to decide how the scope will be validated and controlled. Those decisions will then become part of the scope management plan. Another aspect of iterations is that later parts of project planning, such as the Plan Risk Responses process, can result in scope being added to the project, thereby changing the scope management plan, project scope statement, WBS, or product backlog, and product roadmap.

Product Backlog[3] A product backlog is a single, visible master list of all the functional and nonfunctional work identified for the project. In other words, a backlog is a list of work that needs to be done, and items are removed from the list as they are completed. It's also important to know that items on the backlog are reviewed for risks by the team and prioritized by the business. Backlog items may be tagged with the business benefit of the items and the acceptance criteria needed to prioritize the items and determine when they are complete. Did you know that a backlog item may also be tagged to the stakeholder who requested it? The backlog is organized by priority from the top down, so the highest value items or stories are always at the top, which informs the development team where to focus their attention. While the product backlog contains all the formally recognized scope, low priority items at the bottom of the backlog may never get developed if the cost to produce them is deemed higher than the value they would return.

Product Backlogs are common on fast-moving agile projects. Having a single source of information about all the work being done is essential for effective communication and provides highly visible documentation of the project's scope and status.

A product backlog is primarily used to ensure adaptability. The backlog is always evolving, and it needs to be kept continually updated with the latest requirements and new information. Even after a project is well under way, the product owner will continue to reorganize and reprioritize the backlog. This process of keeping the backlog updated and accurately prioritized is called refining (or grooming) the backlog and is often done in release planning meetings held before the start of each new iteration with all stakeholders present.

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Often, hybrid projects use a product backlog for organizing work with the team. The WBS (or similar reporting tool) is then used to share information with the PMO who may be accustomed to predictive approaches and traditional documentation. In this case, the project manager acts as an interface, translating and presenting views of work in the format preferred or expected by any given group.

Product Roadmap[4] A product roadmap is a visual depiction of the product releases and the main components that will be included in each release of an agile project. This is a communication tool that provides project stakeholders with a quick view of the primary release points and intended functionality that will be delivered.

Although the product roadmap shows what we plan to deliver in each release, remember that this is a high-level planning tool—and we know there will be changes. So, in planning each release, we will go back to the roadmap and confirm that the basic plan will still work or make any necessary adjustments.

The product backlog and the product roadmap work together to help the team plan the project. Think of the backlog as a tool that guides the work of the development team, while the product roadmap is more of a plan of how the product is likely to grow. Both tools will influence the other, and any changes to the priorities or requirements of the project should be reflected on both.

Requirements Management Plan In addition to describing the methods you intend to use to identify requirements, the requirements management plan should answer the following questions: "Once I have as many requirements as I can gather, what will I do to analyze, prioritize, manage, and track changes? What should I include in the requirements traceability matrix?" (The requirements traceability matrix is described later in this chapter.)

Requirements Gathering

Requirements are what stakeholders need from a project or product. Remember, work should not be included in a project just because someone wants it. Instead, requirements should relate to solving problems or achieving the objectives outlined in a project charter. Requirements may include requests about how the work is planned and managed. For example, a stakeholder could request that systems not be shut down to accommodate a project during peak business hours. Requirements may include the capabilities stakeholders would like to see in the product, such as a software application that allows multiple users to access it at the same time. Requirements can also relate to the following:

- **Quality** "The component D must be able to withstand 200 pounds of pressure."
- **Business processes** "You must track and report the project's expenses in this way."
- **Compliance** "By law, we have to meet this safety standard."
- **Project management** "We require risk management procedure X to be used on the project."

PMBOK® Guide
PG: Planning
Process: Collect Requirements

ECO
Domain: II
Task: 8

The Collect Requirements process looks for all requirements, not just those related to the product of a project. This process is critical to project success, as a missed requirement could mean significant changes and conflict throughout the remainder of a project.

It's important to note the difference between predictive and adaptive approaches as it relates to requirements. Agile methods do not attempt to specify fully detailed requirements up front. Instead, agile teams initially define the requirements and progressively refine them. This approach delays decisions on implementation details until the last responsible moment. This helps avoid or lessen the effect of change requests.

The Collect Requirements process involves using the following inputs to create the requirements document and the requirements traceability matrix. Review these inputs, and think through how each input might help you in collecting requirements.

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- **Project Charter** The high-level project and product descriptions are defined in the project charter, which was developed during initiating. The Collect Requirements process begins with these descriptions, and elicits more detailed input about what is required.
- **Assumption Log** The assumption log documents known stakeholder assumptions related to product and project requirements. Collect Requirements includes refining and adding to this list of assumptions.
- **Stakeholder Register** Remember that the stakeholder register was created in initiating. It includes a list of stakeholders identified thus far in the project, as well as their requirements and expectations.
- **Agreements** If the project includes procurements, the requirements of the buyers are documented in the contracts. Any agreed-upon requirements included in letters of agreement within an organization are also a source of requirements.
- **Organizational Process Assets** Organizational process assets, such as historical records and lessons learned, may provide data about requirements from past, similar projects as well as information that may identify commonly overlooked areas of scope.

On large projects, there could be hundreds of stakeholders, and no single method of collecting requirements will work for all stakeholders. Since missing a needed requirement can be very costly, a concerted effort must be made to find as many requirements as possible before work starts on a project or development phase.

The Collect Requirements effort also includes eliciting stakeholders' expectations—their beliefs or mental pictures about how the project will turn out—and translating those expectations into requirements as necessary. Collecting requirements may involve using various techniques (described next). The project manager needs to choose the techniques that are the most appropriate for the project and its stakeholders.

Collect Requirements Tools and Techniques The following tools and techniques can be used to collect requirements:

Brainstorming Be careful here—many people think brainstorming is just a meeting where people discuss ideas but it is more than that. The purpose of brainstorming is not so much to get individuals to share their thoughts on a topic as it is to encourage participants to build on each other's ideas. One person mentions an idea to solve a problem or, in this case, determine scope. That idea generates an idea from another participant, which leads to yet another idea, and so on. The results of brainstorming sessions vary depending on the participants. It can be highly beneficial to include people with different perspectives or backgrounds. The participants may be internal or external to the project and/or the organization. After all the ideas have been captured, the group can evaluate and rank them using the nominal group technique or multicriteria decision analysis, as described in the following sections.

Interviews On the exam, this technique may also be referred to as expert interviews. The team or project manager interviews project stakeholders to elicit their requirements for a specific element of the product or project work, or for the overall project. These interviews can take place between two individuals or in group settings. Interviews can also be conducted via email or phone, or by using virtual collaboration tools.

Focus Groups The focus group technique helps elicit opinions and requirements for the product or an aspect of the project from stakeholders and subject matter experts. Members of a focus group are usually selected from a specific demographic group of customers. They discuss their ideas with each other, and the conversation is directed by a moderator.

Questionnaires and Surveys Questionnaires or surveys are typically used for large groups. The questions are asked in such a way as to elicit requirements from the respondents.

Benchmarking Another way to help identify and define requirements is to look at what the competition is doing. Benchmarking focuses on measuring an organization's performance against that of other organizations in the same industry. There are limitations to this technique, however. Benchmarking can be very

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time-consuming and costly. It may also inhibit the team's creativity because the focus is on studying solutions that have been used elsewhere, rather than on developing new, innovative ideas.

Voting Soliciting input about requirements from stakeholders often results in conflicting requirements. It is essential to resolve these conflicts, as well as to review, analyze, accept or reject, and prioritize requirements before recording them in project documents. Voting is commonly used to make decisions in a group setting. If the group agrees on a requirement *unanimously* (everyone agrees), the decision is easy. The decision-making process is also simplified if a single person is assigned to make the decision for the entire group. However, this *autocratic* method of decision-making can have negative impacts on the project if the stakeholders do not buy into the decision.

When there are conflicting opinions, groups may also take a *majority* approach. With this approach, the group chooses the decision that more than half of its members support. If there is no majority opinion, the group may go with the decision that has the largest number of supporters. This is known as the *plurality* approach.

Multicriteria Decision Analysis[5] Another way to rank ideas is through multicriteria decision analysis. With this technique, stakeholders quantify requirements using a decision matrix based on factors such as expected risk levels, time estimates, and cost and benefit estimates.

Affinity Diagrams[6] In this technique, the ideas generated from any other requirements-gathering techniques are grouped by similarities. Each group of requirements is then given a title. This sorting makes it easier to see additional areas of scope that have not beenidentified. Figure 5.1 shows an example of an affinity diagram.

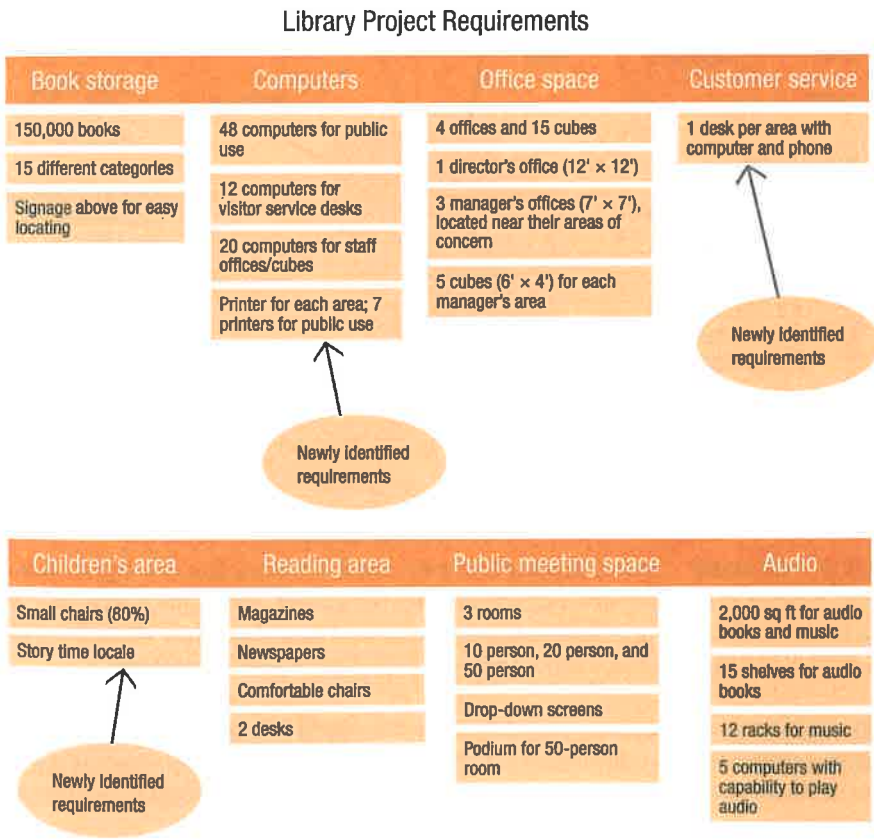

FIGURE 5.1 *Affinity diagram*

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Affinity diagrams can also be organized by requirements categories. The following are some common categories used when collecting requirements:

- **Business requirements** Why was the project undertaken? What business need is the project intended to address?
- **Stakeholder requirements** What do stakeholders want to gain from the project?
- **Solution requirements** What does the product need to look like? What are its *functional* requirements (how the product should work) and *nonfunctional* requirements (what will make the product effective)?
- **Transition requirements** What types of handoff procedures or training are needed to transfer the product to the customer or organization?
- **Project requirements** How should the project be initiated, planned, executed, controlled, and closed?
- **Quality requirements** What quality measures does the product need to meet? What constitutes a successfully completed deliverable?
- **Technical requirements** How will the product be built? What are the product specifications?

Mind Maps[7] A mind map is a diagram of ideas or notes to help generate, classify, or record information. It branches out of a central core word or words as shown in figure 5.2. Colors, pictures, and notations can be used to make the diagram more readable.

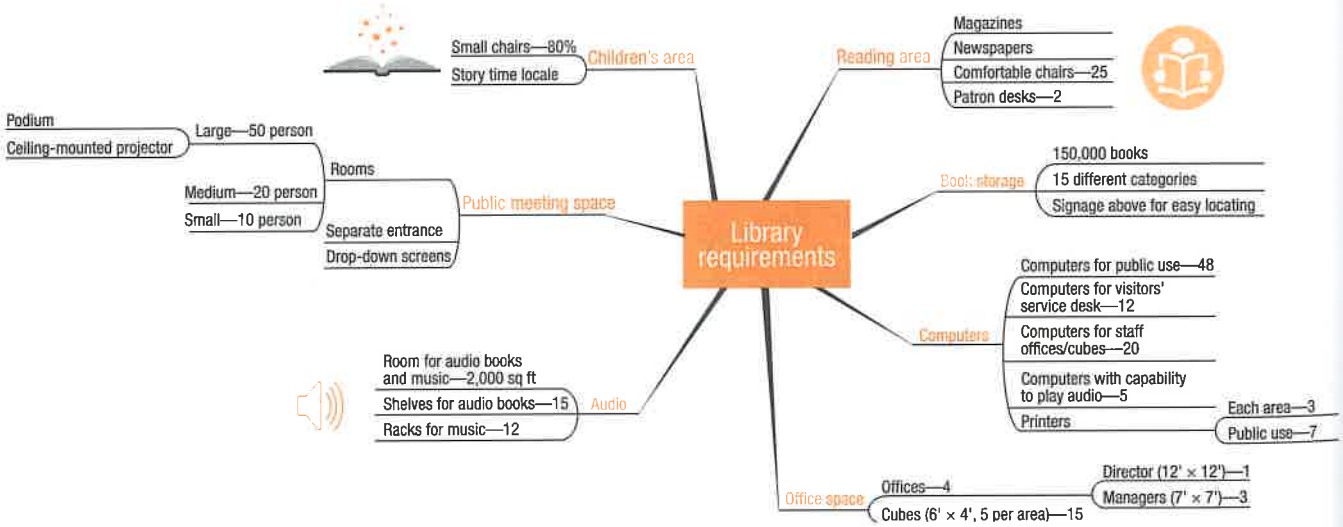

FIGURE 5.2 *Mind map*

Nominal Group Technique[8] This technique is usually, but not always, done during the same meeting as brainstorming. It tends to be more structured than other techniques, and follows these four steps: a question or issue is posed, all meeting participants write down and then share their ideas, the group discusses what's been shared, and then ideas are ranked based on which ideas are the most useful.

Observation Observation is a great way to learn about business processes and to get a feel for the work environment of stakeholders. This technique generally involves job shadowing—watching a potential user of the product at work and, in some cases, participating in the work to help identify requirements.

Facilitation Facilitation brings together stakeholders with different perspectives, such as product designers and end users, to talk about the product and, ultimately, define requirements. This technique uses

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a *consensus* approach, which achieves general agreement about a decision. Those who would prefer another option are willing to accept the decision supported by most members of the group.

Stakeholders may develop user stories during these facilitated sessions. User stories describe functionality or features that stakeholders hope to see. They are often written in the following format:

As a <role>, I want <functionality/goal> so that <business benefit/motivation>.

For example: "As a community organizer, I want the new library to offer public meeting spaces so that we have a central place to gather and can expose community members to the benefits of the library through neighborhood events."

Examples of facilitation sessions include the following:

- **Joint application design (JAD) sessions** Used primarily in software development efforts, JAD sessions involve eliciting requirements and input to enhance the processes of developing the software.
- **Quality functional deployment (QFD)** QFD (also referred to as the Voice of the Customer, or VOC) is a technique used to elicit and prioritize customer requirements. It is generally used in the manufacturing industry.

Context Diagrams[9] A context diagram, also known as a context level data flow diagram, is frequently used to define and model scope. It shows the boundaries of the product scope by highlighting the product and its interfaces with people, processes, or systems. Figure 5.3 shows an example of a context diagram for the payroll system upgrade described in the project charter in the "Integration" chapter.

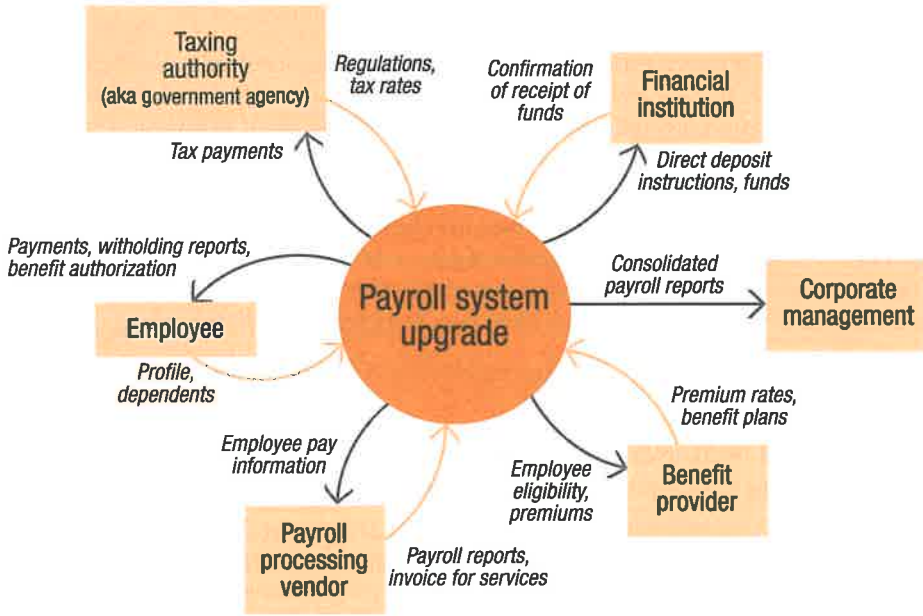

FIGURE 5.3 *Context diagram*

Prototypes A prototype is a model of the proposed product that is presented to stakeholders for feedback. The prototype may be updated multiple times to incorporate stakeholders' feedback until the requirements have been solidified for the product.

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Balancing Stakeholder Requirements This effort is an important aspect of the Collect Requirements process. Part of balancing requirements from stakeholders involves making sure the requirements can be met within the project objectives. If they cannot, then you need to look for options to adjust the competing demands of scope, time, cost, quality, resources, risk, and customer satisfaction.

This type of balancing is never easy or fast. It can become impossible if you don't have clear project objectives and if you don't identify and prioritize all requirements from all stakeholders during the Collect Requirements process. Do you try to get as close to final requirements as possible when managing projects? Are your requirements ranked by order of importance? If not, think about how such actions could improve your projects. When you take the exam, assume that every effort has been made by the project manager to uncover all requirements and that those requirements are ranked by order of importance.

It's important to note that agile and hybrid approaches are often used when the exact requirements are unknown. For example, you may be building something that has not been done in your organization before, such as creating a customer self-service portal that allows customers to manage their own accounts. Here, you may not know what the most popular functions will be or the exact extent of the scope. You may allow customers to change their own name and address fields and enrolled services, but what about deleting their accounts or opting out of communications? Do all of the key stakeholders agree about what features should and should not be included in the self-service portal? Additional requirements are often uncovered after some use of the product or service as well. After launching the self-service portal, you might learn 80 percent of customers access it on a PC, but the portal was optimized for a mobile device. You might also discover a competitor's portal features a "refer-a-friend" option that offers rewards, and you may want to create a similar program. Often, scope and priorities change. The longer the project, the more likely the scope will change due to changes in the market, technology, or organization.

5.1 Exercise This exercise outlines some of the key actions involved in balancing requirements from stakeholders. It goes beyond the Collect Requirements process and looks at this effort throughout the project life cycle. Spend some time thinking about balancing requirements while getting ready for the exam. This exercise will help you determine whether you really understand the process.

In your Exercise Notebook, write down the number of each action, read through each action, then place a checkmark next to the number if you understand the action described. Put an X next to the actions you are able to apply in the real world. After you've gone through the list, write down the unmarked actions in your Exercise Notebook and spend some time working through them.

Action	Understand ✓	Can Do X
1. Identify all stakeholders; understand their needs, wants, assumptions, and expectations related to the project.		
2. Work to get requirements as clear and complete as appropriate for the selected development approach before starting project work.		
3. Use information about stakeholders and their requirements to resolve competing requirements while work is being done on the project.		
4. Look for competing interests during project planning; don't just wait for competing interests to show up during project executing.		
5. Look for possible options to resolve competing interests and alternative ways of completing project activities. This may involve using techniques such as brainstorming, schedule compression, reestimating, and other project management and management-related practices.		

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Action	Understand ✓	Can Do X
6. Resolve competing requirements from stakeholders based on how the requirements affect the project. (See the guidelines listed in the following discussion.)		
7. Give priority to the customer. (For the exam, know that if any needs conflict with those of the customer, the customer's needs normally take precedence.)		
8. Use quality management to support the project's satisfaction of the needs for which it was undertaken.		
9. Deal with problems and conflicts as soon as they arise through the use of team building, problem-solving, and conflict management techniques.		
10. Say no to some of the competing interests. (For the exam, assume the project manager has the authority to say no when necessary to protect the project.)		
11. Fix the project when the project metrics start to deviate from the requirements, rather than changing the requirements to meet the results of the project.		
12. Work toward fair resolutions of disputes—ones that consider the interests of all stakeholders as well as the needs of the project.		
13. Hold meetings, interviews, and discussions to facilitate the resolution of competing requirements.		
14. Call on management to help resolve competing interests when the project manager and the team cannot come up with a fair and equitable solution.		
15. Use negotiation techniques to resolve disputes between stakeholders.		
16. Plan and implement effective communication.		
17. Gather, assess, and integrate information into the project.		

Resolving Competing Requirements Many project managers have no idea how to prioritize competing requirements. What if, for example, the engineering department wants your project to focus on decreasing defects while the accounting department wants your project to focus on lowering costs? Can both needs be met? What if the engineering department is the primary stakeholder or even the sponsor of the project? Should that department's needs outweigh the needs of the accounting department? What if the needs of the engineering department negatively impact the accounting department?

Some issues are so complex they cannot be resolved by the project manager alone, and require management intervention. However, there are some standard guidelines for balancing competing requirements. For example, you should resolve competing requirements by accepting those that best comply with the business case, project charter, project scope statement, and any project constraints.

A stakeholder's request to do or add something to the project that is not related to the reason the project was initiated should be rejected. If a requirement is related to the reason the project was initiated but does not fall within the project charter, this request should also be rejected. Any suggested changes to the project charter must be brought to the sponsor for approval. When considering constraints, if the most

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important constraint is schedule, then any requirements that would delay the schedule will not likely be accepted. Those that compress the schedule (without serious impact to other project constraints) will more likely be accepted. Requests that do not fall within these guidelines could become part of a future project instead.

Verifying Requirements Software projects that use agile and hybrid approaches frequently demonstrate increments of functionality. One common issue is too little interest from stakeholders in early increments that do not have much to demonstrate. In these early stages, stakeholders are often unimpressed by the apparent lack of progress or incompleteness of the solution. However, this is when team members want the most feedback, since they are designing the rest of the solution. Later, when much more functionality is built, the stakeholders see the potential and start requesting changes and new features, but by then, it is much more difficult and costly to change the design.

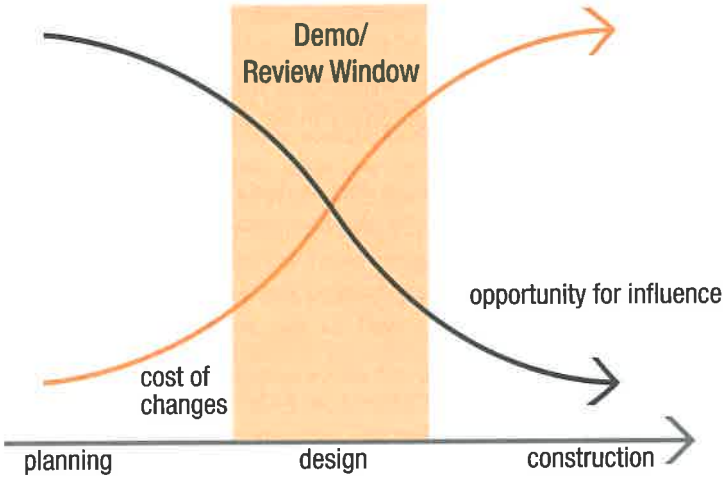

FIGURE 5.4 *The cost of change to a design*

Project managers working on agile and hybrid projects should explain this paradox to their teams and stakeholders. Teams want to discuss changes when the product design is still in development and the cost of changes may still be low. This requires the team to have courage to demonstrate incomplete solutions that may face criticism and the business to have some trust and imagination into how the system may look in order to provide feedback as soon as possible.

Requirements Documentation After requirements have been collected and finalized, they are documented. Imagine you have elicited requirements from hundreds of people. Can you see how documenting those requirements would be useful? This documentation is an output of the Collect Requirements process and helps to ensure all requirements are clear and unambiguous.

Requirements documentation can contain various types of information, but the one thing that must be included is acceptance criteria. To avoid having requirements that could easily be misunderstood, a great question to ask stakeholders is, "How will we know if the work we do will meet this requirement?" Not only is this a good way to make sure you understand the stakeholder's requirement, but it also helps to ensure the work being done will be acceptable.

It's also important to note that the level of detail of documentation is iterated until each requirement satisfies the criteria of being clear, complete, and measurable. Requirements must be described in such a way that associated deliverables can be tested or measured against the requirements in the Validate Scope process to confirm that the deliverables are acceptable.

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Requirements Traceability Matrix[10] Have you ever worked on a project in which some requirements got lost in the details? In the process of determining requirements, one requirement often leads to additional, more refined requirements and clarifications—especially on large projects. It can be difficult to remember where a requirement came from and what its significance is to the project. Losing focus on the reason for a requirement can result in a major strategic or project objective not being met. The requirements traceability matrix, another output of the Collect Requirements process, helps link requirements to the objectives and/or other requirements to ensure the strategic goals are accomplished. The matrix is used throughout the project in analyzing proposed changes to project or product scope. An example of a requirements traceability matrix is shown in figure 5.5.

Information such as requirement identification numbers, the source of each requirement, who is assigned to manage the requirement, and the status of the requirement should be documented in the requirements traceability matrix. For large projects, however, including all this information in the matrix would make it cumbersome and difficult to use. Another option is to store this data in a separate repository, preserving the matrix as an easy-to-reference tool. For the exam, simply understand that the requirements traceability matrix links requirements to objectives and/or other requirements, and that the requirements attributes, such as identification numbers, source, and status, also need to be documented.

Assigning responsibility for management of each requirement is similar to the concept of risk owners, described in the "Risk" chapter. An owner helps ensure the customer receives what they asked for and that the objectives are met. Assigning team members to manage requirements also helps free up the project manager's time. The role of requirement owner is another example of the type of work team members may do on a project in addition to their efforts to produce the product.

	Reading area				Book storage			Public meeting space			Children's area		Audio			Office space		Computers				
Objectives	Magazines	Newspapers	Comfortable chairs—25	Patron desks—2	150,000 books	15 different categories	Signage above for easy locating	Rooms	Separate entrance	Drop-down screens	Small chairs—80%	Story time locale	Room for audio books and music	Shelves for audio books—15	Racks for music—12	Offices—4	Cubes—15	For public use—48	For visitor service desk—12	For staff—20	With audio capability—5	Printers
Improve access to job resources by 20%.		X		X				X		X								X	X			X
Improve local children's reading levels by two grade levels in one year.			X		X		X					X						X				
Provide a pleasant place for community members to meet.	X	X	X					X	X		X		X	X	X							
Replace the existing library by end of next quarter.	X	X	X		X	X	X					X		X		X	X	X		X	X	X

FIGURE 5.5 *Requirements traceability matrix*

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Define Scope

PMBOK® Guide
PG: Planning
Process: Define Scope

ECO
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The Define Scope process is primarily concerned with what is and is not included in the project and its deliverables. This process uses information from the project charter, scope management plan, the requirements documentation created in the Collect Requirements process, the assumption log, and the risk register to define the project and product scope.

Remember that planning is iterative. When the requirements have been determined and the scope is defined, the project manager follows the project management planning process to determine the schedule and budget. If the resulting schedule and budget do not meet the sponsor's or management's expectations for the project, the project manager needs to balance the requirements (scope) against budget and schedule constraints. Through iterations, options for meeting the scope, schedule, and cost objectives of the project are developed. These options are then presented to management for a decision. This work may include compressing the schedule, identifying alternative ways to perform the work on the project, or adjusting the budget or scope. The result is a realistic schedule and budget that can achieve the project's agreed-upon scope.

The process of scope definition is ongoing throughout the project. The following are two key reasons this process is important on the exam:

- Many project managers complain about unrealistic schedules. For the exam, you need to understand that unrealistic schedules are the project manager's fault because they have not done planning in an iterative way, as described in the previous paragraph. Project managers must reconcile the scope to the schedule and the budget, as well as to other project constraints, to resolve any issues before work begins.
- Project managers spend a large portion of their time during executing and monitoring and controlling looking for options to adjust the project and still meet the project schedule or budget. Therefore, all the analysis tools used in planning to come up with a realistic schedule and budget are also utilized while the work is being done.

Whether a project uses a plan-driven or change-driven approach, the process of Define Scope is iterated as the project progresses. Its purpose is always to determine what scope is and is not in the project. How would you utilize an adaptive approach when defining scope? Do you know what method you would use? You'll need to have an understanding of how to tailor your project and use agile methods when taking the exam. If you're unfamiliar with the concept of timeboxing, read the next section carefully and think about how you would use this technique on your real-world projects.

Timeboxing[11] Let's review the concept of timeboxing. A timebox is a short, fixed period in which a defined set of activities or work is undertaken. If the work planned for the timebox isn't complete within the timeframe given, the team stops what they're doing and simply leaves the uncompleted work on the backlog to be undertaken in another timebox. Timeboxes allow agile teams to adjust their scope to achieve the highest-priority, best-quality product within a fixed cost and timeframe, as depicted in the agile triangle of constraints, shown in figure 5.6.

Timeboxes help bring some level of order and consistency to an otherwise highly variable work environment. They offer regular opportunities to assess results, gather feedback, and control the overall costs and risks of a project.

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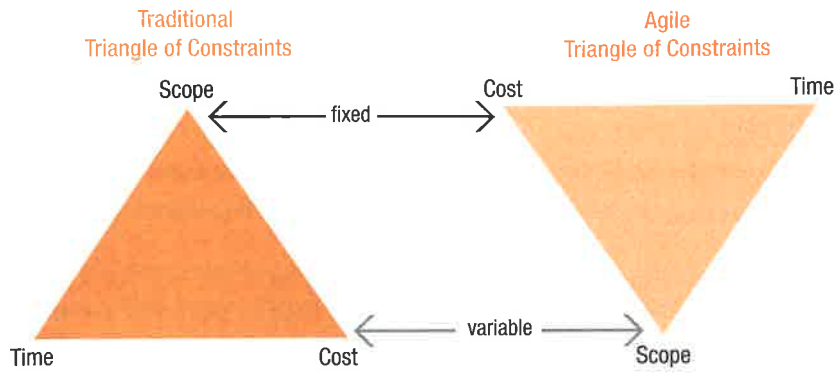

FIGURE 5.6 *Agile triangle of constraints*

Product Analysis As noted at the beginning of this section, part of defining scope is determining what the deliverables of the project are. Product analysis is performed to analyze the objectives and description of the product as stated by the customer or sponsor. That information is then used to define tangible deliverables. The work of product analysis may entail analyzing the product description and stated requirements, or using techniques such as systems engineering, value analysis, or value engineering. Product analysis is a critical tool that allows the project manager to make sure the product and project scope are understood and accurate. For the exam, realize you may need to determine and define deliverables as part of the project, rather than receiving a complete list from the customer.

Project Scope Statement[12] The primary result, or output, of the Define Scope process is the project scope statement. This document in effect says, "Here is what we will do on this project." Or it could say, "Here is the approved project and product or service scope for this project." On a plan-driven project, the development of the project scope statement can take a lot of time and involve the expert judgment of many stakeholders and even experts from outside the organization. The project scope statement for a change-driven project will be less detailed, but will still have sufficient detail to define what is in and out of scope. The product scope will be progressively elaborated as needed. While defining requirements and, in turn, defining scope, you should identify areas where people requested scope but it was not approved to be included in the project. You should also clarify areas where the scope could easily be misunderstood. It is a waste of project time and money to create scope that is not needed or approved, yet it is easy for this to occur. One way to avoid this problem is to identify in the project scope statement what is not in the project, to make it clear that such additions are not allowed.

The project scope statement, along with the WBS and WBS dictionary (described in the next section), comprise the scope baseline, which is part of the project management plan. The project scope statement may include the following:

- Product scope
- Project scope, including a description
- Deliverables of the project
- Acceptance criteria
- What is not part of the project
- Assumptions and constraints

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Scope Decomposition PAGE 156

PMBOK® Guide
PG: Planning
Process: Create WBS

What is a WBS? Correctly understanding this project management tool is essential for successful projects, and for passing the exam.

5.2 Exercise Test yourself! What is a WBS? Write the answer in your Exercise Notebook.

Answer The WBS is a visual, organizational tool showing all of the scope on a project, broken down into manageable deliverables as work packages. It helps ensure that no deliverables are missed. It is a required artifact for all projects in a plan-driven predictive environment. Read the rest of this section to learn more about what a WBS is and how it adds value to projects. Here are just a few additional answers that may further define a WBS.

- The construction of a WBS graphically provides a structured vision for a project and helps to ensure that nothing, including deliverables, is forgotten.
- With a WBS, you can easily break down deliverables into work packages (smaller deliverables, not activities). A WBS also shows how work packages are derived.
- A WBS is created with input from the team and stakeholders. Involving the team and stakeholders helps gain buy-in, and increased buy-in leads to improved performance.
- The process of creating a WBS allows the team to go through a project in their minds and thus improves project plans. The execution of a project is typically easier and less risky as a result.
- Being involved in the creation of a WBS helps people better understand a project. It also makes a project seem more achievable.
- A WBS shows a complete hierarchy of a project, making it easier to see how one deliverable relates to another.

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Review the WBS example in figure 5.7.

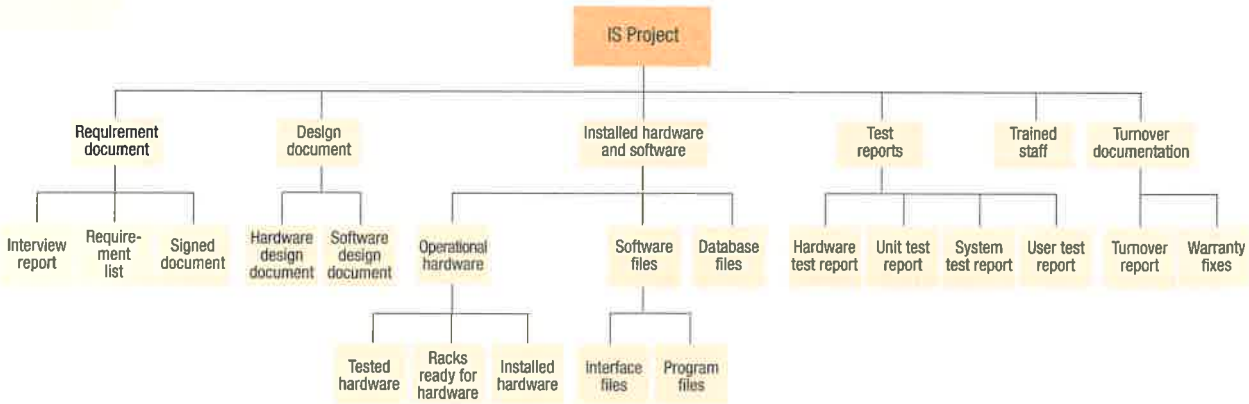

FIGURE 5.7 *A WBS (on a summary level) for a hardware/software creation and installation project*

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Most commonly, the project name goes at the top of a WBS. The next level is typically the same as the development life cycle. The subsequent levels break the project into deliverables, which are then broken down again into smaller component deliverables, ultimately to create work packages (described next). Such decomposition continues until reaching the level appropriate to manage the project.

Did you know that a WBS allows you to break down a seemingly overwhelming project into pieces you can plan, organize, manage, and control? The creation of a WBS is an effort to decompose deliverables into smaller component deliverables called work packages. Decomposition can be done using a top-down approach (starting with the high-level pieces of a project), a bottom-up approach (starting at the work package level), or by following organizational and industry guidelines or templates.

Note that on a WBS, work refers not to an activity, but to the work products or deliverables that result from an activity or group of activities. So, for the exam, note that each work package should consist of nouns—things (deliverables), rather than actions (activities). A WBS is deliverable-oriented. This does not mean that only customer deliverables are included. The complete scope of a project, including product scope, project scope, and project management efforts are included as well.

Every WBS is unique, and every project manager will approach creating a WBS in their own way. But there are a few guidelines that every project manager should follow when creating a WBS:

- A WBS should be created by the project manager using input from the team and other stakeholders.
- Each level of a WBS is a breakdown of the previous level.
- An entire project should be included in the highest levels of a WBS. Eventually, some levels will be further broken down.
- A WBS includes only project deliverables that are required; deliverables not included in the WBS are not part of the project.

During planning, the project management team and subject matter experts break down the scope description until the work package level is reached. This occurs when the deliverables:

- Can be realistically and confidently estimated (including the activities, duration, and cost associated with them)
- Can be completed quickly
- Can be completed without interruption and without the need for more information
- May be outsourced

At this point, you might enter the work packages—the items at the lowest level of the WBS—into some sort of project scheduling software. You would not try to finalize the list of work packages by using software, however. That list comes from the creation of the WBS.

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The levels in the WBS are often numbered for ease of location later. When the WBS is complete, identification numbers are assigned to help distinguish where a work package is in the WBS. There are many different numbering systems you can use. Figure 5.8 provides an example.

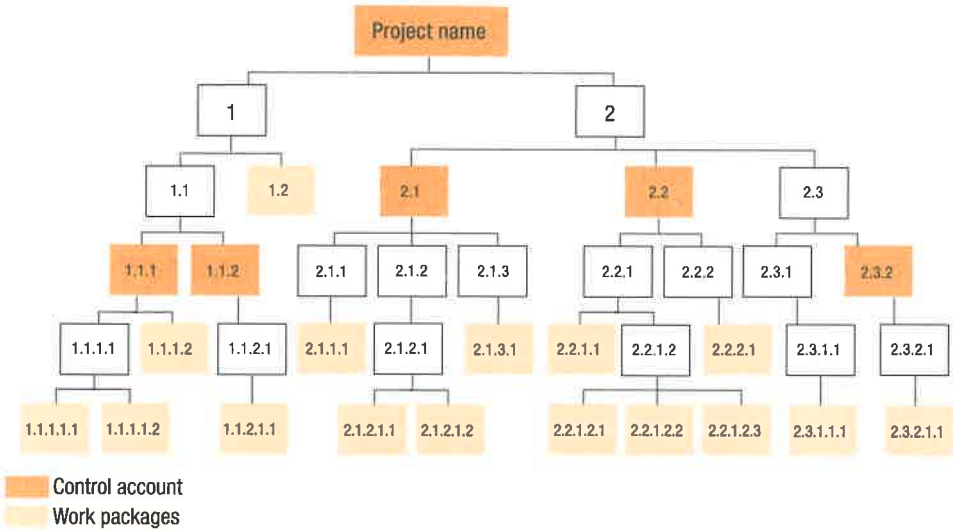

FIGURE 5.8 *Sample WBS numbering system*

You may see the terms "control account"[13] or "planning package" on the exam. Sometimes found at higher levels within the WBS (as shown in figure 5.8), a control account is a tool that allows you to collect and analyze work performance data regarding costs, schedule, and scope. Control accounts, which may include one or more planning packages, provide a way to manage and control costs, schedule, and scope at a higher level than the work package. Each work package in the WBS is assigned to only one control account.

As planning progresses, the team breaks down the work packages from the WBS into the schedule activities (or "activities," for short) that are required to produce the work packages. Note that this further breakdown of the WBS into an activity list is done as part of the schedule management process of Define Activities. The team uses the project scope statement, WBS, and WBS dictionary (described later in this chapter) to help define which activities are required to produce the deliverables.

For example, on small projects, the WBS is often broken down into work packages that take between 4 and 40 hours to complete. Medium-sized projects may have work packages with 8 to 80 hours of work. On large projects, however, the work packages may be much larger and could involve 300 hours of work. Therefore, the Define Activities process is especially important on large projects. Think about how this effort is different on a large project than on a small project.

If your company works on many similar projects, it is important to realize that the WBS from one project may be used as the basis for another. Therefore, the project management office should collect and share WBS examples and encourage the creation of templates. Project WBSs become part of the company's organizational process assets, and may be used by similar projects in the future.

Great project managers not only see the value of the information provided in the WBS, they also recognize the value of the effort involved in creating the WBS. Do you really understand what a WBS is? Try the next exercise. If you miss many of the answers, review this section, and rethink your knowledge before taking the exam.

5.3 Exercise Test yourself! What are the benefits of using a WBS? Write the answer in your Exercise Notebook.

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Answer The following are benefits of using a WBS:

- Helps prevent work from slipping through the cracks
- Provides project team members with an understanding of how deliverables fit into the overall project management plan and gives the project team an indication of the impact of their work on the project as a whole
- Facilitates communication and cooperation between and among the project team and other stakeholders
- Helps manage stakeholder expectations regarding deliverables
- Helps identify risks
- Helps prevent changes
- Focuses the project team's experience on what needs to be done, resulting in increased quality and a project that is easier to manage
- Provides a basis for estimating resources, costs, and schedules
- Provides proof of the need for resources, funds, and schedules
- Helps with planning control efforts and establishing acceptance criteria for deliverables
- Gets team buy-in and builds the project team
- Helps people better understand the project

A WBS is the foundation of a project. This means almost everything that occurs in planning after the creation of a WBS is related to the WBS. For example, project costs and schedules are estimated at the work package or activity level, and not for the project as a whole. Also note that a WBS can help a project manager identify more risks by examining a project at the work package level. Work packages are assigned to individuals or parts of the performing organization, depending on the size of the project. Do the relationships shown in figure 5.9 make sense to you?

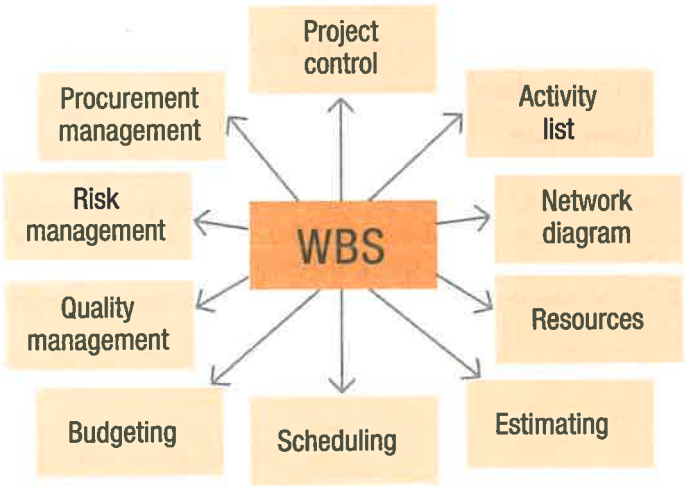

FIGURE 5.9 *The WBS is the foundation of the project*

Let's think about the project control element in figure 5.9. Many people forget to use the project management tools from project planning while the work is being done. They may create a WBS just because it is a required part of a complete scope baseline, but then forget about it. As a result, they do not get the full benefit of the tool.

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5.4 Exercise What do you do with a WBS once it has been created?

If you were going to test someone's WBS knowledge, would you ask questions about the basics of creating a WBS, or would you test their knowledge by asking how a WBS can help a project manager to better manage a project? The exam strongly weighs toward the latter. So, take some time to really think about this question and write the answer in your Exercise Notebook.

Answer When completed, the WBS can be used any time the scope of a project needs to be reevaluated. For example:

- When there is a scope-related change request, a project manager can use the WBS, along with the project scope statement, to determine if the request is within the planned scope of the project.
- A project manager can use the WBS as part of the integrated change control process to evaluate impacts of changes that relate to scope.
- Project managers can control scope creep[14] by using the WBS to reinforce what work is to be done. (The term "scope creep" refers to scope increasing or varying from what was planned.)
- The WBS can be used as a communications tool when discussing the project with the team or the customer.
- The WBS can be used to help new team members see their roles on the project.

TRICKS OF THE TRADE® There may be many WBS references on the exam. To answer these questions correctly, remember that a WBS:

- Is a graphical picture of the hierarchy of a project
- Identifies all deliverables to be completed (if it is not in the WBS, it is not part of the project)
- Is the foundation upon which a project is built
- Is very important and should exist for every project
- Ensures that the project manager thinks through all aspects of a project
- Can be reused for other projects
- Does not show dependencies

TRICKS OF THE TRADE® The previous list should help you get a few more tricky questions right on the exam. Now, would you like to get one more right? Many people confuse the terms "WBS" and "decomposition." The best way to think of decomposition[15] is that decomposition is what you are doing, and a WBS is the means to do it. In other words, you decompose a project using a WBS.

TRICKS OF THE TRADE® The exam may use the term "deconstruction" instead of "decomposition." Both terms mean the same thing.

WBS Dictionary Think about how a work package is identified in a WBS. It is usually described using only one or two words. But assigning a deliverable with such a brief description to a team member allows for too much possible variation. In other words, it allows for scope creep. A WBS dictionary is the solution to this problem. This document provides a description of the work to be done for each WBS work package, and it lists the acceptance criteria for each deliverable, which ensures the resulting work matches what is needed. Therefore, a project manager can use a WBS dictionary to prevent scope creep before work even starts, rather than dealing with scope creep while the work is being done.

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The WBS dictionary is an output of the Create WBS process. This document may be used as part of a work authorization system, which informs team members when their work package is going to start. A WBS dictionary can include descriptions of schedule milestones, acceptance criteria, durations, interdependencies, and other information about work packages. You can also use it to control what work is done when, to prevent scope creep, and to solidify a stakeholder's understanding of the effort required for each work package. The WBS dictionary essentially puts boundaries around what is included in a work package, similar to the way the project scope statement puts boundaries around what is included in a project. Note that some of the entries in a WBS dictionary, such as durations and interdependencies, may be filled in during iterations, rather than when it is first drafted.

A WBS dictionary may look similar to the example shown in figure 5.10.

Control Account ID #	**Work Package Name/Number**	**Date of Update**	**Responsible Organization/Individual**
Work Package Deliverable Description:			
Work Involved to Produce Deliverable:			
Acceptance Criteria (How to know if the deliverable/work is acceptable):			
Assumptions and Constraints:			
Quality Metrics:			
Technical Source Document:			
Risks:			
Resources Assigned:			
Duration:			
Schedule Milestones:			
Cost:			
Due Date:			
Intedependencies (before this work package):			
Interdependencies (after this work package):			
Approved by:		**Date:**	

FIGURE 5.10 *WBS dictionary*

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Scope Baseline As discussed in the "Integration" chapter, baselines help the project manager control their projects. Baselines are simply the final and approved versions of certain pieces of the project management plan. For scope, the baseline is made up of the final versions of the WBS, the WBS dictionary, and the project scope statement that are approved at the end of planning, before the project work begins. As the work on the project is being done, the project manager reviews how the project is progressing and compares that data to the baseline by answering the following questions:

- How is my project going, and how does that compare to the baseline?
- What scope has been completed on the project?
- Does it match what is defined in the WBS, WBS dictionary, and project scope statement?

If scope is needed that is not in the baseline, a change has to be formally approved through the integrated change control process, and a new item (or items) needs to be added to the WBS, WBS dictionary, and project scope statement to show the scope addition. This updated documentation becomes the new scope baseline for the project. Any other components of the project management plan and project documents that are affected by the change in scope also need to be updated, including requirements documentation and the assumption log.

Measurements of success include whether the project has met all the requirements, including the scope baseline. Because a project manager's performance is evaluated along with the success of the project, it is essential to use the tools, techniques, and practices of project management in the real world. These assets make it so much easier to achieve success on a project and to get a great evaluation of your own performance as the project manager.

Validate and Control Scope PAGE 163

PMBOK® Guide
PG: Monitoring and Controlling
Process: Validate Scope, Control Scope

ECO
Domain: II
Task: 8

Many people are confused about what it means to validate scope. If you correctly understand scope control and validation from the perspective of the *PMBOK® Guide*, you can get more questions right on the exam. These next few pages will clarify the process of validating scope along with the process of controlling scope, and will help you find gaps in your knowledge.

TRICKS OF THE TRADE® First, think about the name of the process: scope validation. Many people think Validate Scope means confirming the validity and appropriateness of the scope definition during project planning. This is incorrect, however. The Validate Scope process actually involves frequent, planned meetings with the customer or sponsor to gain formal acceptance of deliverables during project monitoring and controlling. That's a big difference, isn't it?

Let's look at the inputs to this process. Try this exercise.

5.5 Exercise In your Exercise Notebook, can you list "what do I need before I can" validate scope? (The inputs of Validate Scope.)

Answer

- Work must be completed and checked before each meeting with the customer; therefore, you must have what are called verified deliverables from the Control Quality process.
- It's helpful to have the approved scope with you when you meet with the customer, so you need the scope baseline from the project management plan.
- You'll also need to share information about the requirements of the project and show the customer how those requirements have been validated. This information can be found in the requirements management plan and the requirements traceability matrix.

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- In addition, you should have the requirements documentation with you, in order to compare the requirements to actual results. You can then determine whether any action or change needs to take place.
- Other project documents, such as quality reports and lessons learned, should also be reviewed at the start of this process. Quality reports can include information about open or closed issues as well as issue management, while lessons learned can be used to improve the process of validating project deliverables.
- Another component you should have from the project management plan is the scope management plan, which shows the previously agreed-upon deliverables and plans for gaining formal acceptance for them.
- Lastly, you will need to refer to work performance data from the Direct and Manage Project Work process to assess how well product deliverables are meeting the requirements.

TRICKS OF THE TRADE Did you notice that we didn't just list the inputs, but actually described how they will be used? Whenever you think about the inputs of a project management process, make sure you can describe them and explain where they come from and what they can offer. Similarly, make sure you understand how outputs flow logically from each process. For the exam, this deeper understanding will often give you more insight into situational questions, help you distinguish between relevant and extraneous data, and help you select the correct answers.

Now let's try outputs (outcomes).

5.6 Exercise In your Exercise Notebook, list what you'll have when you're done with the Validate Scope process. (The outcomes or outputs of Validate Scope.)

Answer Another way of looking at an output is to think about why you are doing this and what the expected result is. Validate Scope is done to help ensure the project is on track from the customer's point of view during the project, rather than just hoping to get final acceptance in project closure. It is better to find changes and issues during the project than at the end. The customer will either accept deliverables or make change requests. In either case, the project documents will need to be updated to reflect completion or changes. Therefore, the outputs are:

- Updates to project documents
- Work performance information (analyzed work performance data)
- Accepted deliverables
- Change requests

TRICKS OF THE TRADE Beyond the potentially misleading name, there are a few more tricky aspects of the Validate Scope process. First, it can be done at the end of each project phase in the project life cycle (to get formal acceptance of the phase deliverables along the way) and at other points throughout the project as part of monitoring and controlling (to get formal acceptance of any deliverables that require approval in the middle of the phase or project). Therefore, you validate scope with the customer multiple times throughout the life of a project. In a change-driven project, this will happen at the end of each iteration as part of the iteration review with the customer. Second, the difference between the Validate Scope and the Close Project or Phase processes can also be a little tricky. Whereas the Validate Scope process results in formal acceptance by the customer of interim deliverables, part of the reason for the Close Project or Phase process is to get final acceptance or sign-off from the customer for the project or phase as a whole. The third tricky aspect is understanding how Validate Scope relates to the Control Quality process. See the high-level diagram in figure 5.11.

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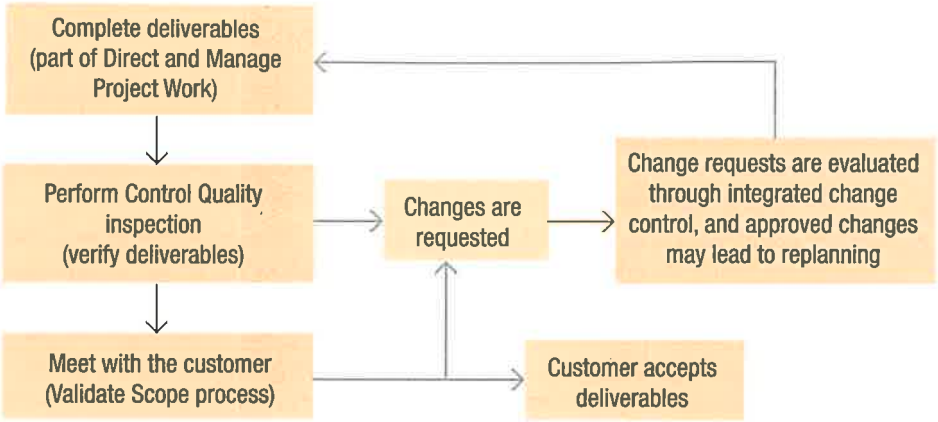

FIGURE 5.11 *Relationship between Validate Scope and Control Quality*

Although Control Quality is generally done first (to make sure the deliverable meets the requirements before it is shown to the customer), the two processes are very similar as both involve checking for the correctness of work. The difference is the focus of the effort and who is doing the checking. In Control Quality, the quality control department checks to see if the requirements specified for the deliverables are met and makes sure the work is correct. In Validate Scope, the customer checks and hopefully accepts the deliverables.

Many project managers do not really control their projects. If this is true for you, you might have some gaps in your knowledge. The Control Scope process involves measuring and assessing work performance data against the scope baseline and managing scope baseline changes. At any point in a project, the project manager must be sure that the scope is being completed according to the project management plan. As you take the exam, assume that the project manager is controlling scope in this way. Assume proper project management is being done on the project unless the question states otherwise.

To control scope, you first need to have a clear definition of the scope (the scope baseline from the project management plan), and you need to have work completed on the project. You also need to be aware of the original requirements recorded in the requirements documentation and the requirements traceability matrix (inputs to this process). You then have to measure the completed work against the scope baseline, perform data analysis, including analyzing any variances, and determine whether the variances are significant enough to warrant changes. If necessary, you would submit a change request through the Perform Integrated Change Control process to assess the impact the change would have on all aspects of the project. New work performance information may result, along with updates to the project management plan and project documents.

Remember that the Control Scope process is extremely proactive. It includes thinking about where changes to scope are coming from on the project and what can be done to prevent or remove the need for any more changes from that source. Properly using project management tools, techniques, and practices will save you from unnecessary problems throughout the life of a project.

As a project manager, your job is not to just process other people's changes; it is to control the project to the project management plan and to meet all baselines. Therefore, you should not be easily swayed or influenced, and you should not let others add scope or change scope without following the approved change management process and without ensuring the suggested changes are within the planned scope of the project. As discussed earlier, people who want work to be done will try to add it to the project whether it is logically part of the project or not. So, you must control the project scope.

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Practice Exam

1. The product of the project has been completed and delivered to the customer by the team. They are informed by the customer that several of the deliverables are not acceptable, as they do not meet the requirements specified early in the project. The project manager and team review the requirements documentation, and are in agreement that the product deliverables meet the customer's requirements as they understand them. The project manager, who is new to the organization, seeks the advice of the project management office in determining what went wrong. After some discussion, the PMO realizes that the Validate Scope process was not performed appropriately by the project manager. Which of the following is a key output of the Validate Scope process?
   A. A more complete scope management plan
   B. Customer acceptance of project deliverables
   C. Requirements analysis
   D. Confirmation of the project scope statement

2. On an agile project, who is responsible for prioritizing the product backlog and keeping those priorities updated?
   A. The project manager
   B. The product owner or customer
   C. Any interested stakeholder
   D. The team leader

3. The work breakdown structure can best be thought of as an effective aid for _____ communications.
   A. Team
   B. Project manager
   C. Customer
   D. Stakeholder

4. During project executing, a team member comes to the project manager because he is not sure what work he needs to accomplish on the project. Which of the following documents contains detailed descriptions of work packages?
   A. WBS dictionary
   B. Activity list
   C. Project scope statement
   D. Scope management plan

5. During which part of the project management process is the project scope statement created?
   A. Initiating
   B. Planning
   C. Executing
   D. Monitoring and controlling

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6. The project is mostly complete. The project has a schedule variance of 300 and a cost variance of -900. All but one of the quality control inspections have been completed, and all have met the quality requirements. All items in the issue log have been resolved. Many of the resources have been released. The sponsor is about to call a meeting to obtain product validation when the customer notifies the project manager that they want to make a major change to the scope. The project manager should:
   A. Meet with the project team to determine if this change can be made.
   B. Ask the customer for a description of the change.
   C. Explain that the change cannot be made at this point in the process.
   D. Inform management.

7. Marketing has asked for a copy of the plan for your agile project, including the release dates and the key features to be included in each release. What will you send them?
   A. The team's product roadmap
   B. A photo of the team's Kanban board
   C. The first page of the product backlog
   D. The product owner's requirements hierarchy

8. The program was planned years ago, before there was a massive introduction of new technology. While planning the next project in this program, the project manager has expanded the scope management plan because as a project becomes more complex, the level of uncertainty in the scope:
   A. Remains the same
   B. Decreases
   C. Decreases then increases
   D. Increases

9. Your agile development team can't agree on the best approach to building the next product increment. As the project manager, how can you help them resolve this debate and move forward?
   A. Ask them to do a benchmarking study of the problem.
   B. Facilitate a team meeting to help them work through their differences.
   C. Ask to see some prototypes of the various options.
   D. Suggest that they take a vote and proceed with the winning approach.

10. To manage a project effectively, work should be broken down into small pieces. Which of the following does not describe how far to decompose the work?
   A. Until it has a meaningful conclusion
   B. Until it cannot be logically subdivided further
   C. Until it can be done by one person
   D. Until it can be realistically estimated

11. A project has just started the second phase, in which work packages are being created. A new team member has completed his work packages for this phase and has asked the project manager to validate the scope of his work packages. The team member is anxious to have the customer see his work packages. The project manager, although confident in this new team member, wants the team member to gain confidence after the customer sees his work packages. When should the Validate Scope process be done?
   A. At the end of the project
   B. At the beginning of the project
   C. At the end of each phase of the project
   D. During the planning processes

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12. A project manager may use _____ to make sure the team members clearly know what is included in each of their work packages.
    A. The project scope statement
    B. The product scope
    C. The WBS dictionary
    D. The schedule

13. On an agile software development project, the project manager asks business stakeholders to create user stories, which will be used in the development and testing of the new application. The main purpose of a user story is:
    A. To document features or functions required by stakeholders
    B. To create a record of issues encountered on the project
    C. To perform what-if analysis
    D. To communicate progress

14. You are managing a six-month project and have held biweekly meetings with your project stakeholders. After five-and-a-half months of work, the project is on schedule and budget, but the stakeholders are not satisfied with the deliverables. This situation will delay the project completion by one month. The most important process that could have prevented this situation is:
    A. Monitor Risks
    B. Control Schedule
    C. Define Scope
    D. Control Scope

15. You have just joined the project management office after five years of working on projects. One of the things you want to introduce to your company is the value of creating and utilizing work breakdown structures. Some of the project managers are angry that you are asking them to do "extra work." Which of the following is the best thing you could tell the project managers to convince them to use work breakdown structures?
    A. Work breakdown structures will prevent work from slipping through the cracks.
    B. Work breakdown structures are of greater value on large projects.
    C. Work breakdown structures are best when the project involves contracts.
    D. Work breakdown structures are the only way to identify risks.

16. A community college has asked you to manage a small project to develop an introductory course for people who want to become family childcare providers. The team is using an agile approach, and so far there hasn't been much upfront planning or requirements gathering. A group of three childcare experts are serving as "authors" (subject matter experts) for the project, working remotely. They have sent you a lot of ideas for designing the course, but everyone seems to have a different opinion about the best approach. How can you best help resolve this stalemate and move forward?
    A. Review the authors' input, choose the best design, and send it to the team for development.
    B. Prepare a context diagram to map how the course design interfaces with the stakeholders.
    C. Bring the authors together and facilitate a design session to help them come to a consensus.
    D. Have the team develop a prototype based on the author's ideas, and ask the authors to review it.

17. All of the following are parts of the scope baseline except the:
    A. Scope management plan
    B. Project scope statement
    C. Work breakdown structure
    D. WBS dictionary

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18. One of the stakeholders on the project contacts the project manager to discuss some additional scope they would like to add to the project. The project manager asks for details in writing and then works through the Control Scope process. What should the project manager do next when the evaluation of the requested scope is complete?
    A. Ask the stakeholder if any more changes are expected.
    B. Complete integrated change control.
    C. Make sure the impact of the change is understood by the stakeholder.
    D. Find out the root cause of why the scope was not identified during project planning.

19. Which of the following is an output of the Collect Requirements process?
    A. Requirements traceability matrix
    B. Project scope statement
    C. Work breakdown structure
    D. Change requests

20. What is the most effective way to provide actionable feedback for your agile team's solution design?
    A. The project manager should attend the team's reviews and retrospectives.
    B. The product owner should carefully review the early, incomplete increments.
    C. The project sponsor should review the team's release and iteration plans.
    D. The QA team should do comprehensive testing of the features before release.

21. Validate Scope is closely related to:
    A. Control Quality
    B. Sequence Activities
    C. Manage Quality
    D. Schedule Management

22. The development phase of a new software product is near completion. A number of quality issues have increased the cost of building the product, but the project manager and team feel these costs will be inconsequential once the project gets to market. The next phases are testing and implementation. The project is two weeks ahead of schedule. Which of the following processes should the project manager be most concerned with before moving into the next phase?
    A. Validate Scope
    B. Control Quality
    C. Manage Communications
    D. Control Costs

23. A highway renewal project you are managing appears to have some missing scope. Your understanding of the scope was that the highway was to be resurfaced. Now, one of the construction foremen has come to ask why he finds no mention of repainting the lines on the repaved road. He also wants to know if there are any guard rail replacement work packages in the project. You have seen some of the resurfaced road that is completed, with the new lines painted on them. Which of the following is most likely to have caused the misinterpretation of the project scope statement?
    A. Imprecise language
    B. Poor pattern, structure, and chronological order
    C. Variations in size of work packages or detail of work
    D. Too much detail

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24. Which of the following best describes the Validate Scope process?
    A. It provides assurances that the deliverable meets the specifications, is an input to the project management plan, and is an output of Control Quality.
    B. It ensures the deliverable is completed on time, ensures customer acceptance, and shows the deliverable meets specifications.
    C. It ensures customer acceptance, shows the deliverable meets specifications, and provides a chance for differences of opinion to come to light.
    D. It is an output of Control Quality, occurs before Define Scope, and ensures customer acceptance.

25. Which of the following best describes the difference between the Control Scope process and the Perform Integrated Change Control process?
    A. Control Scope focuses on making changes to the product scope, and Perform Integrated Change Control focuses on making changes to integration.
    B. Control Scope focuses on controlling the scope of the project, and Perform Integrated Change Control focuses on determining the impact of a change of scope on time, cost, quality, risk, resources, and customer satisfaction.
    C. Control Scope focuses on controlling the scope of the project, and Perform Integrated Change Control focuses on making changes to integration.
    D. Control Scope focuses on making changes to the product scope, and Perform Integrated Change Control focuses on determining the impact of a change to scope, time, cost, quality, risk, resources, and customer satisfaction.

26. It's Monday morning, and you just found out that the lead developer on your agile team has broken his leg and will be out for six weeks. The team is in the middle of a two-week iteration that ends in four days, on Thursday. What should you do?
    A. Explain that everyone will need to work overtime to complete their agreed-upon iteration goal.
    B. Postpone all the upcoming iteration deadlines and the next release date.
    C. Ask the team how much of the iteration plan can be completed by Thursday.
    D. Ask HR to find a temporary replacement on a rush basis from another team.

27. Being prepared to do a complete job of developing and finalizing the scope baseline requires that you have done a thorough and timely job of identifying and analyzing stakeholders, and of collecting requirements. The development of the scope baseline can best be described as involving:
    A. The functional managers
    B. The project team
    C. All the stakeholders
    D. The business analyst

28. The cost performance index (CPI) on the project is 1.13, and the benefit-cost ratio is 1.2. The project scope was created by the team and stakeholders. Requirements have been changing throughout the project. No matter what the project manager has tried to accomplish in managing the project, which of the following is he most likely to face in the future?
    A. Having to cut costs on the project and increase benefits
    B. Making sure the customer has approved the project scope
    C. Not being able to measure completion of the product of the project
    D. Having to add resources to the project

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29. Which of the following is correct in regard to the Control Scope process?
    A. Effective scope definition can lead to a more complete project scope statement.
    B. The Control Scope process must be done before scope planning.
    C. The Control Scope process must be integrated with other control processes.
    D. Controlling the schedule is the most effective way of controlling scope.

30. The product owner on your agile project has learned that a competitor is planning to release a similar product to the one your team is working on. To make sure your product will be competitive, she has added two major new features to the backlog. Your team estimates that this additional work will take five one-week iterations to complete. The sponsor asks you how this addition will impact your ability to meet the delivery deadline. How do you respond?
    A. We will still release on time, but the release version won't include the least important features.
    B. We will try to crash the work, but the release may be delayed by up to five weeks.
    C. We should still release on time, if we are able to shorten the usual testing process.
    D. We can still release on time if you authorize overtime pay and temporary help for the team.

31. Which of the following best describes product analysis?
    A. Working with the customer to determine the product description
    B. Mathematically analyzing the quality desired for the project
    C. Gaining a better understanding of the product of the project in order to create the project scope statement
    D. Determining whether the quality standards on the project can be met

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Answers

1. **Answer** B
   Explanation The output of the Validate Scope process is customer acceptance of project deliverables. The other choices all happen during project planning, well before the time the Validate Scope process takes place.

2. **Answer** B
   Explanation On an agile project, the product owner or value management team is responsible for prioritizing the product backlog and keeping the priorities up to date. This role represents the business and therefore best understands the value that the product is expected to deliver. The members of the development team participate by estimating and reviewing the product backlog items, but they don't prioritize the work. Also, the team works collectively, often in meetings with other stakeholders, so their involvement isn't limited to the team leader. Finally, while various stakeholders may participate in this process as needed, it isn't correct to say that "any interested stakeholder" is responsible for the backlog priorities.

3. **Answer** D
   Explanation The term "stakeholder" encompasses all the other choices. In this case, it is the best answer since the WBS can be used as a communications tool for all stakeholders to see what is included in the project.

4. **Answer** A
   Explanation The WBS dictionary defines each element in the WBS. Therefore, descriptions of the work packages are in the WBS dictionary. Activity lists may identify the work package they relate to, but they do not contain detailed descriptions of the work packages. The project scope statement defines the project scope, but it does not describe the work a team member is assigned. The scope management plan describes how scope will be planned, managed, and controlled. It does not include a description of each work package.

5. **Answer** B
   Explanation The project scope statement is an output of the Define Scope process, which occurs during project planning.

6. **Answer** B
   Explanation Do not jump into the problem without thinking. The customer only notified the project manager that they want to make a change. They did not describe the change. The project manager should not say no until they know more about the potential change, nor should the project manager go to management without more information. The project manager must understand the nature of the change and have time to evaluate the impact of that change before doing anything else. Of these choices, the first thing to do is to determine what the change is. The project manager might then analyze the potential change with the team, but only if their input is required

7. Answer A
   Explanation The requirements hierarchy isn't a plan, and it isn't usually created by the product owner. It simply outlines how the requirements will be broken down into progressively smaller pieces. The team's Kanban board isn't a plan, either—it's simply a diagram of the work that's currently moving through the development process. The product backlog is a prioritized master list of the work that still needs to be done, but it doesn't include the planned release dates or the features that will be included in each release. To provide the requested information, you will need to send Marketing the team's product roadmap. The roadmap is agile's closest equivalent to a traditional project plan.

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8. **Answer** D
Explanation Not all questions will be difficult. The level of uncertainty in scope increases based on the scale of effort required to identify all the scope. On larger projects, it is more difficult to catch everything.

9. **Answer** D
Explanation Neither doing a benchmarking study nor developing prototypes is likely to be relevant or useful for determining how to build the next product increment. Facilitating a team meeting might be helpful, but this isn't the best answer since the scenario implies that the team has already been trying to work out their differences and has gotten stuck. Voting on the options can help them move forward when they aren't able to reach a consensus.

10. **Answer** C
Explanation The lowest level of the WBS is a work package, which can be completed by more than one person. The other choices are aspects of a work package.

11. **Answer** C
Explanation The Validate Scope process occurs during project monitoring and controlling. It is done at the end of each project phase to get approval for phase deliverables, as well as at other points to get approval for interim deliverables.

12. **Answer** C
Explanation The project scope statement describes work on a high-level basis. Work packages need to be specific to enable team members to complete their work without gold plating. The product scope does not tell team members what work is assigned to them. The team should have a copy of the schedule, but a schedule does not show them what work is included in each of their work packages. Work packages are described in the WBS dictionary. NOTE: Do not think of the WBS dictionary as a dictionary of terms.

13. **Answer** A
Explanation A user story is a way of stating a requirement, often using the following format: As a <role>, I want <functionality/goal>, so that <business benefit/motivation>. User stories may be developed in facilitation sessions or as part of other requirements-gathering activities.

14. **Answer** C
Explanation Monitor Risks, Control Schedule, and Control Scope are monitoring and controlling processes. This situation asks how to prevent the problem, which would have been done during planning. The project deliverables are defined in the Define Scope process, which is part of project planning. Good planning reduces the likelihood of a situation like the one described in the question, by including the right people and spending adequate time clarifying the project scope.

15. **Answer** A
Explanation Work breakdown structures are required on projects of every size, regardless of whether contracts are involved. Work breakdown structures can be used to help identify risks, but risks can be identified using other methods as well. Preventing work from being forgotten (slipping through the cracks) is one of the main reasons the tool is used, and is the best choice offered here.

16. **Answer** C
Explanation This scenario calls for a skilled facilitator to bring the authors together and guide them to a consensus. Choosing the best design yourself would be outside the scope of your role as the project manager, since the authors are responsible for the content. That would also contradict the agile principle that collective decision-making is the best way to maximize value. Creating a context diagram or a prototype wouldn't be helpful in this scenario since those tools wouldn't help the authors come to a consensus about the course design.

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17. **Answer** A
Explanation The scope baseline includes the WBS, WBS dictionary, and the project scope statement. The scope management plan is not part of the scope baseline.

18. **Answer** B
Explanation Notice that there are many things the project manager could do listed in the choices; however, the question asks what the project manager should do next. Management of the change is not complete when the Control Scope process is completed. It is important to look at the impact of the change on other parts of the project, such as schedule and budget. Therefore, performing integrated change control is the best thing to do next. This would probably be followed by making sure the impact of the change is understood by the stakeholder, then determining why this scope was not identified in planning, and asking the stakeholder if more changes are expected.

19. **Answer** A
Explanation The project scope statement is an output of the Define Scope process. The work breakdown structure is an output of the Create WBS process. Scope change requests are outputs of the Validate Scope and Control Scope processes. The requirements traceability matrix is an output of the Collect Requirements process, and is used to track the requirements throughout the life of the project.

20. **Answer** B
Explanation It might appear that none of the four answer options refer to the team's solution design. But in fact, a careful review of the early, incomplete increments provides the best opportunity for stakeholders to shape the design of the solution. Since this is when the team is designing the rest of the solution, the cost of change is quite low and the opportunity for influence is high. The team's plans and meetings usually won't provide much opportunity for reviewing or influencing the solution design. Finally, waiting for testable release-ready features will be by far the most costly and inefficient way to review the design and suggest changes.

21. **Answer** A
Explanation Control Quality checks for correctness, and Validate Scope checks for acceptance.

22. **Answer** A
Explanation The Validate Scope process deals with acceptance by the customer. Without this acceptance, the project manager will not be able to move into the next project phase.

23. **Answer** A
Explanation Much of the work on the project is dictated by the project scope statement. Any imprecision in such a key document will lead to differing interpretations.

24. **Answer** C
Explanation The project management plan is completed before the Validate Scope process. The Validate Scope process does not deal with time, but rather with acceptance. The Validate Scope process does not occur before the Define Scope process. The choice stating that the Validate Scope process ensures customer acceptance, shows the deliverable meets specifications, and provides a chance for differences of opinion to come to light is entirely correct, making that the best answer.

25. **Answer** B
Explanation Notice how the choices are similar to each other? Simply look at the first part of each choice "Control Scope focuses on . . ." and see which version of the first part of the statement is correct. Then read the second part of each choice. The only statement that is entirely correct is: Control Scope focuses on controlling the scope of the project, and Perform Integrated Change Control focuses on determining the impact of a change of scope on time, cost, quality, risk, resources, and customer satisfaction.

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26. **Answer** C
Explanation This question tests your understanding of timeboxing; unexpected developments like this are exactly why agile approaches rely on timeboxes to bring order to an unpredictable environment. So the best answer is to find out how much of the planned work the team will be able to complete by the end of the timebox, and return the unfinished work to the backlog. In this scenario, you will want to review the upcoming iterations and releases with the team and customer, but that won't necessarily mean postponing them. Ideally, you will be able to keep the development cycles steady and instead adjust scope. As for the other options, adding a temporary replacement is likely to just lower productivity as the other team members try to bring the new person up to speed. And asking the team to work overtime in response to a crisis that you didn't plan for isn't consistent with the agile principles of sustainable development or servant leadership.

27. **Answer** B
Explanation After obtaining input from the customer and other stakeholders, the project team is responsible for developing the scope baseline. Remember that the scope baseline includes the WBS, WBS dictionary, and project scope statement.

28. **Answer** C
Explanation There are many pieces of data in this question that are distractors from the real issue. Though it is common to have to cut costs and add resources to a project, nothing in the question should lead you to think these will be required in this situation. Customers do not generally approve the project scope (what you are going to do to complete their requirements); instead, they approve the product scope (their requirements). Since requirements are used to measure the completion of the product of the project, not having complete requirements will make such measurement impossible.

29. **Answer** C
Explanation Though it is correct that effective scope definition can lead to a more complete project scope statement, this cannot be the answer, because it does not deal with control. Scope planning occurs before the Control Scope process, not after it. Controlling the schedule is not the best way to control scope, so that is not the best answer. The control processes do not act in isolation. A change to one will most likely affect the others. Therefore, the need to integrate the Control Scope process with other control processes is the best answer.

30. **Answer** A
Explanation This question tests your understanding of the agile triangle of constraints, which shows how agile projects balance the competing demands of cost, time, and scope. On plan-driven projects, scope is fixed while time and cost may vary to ensure that the planned scope is completed. On change-driven projects, on the other hand, cost and time are fixed while scope may vary. So the correct answer is that the release version will be ready on time, but it won't include the least important features that were originally planned. Skipping some of the usual testing isn't a good idea. That could impact quality and customer satisfaction, and therefore reduce the value delivered (agile's key goal). Adding temporary help to the team and working overtime aren't considered good agile practices. An agile team wouldn't "crash" their work; they would maintain their usual iterative timeboxes, focusing on the user stories at the top of the backlog.

31. **Answer** C
Explanation You need to have a product description before you can do product analysis. Analyzing the level of quality desired is related to the Plan Quality Management process. Determining whether the quality standards on the project can be met is done in the Manage Quality process. Product analysis includes gaining a better understanding of the product of the project in order to create the project scope statement.

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Schedule

SIX

This chapter can be difficult for those who do not realize that a realistic schedule is a project manager's key accountability. Yes, it's true! If you know the options for compressing a project schedule, understand that a project schedule must be realistic before project executing begins, and can assume you have the authority and responsibility on the team's behalf to make this happen, this chapter should not be difficult for you.

How do you manage a project schedule? Do you use software? Software can be extremely helpful and save time with scheduling, analyzing what-if scenarios, and performing status reporting functions, but you cannot rely on it to properly manage a project. To answer schedule management questions correctly, you should thoroughly understand the process of scheduling a project. Although most project managers use software to assist with scheduling, you need to understand the details behind the data. For example, the exam has often required test takers to know how to draw network diagrams to answer scheduling questions. Likewise, knowing the details behind building a story map will help you get agile questions right.

Make sure you recognize where each schedule management process falls within the project management process and check your knowledge as you work through this chapter. Particularly if you rely on software on your projects, you may not have the knowledge and experience in schedule management that you will need to pass the exam, such as performing schedule analysis and creating network diagrams, release maps, and story maps.

QUICKTEST

- Schedule management process
- Schedule baseline
- Schedule compression
  - Crashing
  - Fast tracking
- Activity list
- Network diagram
- Dependencies
  - Mandatory
  - Discretionary
  - External
  - Internal
- Precedence diagramming method (PDM)
- Critical path
- Relative sizing
- Story points
- Float (Schedule flexibility)
  - Total float
  - Free float
  - Project float
- Three-point estimating
  - Beta distribution
  - Triangular distribution
- Monte Carlo analysis
- Bar charts
- Schedule model
- Schedule management plan
- Critical path method
- Near-critical path
- Leads and lags
- Milestones, milestone list, and charts
- Reserve analysis
- Padding
- Analogous estimating
- Parametric estimating
- Bottom-up estimating
- Heuristics
- Activity attributes
- Rolling wave planning
- Progressive elaboration
- Alternatives analysis
- Affinity estimating
- T-shirt sizing
- Planning poker
- Resource optimization
  - Resource leveling
  - Resource smoothing
- Velocity
- Agile release planning
- Cumulative flow diagrams
- Reestimating

It's important to know that planning and managing a project schedule and the overall process of schedule management primarily relies on technical skills. Understanding the Schedule Management process from the *PMBOK® Guide* and its relationship to the Plan and Manage Schedule task within the Process domain of the *Examination Content Outline* (ECO) is fairly straightforward. How you carry out the tasks and processes depends on methodology. The following chart will help you understand how each part of schedule management fits into the overall project management process.

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PMBOK® Guide: Schedule Management	Done During
Plan Schedule Management	Planning process group
Define Activities	Planning process group
Sequence Activities	Planning process group
Estimate Activity Durations	Planning process group
Develop Schedule	Planning process group
Control Schedule	Monitoring and controlling process group

ECO Domain II: Process
Task 6: Plan and Manage Schedule

The schedule planning and control processes from the *PMBOK® Guide* are put collectively into the ECO as Plan and Manage Schedule. Many of the same estimating and earned value measurement (EVM) tools for controlling are also used for schedule management.

Defining and sequencing activities, estimating their durations, and developing the schedule are planning functions; throughout the project you are using EVM to control the schedule (including procurement schedules) and manage changes to it. Other, complementary ECO processes are Manage Conflict and Negotiate Project Agreements (domain I tasks 1 and 8, respectively), and Promote Team Performance through the Application of Emotional Intelligence and Ensure Team Members/Stakeholders Are Adequately Trained (domain I tasks 14 and 5). As you think about this, be sure to review the ECO for other synchronizing processes in all domains.

Planning Schedule Management PAGE 179

PMBOK® Guide
PG: Planning
Process: Plan Schedule Management

ECO
Domain: II
Task: 6

The Plan Schedule Management process involves documenting or otherwise ensuring a common understanding about how you will plan, manage, and control the project to the schedule baseline, and how you will manage schedule variances. Many project managers just work on the project and hope the project meets the deadline, but proper schedule management requires you to develop and follow a plan, measuring progress along the way. So as part of planning, you need to determine in advance what the measures of performance will be, how and when you will capture the data you need to evaluate schedule performance, how you will use the data to keep the project on track, and what you will do when variances occur. Plan Schedule Management answers questions such as: "Who will be involved, and what approach will we take to plan the schedule for the project?" and "What processes and procedures will we use to create the schedule?"

A quick note regarding alternate approaches. Did you know that hybrid and agile approaches take a pragmatic view of scope and schedule? Rather than trying to analyze and create the schedule up front, teams form a general plan and then perform project work. Agile teams will then re-evaluate to determine the next best steps based on actual progress. Agile teams will also continually refine the schedule as new details emerge. This approach is an acknowledgment that when trying something new, exploration is a better guide for progress than analysis. When work and environments are familiar and predictable, it is possible to accurately schedule work in advance.

The project life cycle and development approach agreed on in the Develop Project Management Plan process (in "Integration") will influence the level and type of schedule management planning you will do on a project. You may also consider existing enterprise environmental factors. For example, is there a work authorization system in place for the project? Does the organization have a preferred project management software to use for scheduling? If not, will the work of the project include creating a work authorization system or selecting a scheduling software product? How does the company culture and the overall structure of the organization impact the work of scheduling the project?

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Also keep in mind that expert judgment and data analysis techniques, such as alternatives analysis, may be used in planning the methodology you will use to arrive at a final schedule. To plan the schedule, you might also need to review the project charter or hold meetings that include the project sponsor, team members, and other stakeholders.

Schedule Management Plan What is the key outcome of this process? A schedule management plan, which can be formal or informal, is part of the project management plan, and helps make estimating and schedule development faster by specifying the following:

- Scheduling methodology and software to be used.
- Rules for how estimates should be stated (examples include: hours, days, or weeks; story points; and whether estimators identify both the effort and duration).
- How a schedule baseline (for measuring against) will be stated, to determine when and where changes may be needed.
- Performance measures that will be used on the project to identify variances early.
- Acceptable variance threshold(s).
- How schedule variances will be managed.
- A process for determining whether a variance must be acted upon.
- Identification of schedule change control procedures.
- Types, formats, and frequency of reports required relating to schedule.
- The length of releases and iterations for an adaptive life cycle.

Defining and Sequencing Activities PAGE 183

The Define Activities and Sequence Activities processes involve taking the work packages created in the WBS and decomposing them into the activities that are required to produce the work package deliverables and thus achieve the project objectives. The activities should be at a level small enough to estimate, schedule, monitor, and control. These activities are then sequenced. Breaking down the project work into the work packages in the WBS is part of scope management, and the identification of activities is part of schedule management.

PMBOK® Guide
PG: Planning
Process: Define Activities; Sequen Activities

Defining Activities Defining activities is not always done as a separate process. Many project managers combine this effort with creating a WBS and WBS dictionary; they decompose work packages into the activities required to produce them, rather than stopping at the work package level.

ECO
Domain: II
Task: 6

So, what do you need in order to define activities? The schedule management plan gives you important information about the approved methodology for scheduling. The traditional scope baseline (project scope statement, WBS, and WBS dictionary) or the backlog and story cards for agile provide information about what is included in your project scope. This is the work you will now break down into project activities. You may also refer to organizational process assets, including existing templates, historical information—such as activity lists from other similar projects—and any standards, such as a prescribed scheduling methodology. Doing this work with the team helps define activities completely and accurately and therefore makes the estimates more accurate.

TRICKS OF THE TRADE Decomposition is used in schedule management as well as scope management. When you see the term on the exam, it is important to look at the context of what is being decomposed. For predictive approaches, when deliverables are being decomposed into smaller deliverables, or work packages, you know the question is referring to the Create WBS process (for scope management). When work packages are being decomposed into activities to produce them, the question is referring to the Define Activities process (for schedule management).

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TRICKS OF THE TRADE® When using agile approaches, the product owner sequences the work by prioritizing the backlog and their role in release planning. This work is done in conjunction with the team who define dependencies, develop estimates, and provide input on what is achievable. When leading an agile project, do not rely solely on the product owner or team to develop the schedule. To truly combine the needs of the business with technical insights, development of the schedule should be a joint effort between the product owner and the team.

Rolling Wave Planning[1] Have you ever worked on a project that seemed to have too many unknown components to adequately break down the work and then schedule it? It is often better to not plan the entire project to the smallest detail in advance, but instead to plan to a higher level and then develop more detailed plans when the work is to be done. This practice is called rolling wave planning and is a form of progressive elaboration. Remember that progressive elaboration refers to the process of clarifying and refining plans as the project progresses. With this method, you plan activities to the detail needed to manage the work just before you are ready to start that part of the project. This technique is used to varying degrees on both change-driven and plan-driven projects.

Iterations of rolling wave planning during the project may result in additional activities being added, and in the further elaboration of other activities. Therefore, rolling wave planning may create the need for updates to the project management plan, specifically the schedule, scope, and/or cost baselines. These changes require integrated change control, beginning with a change request.

But remember—the option of rolling wave planning does not eliminate the need to ensure all the scope that can be known is known before starting work!

Milestones Defining and sequencing activities also involves determining project milestones. Milestones are significant events within the project schedule. They are not work activities and have no duration. For example, a completed design, company-required checkpoint, phase gate, or iteration completion could be a milestone. Initial milestones are documented in the project charter. The project manager can also insert milestones as checkpoints to help control the project. If a milestone in the schedule is reached and any of the planned work has not been completed, it indicates the project is not progressing as planned. The milestone list is part of the project documents.

Sequencing Activities The next process involves taking the activities and sequencing them in the order in which the work will be performed. The result is a network diagram[2] (also referred to as a project schedule network diagram), which is illustrated in figure 6.1. There are several exercises designed to help you learn how to draw and interpret network diagrams later in this chapter.

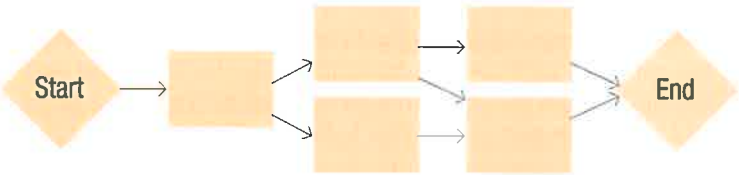

FIGURE 6.1 *Network diagram*

For the exam, know that in its pure form, the network diagram shows just dependencies (logical relationships). If activity duration estimates and leads and lags are added to the diagram later in the schedule management process, it can also show the critical path. If plotted out against time (or placed against a calendar-based scale), the network diagram is a time-scaled schedule network diagram.

Factors that may influence dependencies in the sequencing of activities include the assumption log, activity attributes, and milestone list.

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Precedence Diagramming Method (PDM)[3] In this method, nodes (or boxes) are used to represent activities, and arrows show activity dependencies, as shown in figure 6.2.

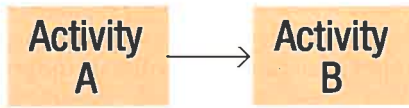

FIGURE 6.2 *Precedence diagramming method*

This type of drawing can have four types of logical relationships between activities, also shown in figure 6.3.

- **Finish-to-start (FS)** An activity must finish before the successor can start. This is the most commonly used relationship. Example: You must finish digging a hole before you can start the next activity of planting a tree.
- **Start-to-start (SS)** An activity must start before the successor can start. Example: You must start designing and wait for two weeks' lag in order to have enough of the design completed to start coding.
- **Finish-to-finish (FF)** An activity must finish before the successor can finish. Example: You must finish testing before you can finish documentation.
- **Start-to-finish (SF)** An activity must start before the successor can finish. This dependency is rarely used.

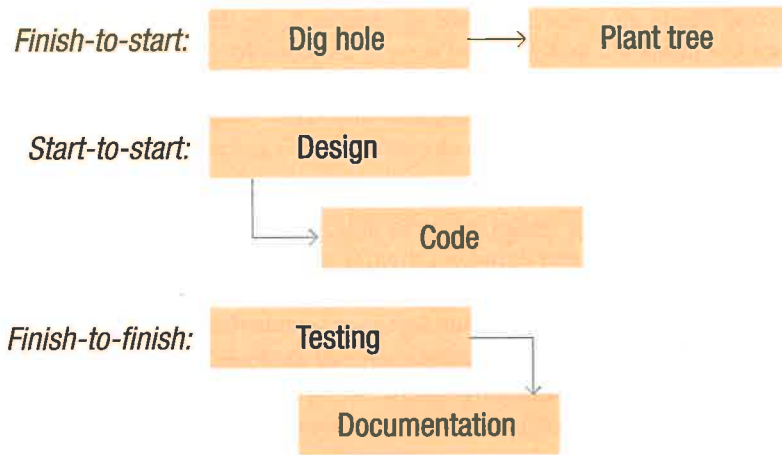

FIGURE 6.3 *Finish-to-start, start-to-start, and finish-to-finish dependencies*

Types of Dependencies[4] The sequence of activities is determined based on the following dependencies:

- **Mandatory dependency (hard logic)** A mandatory dependency is inherent in the nature of the work (for example, you must design before you can construct) or is required by a contract.
- **Discretionary dependency (preferred, preferential, or soft logic)** This is the way an organization has chosen to have work performed. There are other ways it could be done, but this is the preferred approach. Whereas you cannot easily change the other types of dependencies, you can change a discretionary dependency if necessary. Discretionary dependencies are important when analyzing how to compress the schedule to decrease the project duration (fast track the project).
- **External dependency** This dependency is based on the needs or desires of a party outside the project (for example, government or suppliers).
- **Internal dependency** This dependency is based on the needs of the project and may be something the project team can control.

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More than one dependency can be identified for the same work. Combinations include mandatory external, mandatory internal, discretionary external, and discretionary internal.

The project team identifies mandatory and discretionary dependencies; the project manager identifies external and internal dependencies. (Remember, when we use the term "project manager" in this book, we're referring to anyone doing project management activities on the project, which could include not just the lead project manager but also supporting members of the project management team.)

Dependencies in Hybrid Environments Today's digital products have different characteristics than traditional, physical products. Consider how a contractor builds a house. They wouldn't complete the interior of the house before they built the roof, would they? Of course not. The roof needs the walls, the walls need a foundation, and the foundation needs land and permits in place. The dependencies are static, well understood, and slow to change. Techniques like network diagrams, critical path analysis, and detailed Gantt charts are valuable and necessary.

In the digital product space, however, there are many more options and possibilities. Good IT architecture allows services to be swapped out easily and promotes isolating changes. This means there are far fewer dependencies on digital projects. This, coupled with more requirements, renders much of the traditional dependency analysis and dependency management redundant, unreliable, and wasteful. Therefore, many of these techniques are not used in software-heavy digital projects. Instead, project managers work with product owners to define what the priorities are, and they work with the teams on how best to build them. Typically, features can be implemented and evaluated independently of each other.

For example, using a hybrid approach to build an energy trading system for an electrical operator, the product owner may create an initial sequence of features to be developed. Then they may reorder it significantly once the initial bid and validated screens are complete. The product owner may reorder it again after the regulatory body responses get integrated. Such schedule upheavals would require extensive schedule rework with traditional network diagrams and Gantt Charts. By comparison, reordering the backlog on this hybrid project is much less work.

Leads and Lags A lead may be used to indicate that an activity can start before its predecessor activity is completed. For example, web page design might be able to start five days before the database design is finished. A lag is waiting time inserted between activities, such as needing to wait three days after pouring concrete before constructing the frame for a house. When project activities are first being sequenced, the duration of the activities, and required leads and lags, may be uncertain.

Also, when creating complex project schedule network diagrams that include leads and lags as well as other dependencies, an automated scheduling system that is part of the PMIS can be used. This is especially helpful on large projects.

Project Schedule Network Diagram

A project schedule network diagram is an image depicting the flow of project activities in the logical order in which they will be performed. All activities after Start should be connected to at least one predecessor activity. All activities on the network diagram before Finish should be connected to at least one successor activity. In addition to sequencing activities, the network diagram helps you to plan which activities can be completed in parallel and to see where leads or lags are required. Of course, the more complex the project, the more likely it is that activities will overlap. When an activity has two or more activities directly preceding it, this is referred to as path convergence. When an activity has two or more successor activities directly following it, this is referred to as path divergence. Both path convergence and path divergence are indicators of greater risk within the impacted activities.

Rather than just knowing what a network diagram is, you will be expected to answer harder, more sophisticated questions when taking the exam. You need to have worked with network diagrams to accurately answer such questions. You should know that network diagrams can be used in many ways. For example, they can be used to:

- Help justify your time estimate for the project.
- Aid in effectively planning, organizing, and controlling the project.
- Show interdependencies of all activities, and thereby identify riskier activities.

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- Show workflow so the team will know what activities need to happen in a specific sequence.
- Identify opportunities to compress the schedule in planning and throughout the life of the project (explained later in this chapter).
- Show project progress (when used for controlling the schedule and reporting).

The Outputs of Defining and Sequencing Activities When completed, the Define Activities process results in an activity list, which includes all activities required to complete the project, and activity attributes, or details regarding project activities. At this time, known attributes may be limited to the activity name and ID number. As the project progresses, additional attributes—such as planned completion date, leads and lags, and predecessor and successor activities—may be added.

Define Activities is one of only a few planning processes with an output of change requests specifically listed in the *PMBOK® Guide*. Refer back to the discussion of rolling wave planning, and you will see that, as the project progresses, early planning efforts may need to be iterated, potentially resulting in changes to the project baselines.

In addition to a network diagram, the Sequence Activities process may result in updates to project documents such as the activity list, activity attributes, assumption log, and the milestone list. Sequencing the activities can also reveal new risks, resulting in changes to the risk register.

TRICKS OF THE TRADE

Things to Know about Estimating for the Exam The Estimate Activity Durations and the Estimate Costs processes (see the "Cost" chapter) as well as the Estimate Activity Resources process (see the "Resources" chapter) all involve estimating. The following are important points to understand about estimating for the exam:

- Management plans provide the approach for estimating.
- The project manager and team may use one or many techniques to estimate project work.
- Estimating should be based on a WBS or story card (through planning poker, discussed later in this chapter) to improve accuracy.
- Duration, cost, and resource estimates are interrelated; for example, duration and resource estimates could impact cost estimates.
- Identified risks must be considered when estimating the duration, cost, and resource requirements of project work.
- Estimating duration, cost, and resource requirements may uncover additional, previously unidentified risks.
- Whenever possible, estimating should be done by the person doing the work (or the person most familiar with the work) to improve accuracy.
- Historical information from past projects (part of organizational process assets) is key to improving estimates.
- Estimates are more accurate if smaller-size work components are estimated.
- A project manager should never just accept constraints from management, but should instead analyze the needs of the project, develop estimates with input from the team members doing the work when possible, and reconcile any differences to produce a realistic plan.
- The project manager may periodically recalculate the estimate to complete (ETC) for the project to make sure adequate time, funds, and resources, are available for the project.
- Plans based on estimates should be revised, with approved changes, during completion of the work, as necessary.
- There is a process for creating the most accurate estimate possible.
- Padding estimates is not an acceptable project management practice.
- The project manager must meet any agreed-upon estimates.

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- Estimates must be reviewed when they are received from team members or sellers to see if they are reasonable and to check for padding and risks.
- Estimates must be kept realistic through the life of the project by reestimating and reviewing them periodically.
- Estimates can be impacted by reducing or eliminating risks.
- The project manager has a professional responsibility to provide estimates that are as accurate as feasible and to maintain the integrity of those estimates throughout the life of the project.

In the past, the exam has focused on the practices required to produce good estimates, more than it has focused on calculations. Therefore, make sure you take some time to think about these points. Remember, incorrect project management practices will be listed as choices on the exam. Project managers who do not adequately understand and manage their projects in this way have difficulty on the exam.

Estimating the Schedule

PMBOK® Guide
PG: Planning
Process: Estimate Activity Durations

ECO
Domain: II
Task: 6

When the activities have been defined and sequenced, the next step is to estimate how long each activity will take. This is the Estimate Activity Durations process. When possible, the estimators should be those who will be doing the work. On large projects, however, the estimators are more often the members of the project management team, as it is known during planning, who are most familiar with the work that needs to be done. To come up with realistic time estimates, these individuals need to have access to the following:

- **Activity list and activity attributes** The relevant inputs may include the time for required leads or lags between activities, which must be factored into duration estimates.
- **Assumption log** Assumptions or constraints that contribute to risk within the activities to be estimated can be found in the assumption log.
- **Lessons learned register**[5] Information relevant to estimating the duration of schedule activities include lessons learned from earlier in the current project or from past, similar projects performed by the organization.
- **Resource breakdown structure**[6] Created in the Estimate Activity Resources process of Resource Management, the resource breakdown structure represents categories of resources required for the project.
- **Resource requirements** These requirements indicate the skill levels of resources required to perform specific project work.
- **Project team assignments** Project team assignments should include the number and experience level of individuals who have been committed to the project.
- **Resource calendars** These calendars provide information on when key resources with specialized skills needed for project activities will be available. If the resources are not available within the timeframe of your project, you may need to add extra time to some activity estimates, allowing for less experienced resources to do the work.
- **Risk register** The risk register may include identified threats and/or opportunities that should be reflected in the estimates.

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Now let's think about how estimating works on your projects for a moment. Do your team members feel like this?

This response is an example of padding. Do you consider this practice normal or appropriate? It is not. Many project managers rely on this practice, but padding undermines the professional responsibility of a project manager to develop a realistic schedule and budget. This is another point that is essential to understand for the exam.

So what is wrong with padding? A pad is extra time or cost added to an estimate because the estimator does not have enough information.

In cases where the estimator has many unknowns and the information required to clarify the unknowns is unavailable, the potential need for additional time or funds should be addressed with reserves through the risk management process. Through risk management, the uncertainties are turned into identifiable opportunities and threats (risks). They should not remain hidden; instead, estimators need to identify and openly address uncertainties with the project manager.

What happens if all or many of your estimates are padded? Quite simply, you have a schedule or budget that no one believes. And if that is the case, why even bother creating a schedule or a budget? In the real world, we need the schedule and the budget to manage the project against. So we need them to be as believable and realistic as possible, and we need to adhere to them. To be a successful project manager, you need to be able to meet the agreed-upon project completion date and budget. It is important to understand that padding is a sign of poor project management and that it can damage your reputation and the credibility of the project management profession as a whole.

You may see questions on the exam that include padding as a solution to an estimating scenario. Just remember, padding is never a viable way to plan a project or to solve a problem—on the exam or in the real world.

In a properly managed project, the estimators have a WBS and may even have helped create it. They also have a description of each work package (the WBS dictionary) and may have helped create that as well. They may even have helped create the activity list from the work packages. They know there will be time and cost reserves on the project that will be determined through actual calculations—not arbitrary guesses—to address identified risks or unknowns. With all that information, they should not need to pad their estimates!

If you allow padding on your projects now, and consider it to be an appropriate practice, please make sure you reread this section and carefully review the "Risk" chapter. You need to recognize the difference between padding and creating reserves, and understand how padding can be detrimental to your project. The exam questions in this area are designed to identify those who make common project management errors, such as padding.

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How Is Estimating Done? As stated earlier in this chapter, those who will be doing the work, or those most familiar with the activities to be done, should create the activity estimates. They may use one or many techniques, which were identified in the schedule management plan.

Before we discuss estimating techniques, let's look at the project manager's role in this process. If other people are creating the estimates, then what is the project manager doing?

The role of the project manager in estimating is to:

- Provide the team with enough information to properly estimate each activity.
- Let those doing the estimating know how refined their estimates must be.
- Complete a sanity check of the estimates.
- Prevent padding.
- Formulate a reserve (more on this later—in the reserve analysis discussion in this section and in the "Risk" chapter).
- Make sure assumptions made during estimating are recorded for later review.

Relative Sizing Estimating on adaptive projects may differ from estimating on predictive projects. Agile projects use relative estimates instead of absolute estimates. This is known as relative sizing. This form of estimating uses a relative unit called a "story point"[7] rather than hours or days. Relative sizing uses completed tasks to help estimate future project timelines. For example, imagine you have already developed a simple input screen for a new piece of software, and you gave that task a relative size of two story points. You can then estimate the remaining tasks by comparing them to the input screen. You might assign one story point to a simple fix or change because you think it will take about half as much development work. You might estimate other input screens as two story points and bigger pieces of work as three points or five points.

TRICKS OF THE TRADE Think of relative sizing as similar to giving directions to a friend. Using a predictive estimating approach, you would say "You can get to the grocery store by traveling 1.3 miles southeast." Using an adaptive relative sizing approach, you would say "Go straight out the door for about eight or nine blocks until you reach the park; the grocery store is another five blocks straight ahead." Relative sizing estimates use recognizable landmarks and relative measures (blocks) rather than absolute measurements (miles).

Now let's look at estimating techniques that may be used on a project.

One-Point Estimating When estimating time using a one-point estimate, the estimator submits one estimate per activity. For example, the person doing the estimating says that the activity will take five weeks. The time estimate may be based on expert judgment or historical information, or it could be just a guess. As a result, this technique can be problematic.

Although one-point estimating is often not the best method to use, it is an easy way to illustrate how to draw network diagrams and find the critical path. Using one-point estimates also allows for quick calculation on the exam and demonstrates that you understand concepts such as the critical path. You may see references to one-point estimating on the exam, as shown in the exercises later in this chapter.

One-point estimating can have the following negative effects on the project:

- Being limited to making a one-point estimate may encourage people to pad their estimates.
- A one-point estimate doesn't provide the project manager with important information about risks and uncertainties they need in order to better plan and control the project.
- One-point estimating can result in a schedule that no one believes in, thus decreasing buy-in to the project management process.
- When a person uses one-point estimating to develop an estimate that an activity will take 20 days and it is completed in 15 days, it can make the person who provided the estimate look unreliable.

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Analogous Estimating[8] (Top-Down) Applicable to duration, cost, and resource estimating, analogous estimating uses expert judgment and historical information to predict the future. Management or the sponsor might use analogous estimating to create the overall project constraint/estimate given to the project manager as the project is chartered. The project manager may use analogous estimating at the project level, using historical data from past, similar projects. (For example, the last five projects similar to this one each took eight months, so this one should as well.) Analogous estimating can also be used at the activity level, if the activity has been done on previous projects and if there is substantial historical data to support the accuracy of such an estimate. (For example, the last two times this activity was completed each took three days; since we have no other information to go on, we will use three days as the estimate for this activity and review the estimate when more details become available.) Be aware for the exam that analogous estimating can be done at various times, and the level of accuracy depends on how closely the project or activity matches the historical data used.

Parametric Estimating Parametric estimating involves creating a mathematical equation using data from historical records or other sources, such as industry requirements or standard metrics, to create estimates. The technique analyzes relationships between historical data and other variables to estimate duration or cost. It can be applied to some or all the activities within a project. For example, when estimating activity duration, the estimator may use measures such as time per line of code, time per linear meter, or time per installation. When used in cost estimating, the measures include cost as one of the variables. So the measures would be cost per line of code, cost per linear meter, etc.

An estimator might create parametric estimates using the following:

- **Regression analysis[9] (scatter diagram)** This diagram tracks two variables to see if they are related; the diagram is then used to create a mathematical formula to use in future parametric estimating. Figure 6.4 shows an example of a scatter diagram.
- **Learning curve** Example: The 100th room painted will take less time than the first room because of improved efficiency.

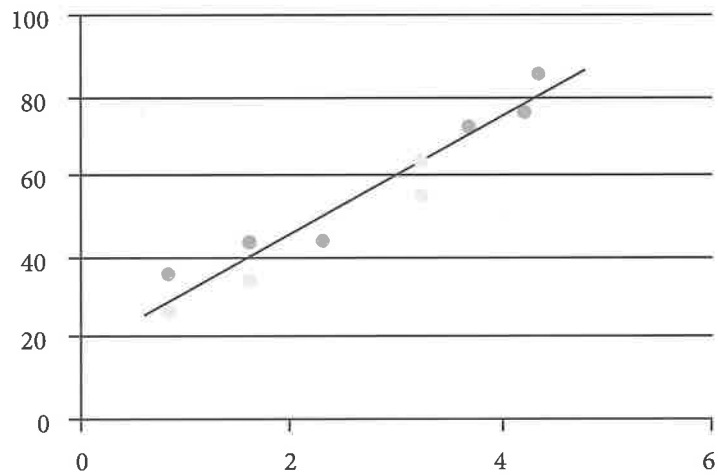

FIGURE 6.4 *Regression analysis (scatter diagram)*

Heuristics[10] A heuristic means a generally accepted rule, or best practice. An example of a heuristic is the 80/20 rule. A schedule heuristic might be, "Design work is always 15 percent of the total project length." The results of parametric estimating can become heuristics.

Three-Point Estimating[11] Statistically, there is a very small probability of completing a project on exactly any one date. As we know, things do not always go according to plan. Therefore, it is often best to state estimates in a range using three-point estimates. Analyzing what could go right (opportunities) and what

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could go wrong (threats) can help estimators determine an expected range for each activity. By analyzing this range of time or cost estimates, the project manager can better understand the potential variation of the activity estimates. With the three-point technique, estimators give an optimistic (O), pessimistic (P), and most likely (M) estimate for each activity. Three-point estimating allows more consideration of both the uncertainty of estimating and the risks associated with the activities being estimated. A wide range between the optimistic and pessimistic estimates can indicate uncertainty—and therefore risk —associated with the activity.

Ultimately, three-point estimates can be used to calculate a risk-based expected duration estimate for an activity by taking either a simple average or a weighted average of three estimates. See the following information and formulas.

Triangular Distribution (Simple Average) A simple average of the three-point estimates can be calculated using the formula (P + O + M)/3. The use of simple averaging gives equal weight to each of the three-point estimates when calculating the expected activity duration or cost. Using this formula, the risks (P and O estimates) are considered equally along with the most likely (M) estimate.

Beta Distribution (Weighted Average)[12] The use of beta distribution (a weighted average) gives stronger consideration to the most likely estimate. Derived from the program evaluation and review technique (PERT),[13] this technique uses a formula to create a weighted average for the work to be done: (P + 4M + O)/6. Since the most likely estimate is multiplied by 4, it weights the average toward that estimate. This method of estimating leverages the benefits of risk management in reducing the uncertainty of estimates. When a good risk management process is followed, the most likely estimates are more accurate because risk response plans have been developed to deal with identified opportunities and threats that have been factored into the pessimistic and optimistic estimates.

TRICKS OF THE TRADE For the exam, you should know the formulas for both triangular and beta distribution and understand that if you are asked to calculate the activity duration or cost, you will need to read the situation carefully to determine which formula to use. Terms like "simple" or "straight" refer to triangular distribution, "weighted" refers to beta distribution. Knowing this will help you choose the correct formula.

You may be asked to perform calculations using the formulas, or to analyze information to determine which calculation is best for the situation presented. If the scenario indicates that you don't have a lot of experience or historical information, you would use triangular distribution, which provides a straight average. Beta distribution is used when there are historical data or samples to work with. The exercises that follow can help you prepare for three-point estimating questions on the exam. But first, review the formulas, shown again in figure 6.5.

You must memorize these formulas and remember that they can be used for both time and cost estimates.

Expected activity duration (triangular distribution)	Expected activity duration (beta distribution)
$\frac{P + M + O}{3}$	$\frac{P + 4M + O}{6}$

Legend: P = Pessimistic, M = Most likely, O = Optimistic

FIGURE 6.5 *Triangular distribution and beta distribution formulas for three-point estimating*

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6.1 Exercise Calculate the expected activity duration using triangular distribution and write the answer in your Exercise Notebook. It is best to calculate to three decimal places. All estimates are in hours.

Activity	P	M	O
A	47	27	14
B	89	60	41
C	48	44	39
D	42	37	29

Answer

Activity	Expected Activity Duration (Triangular Distribution)
A	29.333
B	63.333
C	43.666
D	36

6.2 Exercise Calculate the expected activity duration using beta distribution and write the answer in your Exercise Notebook. Calculate to three decimal places. All estimates are in hours.

Activity	P	M	O
A	47	27	14
B	89	60	41
C	48	44	39
D	42	37	29

Answer

Activity	Expected Activity Duration (Beta Distribution)
A	28.167
B	61.667
C	43.833
D	36.500

Compare the answers in the "Expected Activity Duration (Beta Distribution)" column to the answers in the "Expected Activity Duration (Triangular Distribution)" column in the previous exercise. You may notice that the results are not significantly different, but think about cumulative effects.

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On the exam, if you do not select the right formula for a question that requires a calculation of expected activity duration, you could end up choosing the wrong answer. These exercises are provided for understanding and do not necessarily represent the complexity of questions on the exam. Most of the questions on the exam relating to three-point estimating are relatively simple and may require assessment, but not calculations.

Activity standard deviation[14] is the possible range for the estimate. For example, an activity estimate of 30 hours that has a standard deviation of +/− 2 is expected to take between 28 hours and 32 hours. The formula for beta activity standard deviation is (P − O)/6. Calculation using these formula is not a focus of the exam, but understanding and interpreting standard deviation in a situational question is important.

Although there is a standard deviation formula for triangular distribution, it's complicated and is unlikely to be on the exam so we are not showing it here. What you need to remember for the exam is that the greater the standard deviation, the greater the risk.

To establish a range for an individual activity estimate using weighted (beta) averaging, you need to know the beta expected activity duration (EAD) and the beta activity standard deviation (SD). You calculate the range using beta EAD +/− SD. The start of the range is beta EAD − SD, and the end of the range is beta EAD + SD. Review the following table to see how the information is presented. Keep in mind that the exam scenario may include information for you to do the same evaluation with triangular distribution.

Activity	P	M	O	Expected Activity Duration (Beta Distribution)	Beta Activity Standard Deviation	Range of the Estimate
A	47	27	14	28.167	5.500	22.667 to 33.667, or 28.167 +/− 5.500
B	89	60	41	61.667	8.000	53.667 to 69.667, or 61.667 +/− 8.000
C	48	44	39	43.833	1.500	42.333 to 45.333, or 43.833 +/− 1.500
D	42	37	29	36.500	2.167	34.333 to 38.667, or 36.500 +/− 2.167

The formulas we've been discussing relate to activities, rather than the overall project. The exam concentrates on using three-point estimating to find ranges for activity duration and cost estimates. You can also use this information to calculate the overall project estimate and the project standard deviation to help manage a project successfully. Consider how these ranges might affect the estimate of the overall project duration and cost, and use this knowledge to effectively address variations on your project.

For the exam, you should be able to do simple calculations using the formulas, understand that estimates of time (or cost) should be in a range, and interpret the information to answer situational questions. You may also see beta total project duration (for example, the project duration is 35 months plus or minus 3 months) used in questions that require you to evaluate the situation, rather than complete a calculation, to answer the questions correctly. Remember that, just like with an activity, the greater the range for the project as a whole, the greater the risk.

Why do project managers need to understand expected durations, range estimates, and standard deviations? The main purpose is to use these concepts to better monitor and control projects. These calculations help you know the potential variances on your project and determine appropriate courses of action.

You can use estimated ranges and standard deviation to assess risk. Looking back at the table presenting beta standard deviation in this section, which activity has the most risk? The answer is Activity B. It has the widest range and the highest standard deviation, and is therefore likely to have the greatest risk. These

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calculations are based on the pessimistic, optimistic, and most likely estimates for an activity. The further away from the mean these estimates are, the more that could go right or wrong and affect the activity. Therefore, you can assess and compare the risk of various activities by looking at activity ranges and standard deviations.

Don't forget that these concepts also apply to cost. Let's say you have estimated that a portion of your project will cost $1 million with a standard deviation of $200,000. You need to decide whether to use a fixed-price contract to outsource that piece of the project work. The standard deviation indicates there is a 40 percent range in the cost estimate for the work. Therefore, you would not likely choose a fixed-price contract, since this large standard deviation suggests there is not a firm definition of the scope of the work to be done. (See the "Procurement" chapter for information about types of contracts.)

Bottom-Up Estimating[15] This technique involves creating detailed estimates for each part of an activity (if available) or work package (if activities are not defined). Doing this type of estimating well requires an accurate WBS. The estimates are then rolled up into control accounts and finally into an overall project estimate.

Make sure you have a general understanding of these estimating concepts. If you are still struggling with this topic, review this section again.

Affinity Estimating Affinity estimating is an adaptive technique that involves grouping items into similar categories or collections—i.e., "affinities." Teams use this technique for many purposes, but one of the most important is to make sure a story point unit remains consistent for all estimates over the duration of the project. Affinity estimating is a form of triangulation—it offers a comparative view of the estimates and provides a reality check. Placing user stories into size categories makes it easier to see whether stories with similar estimates are, in fact, comparable in size. This helps ensure you have not gradually altered the measurement of a story point during the estimating process.

T-shirt Sizing[16] T-shirt sizing is a high-level estimating approach that is used to do the initial estimates of the product features and user stories during the early stages of an adaptive project. At that point in the project, the team is not trying to generate detailed estimates; they are aiming to do just enough estimating to map out the overall effort they expect will be involved in the project and get the work started. This is referred to as coarse-grained estimating, since these early estimates will be progressively refined as the project continues.

To see how this works, let's look at an example project. For an online movie service, the team has identified six product features:

- Rate movies
- Browse movies
- Rent movies
- Sell movies
- Review movies
- Sort movies by year

The next step is to roughly size the six features for the movie service, so you can assess the relative effort involved in developing each one. Since you haven't done any work on the project yet, you'll have to make these estimates based on your experience with similar work items in the past. To reflect the uncertainty involved in those estimates, the estimating unit will be T-shirt sizes, ranging from Extra Small (ES) to Extra-Extra-Large (XXL). You won't try to estimate the absolute size of each category, or even how much bigger or smaller each size is compared to the other sizes. All we will know is that Extra Small is smaller than Small, which is smaller than Medium, and so on.

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ES	S	M	L	XL	XXL
Sort movies by year	Rate movies	Browse movies Review movies	Rent movies	Sell movies	

FIGURE 6.6 *Features by t-shirt size*

The results of our sizing effort are shown in figure 6.6. As you can see, we've decided that:

- The functionality that allows users to sort movies by year will require the least effort to build, so this feature is Extra Small.
- The online shopping cart we need to sell movies will require the most effort to build, so this feature is Extra Large.
- There are two features that we think will take Medium effort to build—"Browse movies" and "Review movies."
- None of these features will require an Extra-Extra-Large effort.

Next, you need to decompose these six product features into user stories.

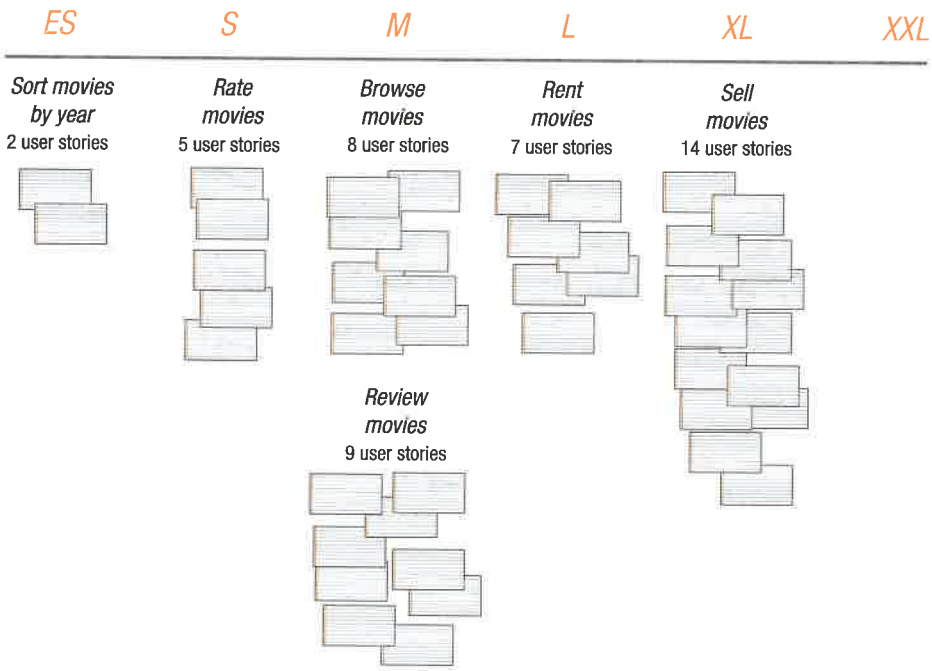

FIGURE 6.7 *Features and user stories*

These 45 user story cards represent all the work that you estimate will need to be done to build the product. Of course, these user stories may change as you proceed—but this is your initial working plan. Just based on the number of user stories in each feature, this breakdown appears to confirm that "Sell movies" will take the most effort to build, and "Sort movies by year" will take the least effort, as originally predicted.

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However, it also appears that "Rent movies," which was sized Large, might actually be smaller than "Browse movies" and "Review movies," which was sized Medium.

Or maybe not—because you haven't determined the relative size of the 45 stories yet. Some of them might be very small, and others might be very large. So our next step is to estimate all the user stories in T-shirt sizes—just like we did for the features. After that, you can also use affinity estimating to ensure the stories in each category are comparable in size.

The 45 user stories based on T-shirt sizes might look something like this:

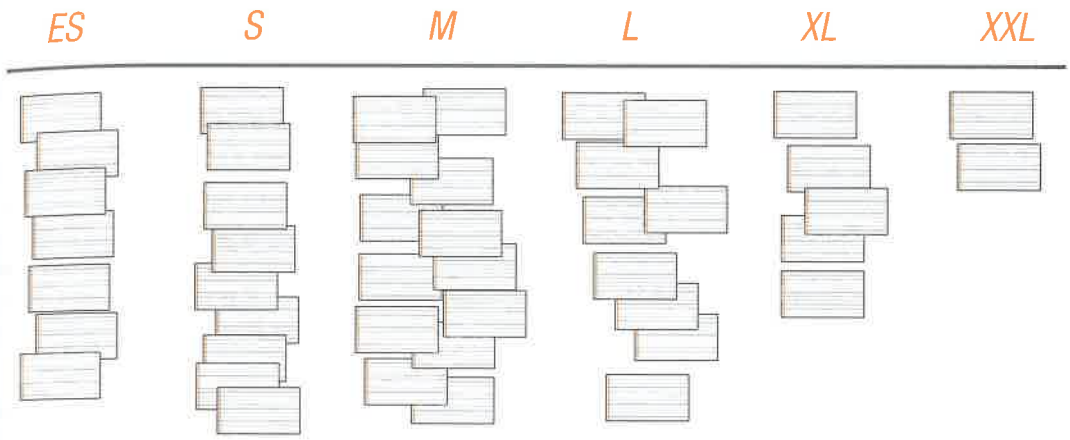

FIGURE 6.8 *User stories by t-shirt size*

Now that you have sized all the stories, you can use the relative sizes of the stories in each feature to refine your T-shirt estimates of the features. Let's say in this example you find out that, on average, the user stories in "Rent movies" are materially larger than the stories in "Browse movies" or "Review movies." As a result, you can see that "Rent movies" really will require more effort than the two Medium features, just as you had originally predicted.

It's important to note that adaptive estimating is done in stages, using progressive elaboration. The purpose of using T-shirt-size estimates is to come up with the initial plan that will be continually refined during release and iteration planning throughout the project.

Planning Poker[17] One common way agile teams come up with the estimates for their user stories is a collaborative game called planning poker. Planning poker is a fast, efficient process that is iterative, adaptive, collaborative, and anonymous enough to minimize most bias. Planning poker uses playing cards that show numbers based on a specific sequence. Each participant receives a set of these cards, as shown below. The numbers on these cards represent the relative units that will be used for the estimates, such as story points.

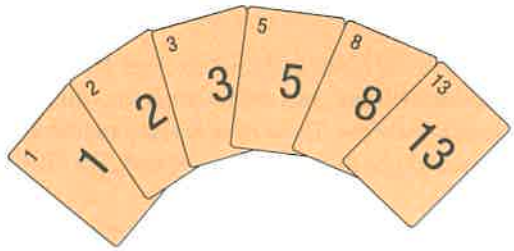

FIGURE 6.9 *Planning poker cards*

Once everyone has a set of cards, the facilitator reads a user story. For example, let's say the first story is, "As a customer, I want to be able to change my password so I can ensure my account is secure." The group first discusses the story briefly. Then each estimator selects a card to represent their estimate of the size of

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that story, without showing it yet. When everyone is ready, the facilitator counts to three, and everyone lays down their cards at the same time, showing their estimates of the effort required to develop that user story.

If the range of played cards is small and there is a rough consensus on the estimate, the largest estimate is selected. After that, the team will move on to the next story to keep the game moving quickly. However, if there is a large discrepancy in the cards played, the team discusses the reasoning behind the differences in their estimates. Then, everyone picks up their card and estimates again, taking the new information into account.

The goal of planning poker is not to create precise estimates. Instead, it aims to help the team quickly and efficiently reach consensus on reasonable estimates so the project can keep moving forward.

Data Analysis Estimate Activity Durations uses two forms of data analysis; alternatives analysis and reserve analysis.

Alternatives Analysis When activity estimates are not acceptable within the constraints of the project, alternatives analysis is used to look more closely at the variables that impact the estimates. For example, comparing options such as outsourcing work versus completing it internally to meet a schedule constraint, or purchasing testing software to decrease the time of manually testing components. Alternatives analysis involves evaluating the impact of each option on project constraints, including financial investment versus time saved and level of risk. This process will result in the determination of the best approach to complete project work within the constraints.

Reserve Analysis Now let's connect the topics of estimating and risk management. Estimating helps to identify more risks. Risk management reduces the uncertainty in time and cost estimates. This is accomplished by evaluating and planning for significant opportunities and threats, including how they will be dealt with if they occur. Risk management saves the project time and money!

Project managers have a professional responsibility to establish a reserve to accommodate the risks that remain after the risk management planning processes are completed. Often in the risk management process, an initial reserve is estimated, the Plan Risk Responses process is performed to reduce the risk, and then a revised reserve is created. This is another example of the iterative nature of project planning.

As described in the "Risk" chapter, two types of reserves can be added to the project schedule: contingency reserves and management reserves.[18]

Contingency reserves for schedule are allocated for the identified risks remaining after the Plan Risk Responses process (known unknowns). These reserves are included in the project schedule baseline.

Significant risks to critical path activities may be managed by allocating a specific amount of schedule reserve. The amount of this schedule reserve is based on the impact of identified risks on the activity as well as the contingency plans to deal with it.

The expected values of each contingency plan are added together to create a schedule contingency reserve. The project manager employs the contingency plan and uses the contingency reserve when identified risks occur. This keeps the project within the schedule baseline. (See the "Risk" chapter for a more detailed discussion of reserves.)

Management reserves are additional funds and time to cover unforeseen risks that could impact the project's ability to meet the schedule. (These risks are referred to as unknown unknowns.) Management reserves are not part of the schedule baseline. These reserves may not be applied at the project manager's discretion, but rather require approval of a formal change request. The "Risk" chapter explains how these reserves are calculated.

For the exam, you should understand the major difference between the practice of creating reserves and the practice of padding. In creating reserves, the project manager has the information necessary to reliably calculate additional time or funds needed for the project, whereas with padding, team members arbitrarily determine how much of a pad they want to attach to their estimates.

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Decision-Making Involving team members in estimating can be beneficial on many levels. Those doing the work are most likely to have a good understanding of the time required to complete the effort. Additionally, including team members in the estimating process increases their buy-in to the resulting schedule.

Voting is a method that can be used during decision-making—giving every participant the opportunity to weigh in on a decision regarding an activity estimate or amount of reserve needed. On plan-driven projects, voting may result in a decision based on plurality, majority, or unanimity. A voting technique commonly used on change-driven projects is "fist of five," also called "fist to five." In this variation, team members are asked to physically show their level of support for a decision. A closed fist indicates a zero (no support) and an open fist indicates five (full support). Team members who are not supportive, and showed two or fewer fingers in the vote, are allowed to share why they are not in support of the option. Voting is repeated until everyone in the group indicates their support by showing at least three fingers.

Outputs of Schedule Estimating When the Estimate Activity Durations process is completed, you will, of course, have estimates, including reserves. But remember that you may also update or make changes to the project documents, including activity attributes, assumption log, and lessons learned register as a result of this process. Outputs of this process on adaptive projects include an updated, prioritized backlog of user stories, coarse-grained estimates of user stories, a release goal focused on customer value, and a target date for release.

Another output of this process is the basis of estimates. The basis of estimates is an explanation of how the estimates were derived, what assumptions and constraints were included, and what risks were taken into consideration in the estimation process. Basis of estimates also includes the confidence level of the estimators, expressed as a range, such as plus or minus 20 percent within which the actual project results are expected to fall.

Preparing the Schedule PAGE 205

After network diagram and activity duration estimates are completed, it is time to create a schedule model.[19] This can be done using a variety of software tools within a project management information system (PMIS). The schedule model includes all the project data that will be used to calculate the schedule, such as the activities, duration estimates, dependencies, and leads and lags. The project schedule is the output of the schedule model, and it consolidates all the schedule data. Representations of the schedule include bar charts and milestone charts. The approved project schedule is the baseline (a version of the schedule model that can only be changed with change control procedures), and is part of the project management plan.

PMBOK® Guide
PG: Planning
Process: Develop Schedule

ECO
Domain: II
Task: 6

The schedule is calendar-based, approved, and realistic as it includes all the activities needed to complete the work of the project, as well as contingency reserves to manage risk events. Consider what is involved in creating a schedule. Let's start at the beginning. What do you need before you can develop a schedule for your project? To develop a schedule, you need to have:

- Historical records of previous, similar projects including lessons learned
- Components of the project management plan needed to develop a realistic schedule (schedule management plan and scope baseline)
- Defined activities (activity list and attributes)
- Milestone list
- Assumption log
- The order in which the work will be done (network diagram)
- Basis of estimates
- An estimate of the duration of each activity (activity duration estimates)
- An estimate of the resources needed (resource requirements)

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- An understanding of the availability of resources (resource calendars)
- The required resources by category (resource breakdown structure)
- A company calendar identifying working and nonworking days
- A list of resources already assigned to specific project activities by management or agreement/contract (project team assignments)
- A list of risks that could impact the schedule (risk register)

6.3 Exercise As a project manager, you need to use the estimating data and other inputs to create a schedule that you will be able to stake your reputation on meeting. What do you need to do to create such a schedule? Write the answer in your Exercise Notebook.

Answer Let's go beyond the *PMBOK® Guide*. The Develop Schedule process really includes everything you need to do to develop a finalized schedule that is bought into, approved, realistic, and formal. This is what developing the schedule is all about. What do you need to do to get it to that level?

- Work with stakeholders' priorities.
- Look for alternative ways to complete the work.
- Look for impacts on other projects and on operations.
- Take into consideration the skill levels and availability of known resources assigned to the team.
- Apply leads and lags to the schedule.
- Compress the schedule by crashing, fast tracking, and reestimating.
- Adjust components of the project management plan as necessary (for example, change the WBS to reflect planned risk responses).
- Input the data into a scheduling tool and perform calculations to determine the optimum schedule.
- Simulate the project using Monte Carlo and other analysis techniques to determine the likelihood of completing the project as scheduled.
- Optimize resources if necessary.
- Give the team a chance to approve the final schedule; they should review the calendar allocation of their estimates to see if they are still feasible.
- Conduct meetings and conversations to gain stakeholder buy-in and formal management approval.

The Develop Schedule process is iterative and can occur many times over the life of the project (at least once per project life cycle phase on a large project). The Develop Schedule process is a source of problems on the exam for many project managers. The exam will test you as an expert in handling schedule development during project planning and whenever there are changes to the project.

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Schedule Network Analysis Schedule network analysis is used to create the schedule model, and, ultimately, to finalize the project schedule. This analysis may use one or more of the following techniques:

- Critical path method
- Schedule compression
- What-if/Monte Carlo analysis
- Resource optimization
- Agile release planning

Critical Path Method[20] The critical path method involves determining the longest duration path through the network diagram, the earliest and latest an activity can start, and the earliest and latest it can be completed. To use this method, you need to understand the following basic concepts.

Critical Path The critical path is the longest duration path through a network diagram, and it determines the shortest time it could take to complete the project.

The easiest way to find the critical path is to identify all paths through the network and add the activity durations along each path. The path with the longest duration is the critical path. Be careful that you do the exercises that follow and practice doing this manual work for the exam.

Near-Critical Path[21] In addition to the critical path, you should be familiar with the concept of a near-critical path. This path is closest in duration to the critical path. Something could happen that shortens the critical path or lengthens the near-critical path to the point where the near-critical path becomes critical. The closer in length the near-critical and critical paths are, the more risk the project has. You need to focus time and effort monitoring and controlling activities on both the critical and near-critical paths (yes, there can be more than one) so there is no delay to project completion.

Float[22] (Schedule Flexibility) You should understand float and be able to calculate it manually for the exam. Note that the terms "float" and "slack" mean the same thing. Slack is an older term for this concept, and is rarely used in project management. It is unlikely that you will see the term "slack" used on the exam.

The three types of float to know for the exam are:

- **Total float** Total float is the amount of time an activity can be delayed without delaying the project end date or an intermediary milestone, while still adhering to any imposed schedule constraints. This is the primary type of float, but there are others.
- **Free float** Free float is the amount of time an activity can be delayed without delaying the early start date of its successor(s) while still adhering to any imposed schedule constraints.
- **Project float** Project float (also referred to as positive total float) is the amount of time a project can be delayed without delaying the externally imposed project completion date required by the customer or management, or the date previously committed to by the project manager.

Activities on the critical path have zero float. Critical path activities that are delayed or have an imposed completion date can result in negative float. This must be addressed before the project begins, as the project manager is responsible to ensure that the project schedule is realistic and achievable. Negative float analysis results in options to bring the schedule back within the baseline.

Float is an asset on a project, as it provides schedule flexibility. If you know where you have float, you can use it to help organize and manage the project. Do you do this on your projects? If not, study this section carefully.

When you know the critical path and any near-critical paths, you can use float as a way to focus your management of a project and to achieve better allocation of resources. For example, if you have a resource who is not very experienced but whom you must use for the project, you can assign them (assuming they have the skill set) to work on the activity with the most float. This gives you some level of security; even if their activity takes longer, the project is less likely to be delayed.

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Knowing the float also helps team members juggle their work on multiple projects. They of course need to get approval from the project manager for any delays from the plan, but the amount of float tells them how much time flexibility they may have for each activity they are working on.

Sometimes the exam questions are presented in such a way that you can simply see the amount of float, but other times you will need to calculate it. Float is calculated using either of the following equations:

- Float = Late start (LS) – Early start (ES)
- Float = Late finish (LF) – Early finish (EF)

Either formula gets you the same answer. Do you want to remember them without any further study? Just know the following:

TRICKS OF THE TRADE®

"There is a start formula and a finish formula, and we always begin late." Notice that the formula uses either two start or two finish data elements and each begins with late.

Start Formula	Finish Formula
Float = LS – ES	Float = LF – EF

You determine whether to use the start or finish formula based on the information available. For example, if an exam question states that you have a late start of 30, an early start of 18, and a late finish of 34, how do you find the float? Using the previous trick, you know to subtract the two starts or the two finishes. Since you do not have two finishes, you use the equation 30 – 18, which equals 12.

Using the Critical Path Method Now that we have discussed the basic concepts, let's look at how the critical path method works. We'll use the network diagram in figure 6.10 as an example. The critical path is identified by the bold arrows.

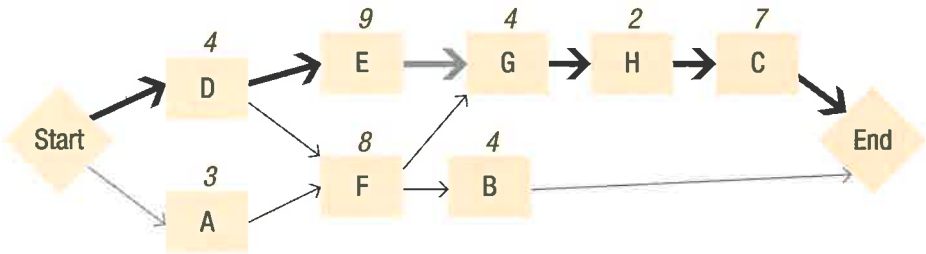

FIGURE 6.10 *Critical path method*

To determine the earliest and latest each activity can start and the earliest and latest each activity can be completed, you need to perform a forward and backward pass through the network diagram. The "early" figures are found by calculating from the beginning of the project to the end of the project, following the dependencies in the network diagram—a forward pass through the network diagram. The "late" figures are found by moving from the end of the project, following the dependencies to the beginning of the project—a backward pass.

The first activity in the diagram normally has an early start of zero. Some people, however, use 1 as the early start of the first activity. There is no right way to start calculating through network diagrams for the early and late starts; either method will get you the right answer. Just pick one method, and use it consistently. We use zero as the early start because it saves a bit of calculation and people consistently find it easier when learning this concept.

Let's start with the forward pass. You need to move through the activities from the start until you reach the end, determining the early starts and early finishes, as illustrated in figure 6.11. This example uses zero as the early start for the first activities.

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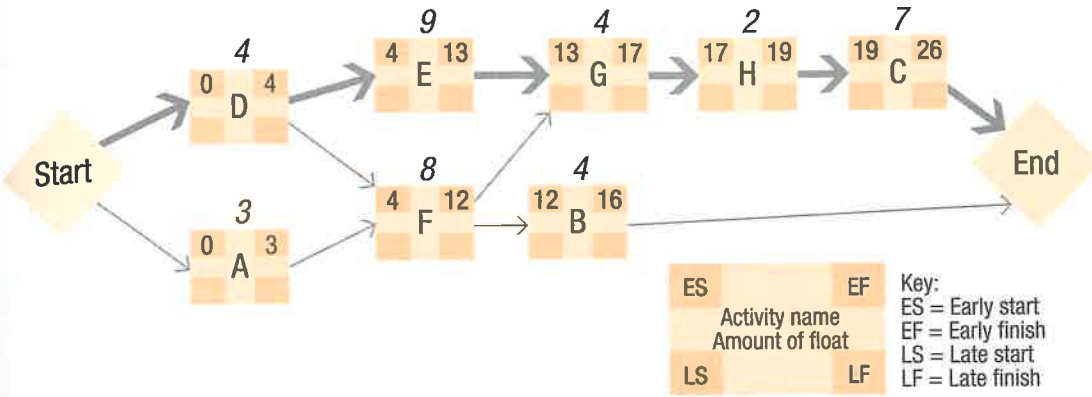

FIGURE 6.11 *Forward pass through network diagram*

It is important to look at where paths converge (path convergence). To compute the early start and the early finish in a forward pass, you have to take into account all the paths that lead into that activity (see activity F and activity G in figure 6.11). The same concept applies to the backward pass; to compute the late finish and late start you need to consider all the paths that flow backward into an activity (see activity D and activity F in figure 6.11). In this diagram, paths converge during the forward pass at activity F and at activity G. So you need to do the forward pass on both paths leading up to activity F, calculating the early finishes for activities D (EF = 4) and A (EF = 3). You then select the later early finish of activities D and A to use as the early start for activity F, since activity F cannot start until both activities D and A are complete. Therefore, the early start of activity F is 4. You use the same process for calculating the early finish of activities E (EF = 13) and F (EF = 12) before determining the early start of activity G (ES = 13).

Once you have completed the forward pass, you can begin the backward pass, computing the late finish and late start for each activity. The backward pass uses the duration of the critical path (in this case, 26) as the late finish of the last activity or activities in the network. See figure 6.12 for the late start and late finish data.

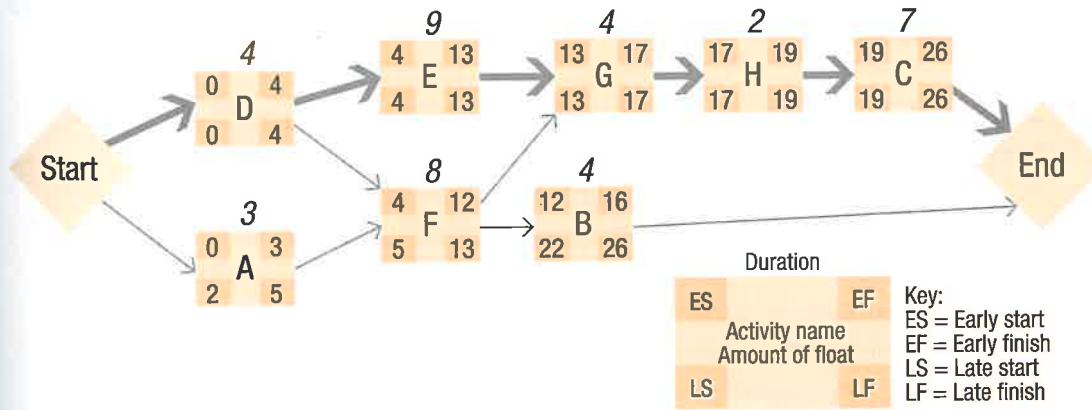

FIGURE 6.12 *Backward pass through network diagram*

Again, you need to be careful at points of convergence as you move through the network diagram. There is convergence at activity F and at activity D. You work from the end back to these by first computing the late start of activities B (LS = 22) and G (LS = 13). Select the earlier late start to use for the late finish of activity F, since activity F must be finished before either activity B or G can start.

Therefore, the late finish of activity F is 13. This same process should be used on activities E (LS = 4) and F (LS =5) before calculating the late finish for activity D (LF = 4).

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Once you finish calculating the starts and finishes, you have the data required to calculate float. It's time to use those formulas. What was that trick again? "There is a start formula and a finish formula, and we always begin late." Therefore, the formulas are:

Start Formula (Used in Forward Pass)	Finish Formula (Used in Backward Pass)
Float = LS – ES	Float = LF – EF

The activities with zero float are on the critical path (identified by the bold arrows). See figure 6.13 for the float of each activity.

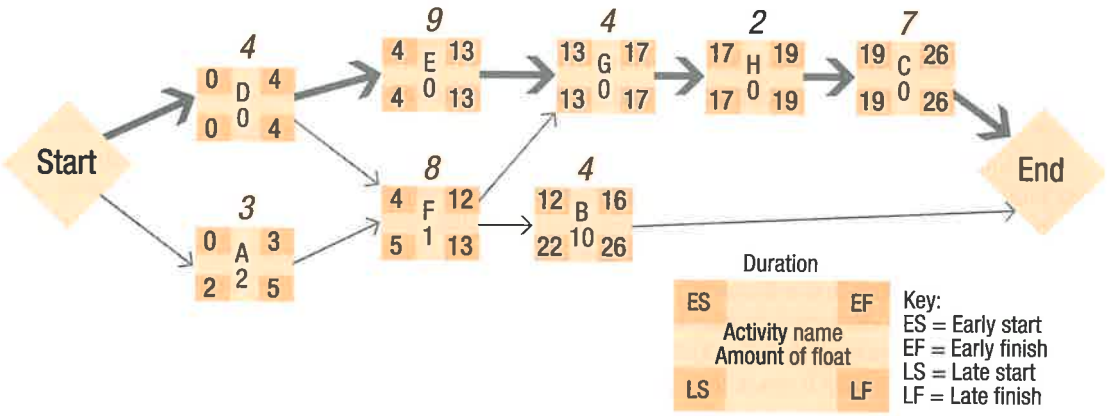

FIGURE 6.13 *Float of activities on network diagram*

The next few exercises should help you better understand these concepts. As you do the exercises, think about how knowing float helps you manage your projects.

Be prepared for different types of exam questions. Some questions may be substantially similar to the following exercises, and others may be more situational and wordy. Not all questions will require you to draw a network diagram.

6.4 Exercise Test yourself. In your Exercise Notebook, draw a network diagram based on the following information, and then answer questions 1-7 below.

You are the project manager for a new project and have figured out the following dependencies:

- Activity 1 can start immediately and has an estimated duration of 3 weeks.
- Activity 2 can start after activity 1 is completed and has an estimated duration of 3 weeks.
- Activity 3 can start after activity 1 is completed and has an estimated duration of 6 weeks.
- Activity 4 can start after activity 2 is completed and has an estimated duration of 8 weeks.
- Activity 5 can start after activity 4 is completed and after activity 3 is completed. This activity takes 4 weeks.

1. What is the duration of the critical path?
2. What is the float of activity 3?
3. What is the float of activity 2?
4. What is the float of the path with the longest float?
5. The resource working on activity 3 is replaced with another resource who is less experienced. The activity will now take 10 weeks. How will this affect the project?

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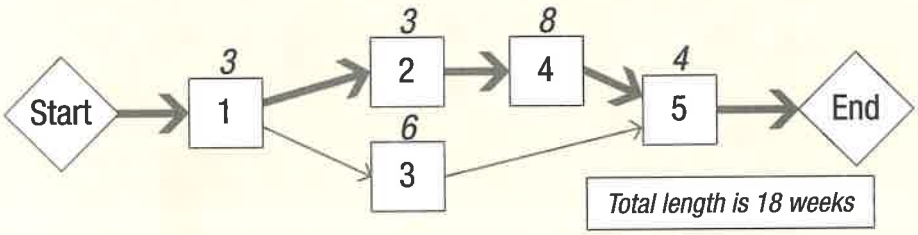
6. After some arguing between stakeholders, a new activity 6 is added to the project. It will take 11 weeks to complete and must be completed before activity 5 and after activity 3. Management is concerned that adding the activity will add 11 weeks to the project. Another stakeholder argues the time will be less than 11 weeks. Who is correct? Use the original information (without the change to activity 3 listed in the previous question) to answer this question.

7. Based on the information in question 6, how much longer will the project take?

Answer There are many ways to answer these questions. If you learned another way in your project management training and are comfortable with that method, use it. Here is a simple way to compute the answers.

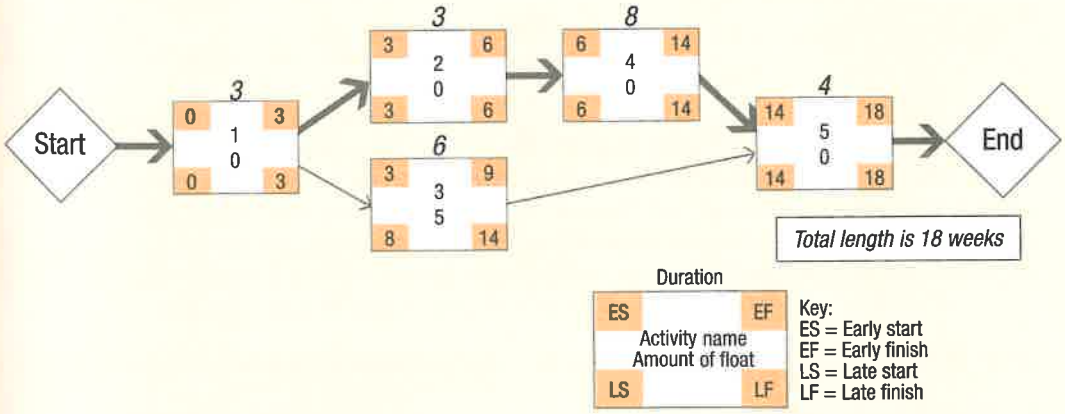
1. The length of the critical path is 18. There are two paths here:

Paths	Duration
Start, 1, 2, 4, 5, End	18
Start, 1, 3, 5, End	13



Start, 1, 2, 4, 5, End (shown with the bold arrows in the diagram) is the longest duration path and is therefore the critical path. The durations of the activities add up to 18, so the critical path is 18 weeks long.

2. The float of activity 3 is 5 weeks, per the following diagram, which shows how to calculate float using the forward and backward pass.



You can use either float formula to compute float. Late finish – Early finish = 14 – 9 = 5, or Late start – Early start = 8 – 3 = 5.

3. The float of activity 2 is zero; it is on the critical path. An activity on the critical path generally has no float.

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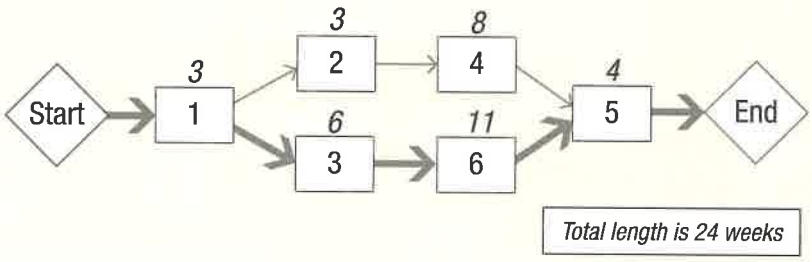
4. The float of the path with the longest float is 5 weeks. There are only two paths in this example: Start, 1, 2, 4, 5, End and Start, 1, 3, 5, End. Only the non-critical path (Start, 1, 3, 5, End) will have float. You can calculate the float for this path by adding the float for each activity: 0 + 5 + 0 = 5. Therefore, the total float of the path with the longest float is 5.
5. The resource change on activity 3 will have no effect. The length of path activities 1, 3, and 5 is 13. Adding 4 more weeks to the length of activity 3 will make that path 17. Since that path is still shorter than the critical path, the critical path does not change. The length of the critical path is still 18 weeks because activity 3 is not on the critical path.
6. The stakeholder who says the time that will be added to the project will be less than 11 weeks is correct. The new activity will be added to a non-critical path that has a float of 5 weeks. Therefore, adding 11 weeks will make this path the new critical path. The overall effect of adding an activity that takes 11 weeks will be a delay to the project of 6 weeks.
7. The project will take 6 weeks longer. (Note: If you answered 24, you did not read the question correctly!) Follow the bold arrows in the following diagram.



6.5 Exercise Use the data in this table to answer the questions that follow. Write your answers in your Exercise Notebook.

Activity	Preceding Activity	Estimate in Months
Start		0
D	Start	4
A	Start	6
F	D, A	7
E	D	8
G	F, E	5
B	F	5
H	G	7
C	H	8
End	C, B	0

1. What is the duration of the critical path?
2. What is the float of activity B?
3. What is the float of activity E?
4. What is the float of activity D?
5. To shorten the length of the project, the sponsor has offered to remove the work of activity E from the project, making activity D the predecessor to activities G and F. What will be the effect?

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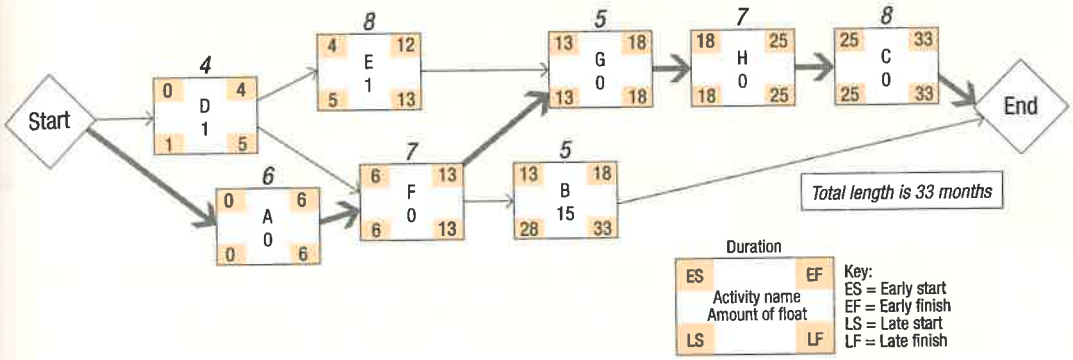
Answer

1. The critical path (project duration) is 33 months.

Paths	Duration
Start, D, E, G, H, C, End	32
Start, D, F, G, H, C, End	31
Start, D, F, B, End	16
Start, A, F, G, H, C, End	33
Start, A, F, B, End	18

2. The float of activity B is 15 months, per the following diagram.



3. The float of activity E is one month. Once you have finished calculating using the long way, all the other answers are usually quick. Just look at the diagram to see the float of any activity.

   Watch out here for the float of activity E. The project must be completed by the end of month 33. Activity E must be completed before activities G, H, and C can start. So the late finish for E is 33 – 8 – 7 – 5, or 13.

   Activity E must be completed after activity D. So the early finish is 4 + 8, or 12. Float = Late finish – Early finish, so 13 – 12 = 1.

   Float = Late finish – Early finish, so 13 – 12 = 1.

4. The float of activity D is one month.

   Now let's look at using a calculation to determine the float for activity D. The project must be completed by the end of month 33. Activity D must be completed before activities E, F, G, H, C, and B can start. Looking backward through the dependencies, the late finish is 33 – 8 – 7 – 5, but then we run into a problem. Normally we would go along the critical path, but look at activities E and F. Activity E is longer than activity F, so we must go along the longest duration path, from activity G to activity E, making the late finish 33 – 8 – 7 – 5 – 8, or 5.

   Early finish is easier. There are no predecessors, so the early finish is the end of month 4.

   Float = 5 – 4, or 1 month.

5. Removing the work of activity E will have no effect on the critical path. The paths are now:

Paths	Duration
Start, D, G, H, C, End	24
Start, D, F, G, H, C, End	31

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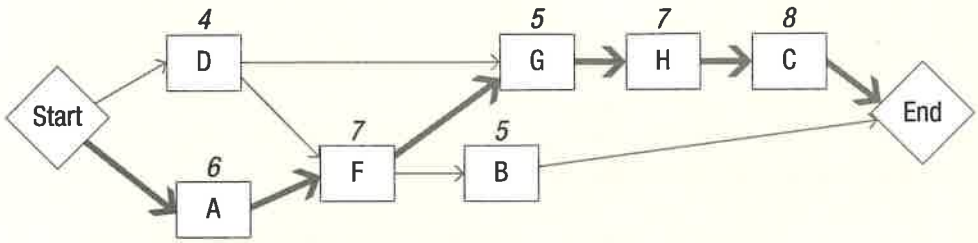
Paths	Duration
Start, D, F, B, End	16
Start, A, F, G, H, C, End	33
Start, A, F, B, End	18



You survived! Hopefully it was not too hard.

TRICKS OF THE TRADE The following are good questions to test your knowledge about critical paths, float, and network diagrams:

- Can there be more than one critical path? Yes, you can have two, three, or many critical paths.
- Do you want there to be? No; having more than one critical path increases risk.
- Can a critical path change? Yes.
- Can there be negative float? Yes; it means you are behind.
- How much float does the critical path have? In planning, the critical path generally has zero total float. During project executing, if an activity on the critical path is completed earlier or later than planned, the critical path may then have positive or negative float. Negative float on the critical path requires corrective action or changes to the project to bring it back in line with the plan.
- Does the network diagram change when the end date changes? No, not automatically, but the project manager should investigate schedule compression options such as fast tracking and crashing the schedule to meet the new date. Then, with approved changes, the project manager should change the network diagram accordingly.
- Would you leave the project with negative float? No; you would compress the schedule. If schedule compression efforts do not result in zero or positive float, you need to request a change to adjust the baseline.

TRICKS OF THE TRADE When you manually create a network diagram while taking the exam, label it with the question number, in case you want to go back to it later. You may be able to reuse the same network diagram to answer additional questions later in the exam.

It is easy to miss paths through a network diagram. When attempting to identify the critical path, carefully calculate the duration of each path to ensure you look at all paths before determining which is critical.

Schedule Compression[23] One of the most common problems on projects is an unrealistic timeframe. This problem can arise during project planning when management or the customer requires a completion date that cannot be met, or during project executing when the project manager needs to bring the project back in line with the schedule baseline or adjust the project for changes. As we discussed earlier, many project managers blame their sponsors or executives for unrealistic schedules, but project managers have a

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professional responsibility to push back, present options, and make sure the project is achievable by properly planning the project and using schedule network analysis techniques such as schedule compression.

Also keep in mind that schedule compression is a way to utilize float by fast tracking activities that are on the critical path. This means adjusting the network diagram so critical path activities that were originally planned to be completed in a series are replanned to be done in parallel. As we discuss next, fast tracking can save time, but it also adds risk to the project.

During project planning, schedule compression can help a project manager determine if the desired completion date can be met and, if not, what can be changed to meet the requested date.

Later in the project, schedule compression may be used during Perform Integrated Change Control and Control Schedule to evaluate options to manage the impacts of changes. The objective of this technique is to manage the schedule without changing the schedule baseline. This isn't always possible, but we try.

Fast Tracking This technique involves taking critical path activities that were originally planned to be done one after another and doing them instead in parallel for some or all of their duration, as shown in figure 6.14. Fast tracking often results in rework, usually increases risk, and requires more attention to communication.

FIGURE 6.14 *Fast tracking*

For example, which activity in figure 6.15 would you fast track to shorten the project length?

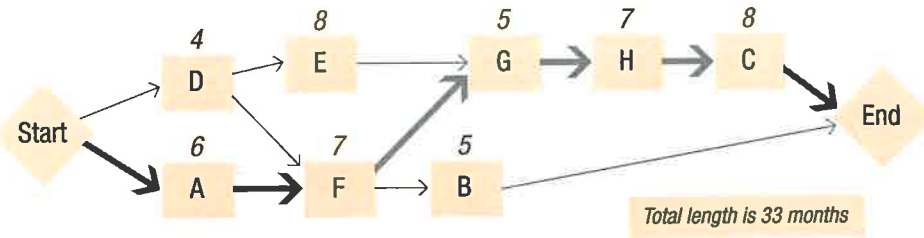

FIGURE 6.15 *Which activity would you fast track?*

Assuming the dependencies are discretionary, activity H could be fast tracked by making it occur at the same time as, or in parallel with, activity G. Any other pair of activities on the critical path could be fast tracked. Activities C and H could also be fast tracked by having part of activity C done concurrently with activity H.

Let's take a look at a real-world scenario with fast tracking. A cable TV provider was using a hybrid project approach to implement web analytics tools. The project team was asked to fast track their project to be ready for a large marketing push in response to a competitor's campaign. The product owner met with the steering committee and reviewed the release roadmap and product backlog. They identified scope that could be deferred until after initial launch, allowing the bulk of the functionality to be delivered on time to track the new promotion. The customer could create some reports on their own in spreadsheets rather than relying on the tool, and some metrics could be eliminated from scope or deferred. However, the core data and decision-making frameworks would be delivered on time if the steering committee understood and approved the workarounds and reduced functionality. Once the necessary approval was given, the project proceeded and was largely ready on time. The team struggled some when analyzing data via spreadsheets rather than reports, but the project was able to fast track most of the business value in time for the marketing campaign. A future release of the project completed the functionality and retired the analysis spreadsheets.

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As you can see, fast tracking added some risk to the project and reduced initial functionality of the product, but it was an effective way for the project manager to meet the new, shorter schedule requirement.

Crashing[24] This technique involves adding or adjusting resources in order to compress the schedule while maintaining the original project scope. Crashing, by definition, always results in increased costs, and may increase risk. It trades time for money.

For example, in the network diagram in figure 6.15, a contract resource could supplement the internal resource's efforts on a critical path activity (assuming this is logical, based on the nature of the work). Another option to crash the project might be to buy a software application; the purchase adds cost to the project but helps the team work more efficiently, thus saving time.

If you have negative project float (meaning the estimated completion date is after the desired date), would your first choice be to tell the customer the date cannot be met and to ask for more time? No; the first choice would be to analyze what could be done about the negative float by compressing the schedule. In crashing or fast tracking, it is best to see all potential choices and then select the option or options that have the least negative impact on the project. For the exam, remember that you need to identify all the possible options and, if given a choice between crashing or fast tracking options, select the choice or combination of choices with the least negative impact on the project. This tip can help you on exam questions that seem to have two right answers.

In the real world, many project managers use the network diagram to manage the day-to-day operations of the project and to make adjustments when changes occur. You should expect this to be reflected on the exam in terms of the number of questions involving network diagrams, calculations, and "What do you do in this situation?" scenarios.

Let's make sure you are prepared to deal with unrealistic schedules on the exam. This issue is so important that you can expect to see more than 10 questions about it. Most project managers have some gaps in their knowledge in this area, and it shows on their score sheets. To remedy this, let's review a scenario (described next) and see if the explanations make sense to you.

Figure 6.15 shows that the project duration is estimated to be 33 months. But what if you're given a constraint of 30 months? Options are listed in the following table to illustrate how the project duration can be shortened by three months.

Option	How to Achieve It	Explanation (Including Assumptions Made)
Reestimate.	Review risks.	Now it is time to look at the estimates and see which contain hidden risks. By reducing the risks, the estimate can be lowered, and the project finished faster. It is never an option to just cut 10 percent off of the estimate.
Execute activities H and C in parallel.	Fast track (schedule compression).	We assume that the dependency between activities H and C is a discretionary one.
Add resources from within the organization (at additional cost to the project) to activity G.	Crash (schedule compression).	We assume that adding resources to activity G would, in fact, be practical and that there are resources available.
Cut activity H.	Reduce scope.	Although not the first choice, as it will likely affect the customer, reducing scope should be considered an option.

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Option	How to Achieve It	Explanation (Including Assumptions Made)
Hire consultants to assist on activity G, H, or C (at additional cost to the project).	Crash (schedule compression).	We assume that adding external resources to these activities would be practical and that there are resources available.
Move more experienced people to activities on the critical path (activities G, H, or C).	Compress the schedule.	We assume that some of the critical path activities are being done by less experienced people.
Cut time.	Lower quality standards.	Do not get excited. Quality is a project constraint, and lowering quality standards is an option. In this case, it would probably be easier—and thus faster—to complete the project with the lowered quality standards.
Say no; the project must have 33 months.	Stand your ground.	This is not a viable option until other alternatives are exhausted.
Get more work done with the same amount of resources.	Work overtime.	This is not an option during project planning. There are too many other ways to compress the schedule that do not have the negative effects of overtime. Save it for a last resort.

Which of the options listed is the best? To answer the question, think of the impacts on the project of each one. Is the best option to cut time by lowering quality standards? What are the impacts of cutting quality? Is there another option? Why not do what many project managers do—ask for more resources? But adding resources may also add cost. Why not work overtime? Most organizations are working at close to 100 percent capacity. Having your project team work overtime limits the possibility of resources responding to emergencies for any other project they are working on, thereby putting other projects at risk. Besides, how much overtime can a person take? Overtime is not free.

The best choice is to look at risks and then reestimate. Once it is known that the schedule (or budget) must be reduced, a project manager can investigate the activity estimates that contain the most unknowns, eliminate or reduce these risks, and thus decrease the estimate. Eliminate risks in the risk management process and everyone wins! If this is not enough, the project manager would continue the effort to shorten the schedule by using other schedule compression techniques.

Let's look at these concepts again.

Review the impacts of the schedule-shortening options listed in the following table.

Option	General Impacts on the Project
Fast track	• Always adds risk • May add management time for the project manager
Crash	• Always adds cost • May add management time for the project manager • May add risk

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Option	General Impacts on the Project
Reduce scope	• May save cost, resources, and time • May negatively impact customer satisfaction
Cut quality	• May save cost, resources, and time • May increase risk • Requires good metrics on current and desired levels of quality to be effective • May negatively impact customer satisfaction

6.6 Exercise Here is another chance to test yourself on schedule compression. In your Exercise Notebook, use the information from the following table to answer the questions below.

Activity	Original Duration (Months)	Crash Duration (Months)	Time Savings	Original Cost (Dollars)	Crash Cost (Dollars)	Extra Cost (Dollars)	Cost per Month
J	14	12	2	$10,000	$14,000	$4,000	$2,000
K	9	8	1	$17,000	$27,000	$10,000	$10,000
N	3	2	1	$25,000	$26,000	$1,000	$1,000
L	7	5	2	$14,000	$20,000	$6,000	$3,000
M	11	8	3	$27,000	$36,000	$9,000	$3,000

1. Imagine that this project has a project float of –3 months. Which activity or activities presented above would you crash to save three months on the project, assuming that the activities listed above represent critical path activities?
2. How much would it cost to crash this project?

Answer

1. The following activities could be crashed to save three months on the project:

Activities	Cost
J and K	$14,000
J and N	$5,000
K and L	$16,000
L and N	$7,000
M	$9,000

Crashing activities J and N is the least expensive option, and because there is nothing in the question to eliminate it, the option to crash activities J and N is the best answer. Any time you have negative project float, it means that the project is not going to meet its deliverable date. The answer, depending on how the question is worded, involves crashing or fast tracking the project and coming up with options, or telling the customer the date cannot be met.

2. Crashing activities J and N would result in the least added cost—only $5,000. The "Cost per Month" column in this exercise is a distractor; you can answer this question with just the "Activity," "Time Savings," and "Extra Cost" columns. Don't assume you will need all the data provided to you in questions on the exam.

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6.7 Exercise Consider the following question and write the answer in your Exercise Notebook:

Question Management has told you to get the project completed two weeks early. What is the best thing for you to do?

A. Consult the project sponsor
B. Crash
C. Fast track
D. Advise management of the impact of the change

Answer Did you get fooled by this question? Did you think you had to choose between crashing and fast tracking? There is no information provided to help you determine which one is better. Therefore, the best choice presented is D, advise management of the impact of the change.

The exam will include many such questions requiring you to know that a project manager needs to analyze first, create options to deal with the change, and then let management, the sponsor, the customer, or other parties know the impacts of their request (see the four-step process for handling changes in the "Integration" chapter). A project manager does not just say yes! Instead, after analyzing the change for its impact on all areas of the project (cost, risk, resources, etc.), they could say something like, "Yes, I would be happy to make the change, but the project will be delayed two weeks. And I will need two more resources, or the project will cost $25,000 more."

TRICKS OF THE TRADE Exam Tip: For questions about changes to the network diagram, make sure you look for shifts to new critical paths caused by the changes to the network diagram or to activity durations.

Data Analysis/Simulation In creating a finalized, realistic schedule, it is helpful to ask, "What if a particular factor changed on the project? Would that produce a shorter schedule?" The assumptions for each activity can change and, therefore, the activity durations can also change. One of the ways to calculate the effect of these changes is through what-if scenario analysis.

Monte Carlo Analysis[25] This technique uses computer software to simulate the outcome of a project, based on the three-point estimates (optimistic, pessimistic, and most likely) for each activity and the network diagram. The simulation can tell you:

- The probability of completing the project on any specific day
- The probability of completing the project for any specific cost
- The probability of any activity actually being on the critical path
- An indication of the overall project risk

Monte Carlo analysis is another way of putting together the details of three-point estimates into a project estimate. It is more accurate than other methods because it simulates the actual details of the project and calculates probability.

Monte Carlo analysis can help deal with "path convergence," places in the network diagram where multiple paths converge into one or more activities, thus adding risk to the project (see figure 6.16). Monte Carlo analysis is also used as a risk management tool to quantitatively analyze risks (see the "Risk" chapter).

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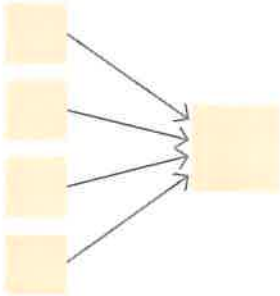

FIGURE 6.16 *Path convergence*

Resource Optimization[26] Resource optimization refers to finding ways to adjust the use of resources. There are two techniques that can achieve this outcome.

- **Resource Leveling**[27] Resource leveling is used to produce a resource-limited schedule. Leveling lengthens the schedule and increases cost to deal with a limited number of resources, resource availability, and other resource constraints. A little-used function in project management software, this technique allows you to level the peaks and valleys of the schedule from one month to another, resulting in a more stable number of resources used on your project.

  You might level the resources if your project used 5 resources one month, 15 the next, and 3 the next, or some other up-and-down pattern that was not acceptable. Leveling could also be used if you did not have 15 resources available and preferred to lengthen the project (which is a result of leveling) instead of hiring more resources.
- **Resource Smoothing**[28] Resource smoothing is a modified form of resource leveling, where resources are leveled only within the limits of the float of their activities, so the completion dates of activities are not delayed.

Velocity[29] Velocity is the measure of a team's capacity for work for each iteration. This powerful metric allows the team to gauge how much work they will be able to do in future iterations based on the amount of work they completed in past iterations. This provides a way to track and communicate what they have accomplished, anticipate what they will be able to accomplish in the future, and forecast when the project (or release) is likely to be done.

Project performance metrics like velocity allow agile teams in particular to make fairly reliable estimates about how long it will take them to complete work despite the changes to the project and scope. On change-driven projects especially, velocity is used for estimating and planning upcoming releases and iterations. Figure 6.17 is an example of tracking a team's velocity across iterations.

Velocity usually varies the most in the first few iterations when the team is getting used to working together, interacting with project stakeholders, and using the project tools. This makes it a very powerful tool for planning and estimating.

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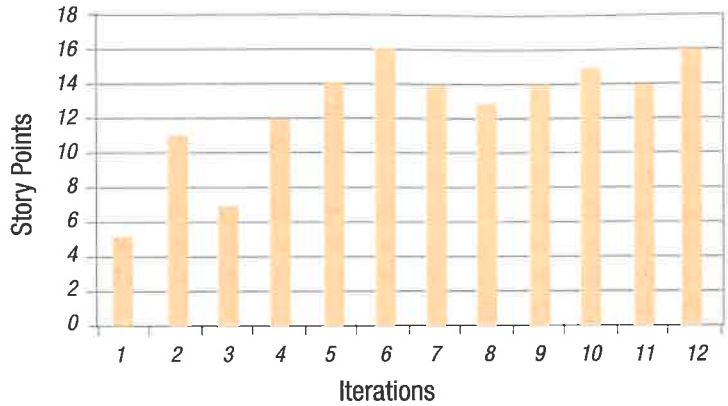

FIGURE 6.17 *Velocity tracking chart*

Care needs to be taken when using velocity metrics outside of the team environment to avoid abuse or gaming the metrics. For instance, organizations will sometimes try to compare velocities of two or more teams, but these comparisons are meaningless since each team defines their own units based on what is meaningful and valuable to them. Another mistake some organizations make is incentivizing velocity, which usually results in inflation of the points assigned to work rather than an increase in work done since it is easier to pad estimates than work faster. Many agile experts today discourage the use of velocity because of the negative affects it can have. However, velocity can still be a useful team metric if used internally within the team. Teams need to be vigilant that conditions do not arise that could lead to its misuse.

Consider this scenario. A hybrid team is using story points to track their velocity on a rewrite of a customer account management website. The team is using short iterations and demos to deliver functionality in a largely predictive organization. After the steering committee learned the team was using story points and velocity to track their progress, they focused on the weekly velocity figures.

If the points completed did not increase each week, the team was asked to explain. Consciously or unconsciously, the team started to inflate their story-point estimates for work. That way, they would have more points to report as complete each week. A screen that might have been originally estimated as three points became five. However, the points were now meaningless to the team since they could not compare current to past performance. Questions like "are these five new points or five old points?" became common wastes of time.

To reset the process, the team used affinity estimation to compare and reset new stories with the point value from previous stories of comparable size and complexity. Story point inflation was reversed, and points became useful for the team once more. The project manager explained the situation to the steering committee, who agreed not to overtly track and inquire about velocity—although they continued to do so in private.

Agile Release Planning Agile projects are often divided into releases and iterations. An iteration is a short, timeboxed development period, typically one to four weeks in duration. A release is a group of iterations that results in the completion of a valuable deliverable on the project. An agile project will have one or more releases, each of which will contain one or more iterations, as illustrated in figure 6.18.

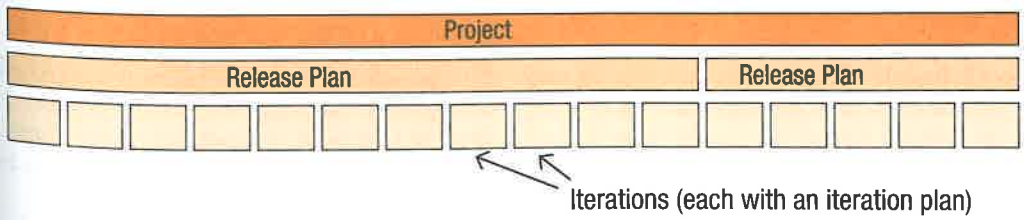

FIGURE 6.18 *Project broken into releases and iterations*

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This diagram shows a single project with two releases to production. The first release contains eleven iterations, and the second contains five iterations. Agile teams start planning releases and iterations early in the project life cycle and progressively refine the planning effort multiple times as the project progresses.

Do you remember our discussion on the backlog and product roadmap in the "Scope" chapter? While the backlog and the product roadmap help identify and manage project scope, they are also valuable tools that help develop and manage the project schedule.

On agile projects, teams select from the top-priority backlog items to come up with their next iteration goal. Then, they decompose the iteration goal into user stories to get the iteration plan. Planning continues by decomposing those user stories into tasks. While the work is being done, the team discusses the details of the work in the daily stand-up meetings.

Cumulative Flow Diagrams[30] Cumulative flow diagrams (CFDs) are valuable tools for tracking and forecasting the delivery of value. They can help us gain insight into project issues, cycle times, and likely completion dates. Basically, CFDs are stacked area graphs that depict the features that are in progress, remaining, and completed over time. An example of a CFD is illustrated in figure 6.19.

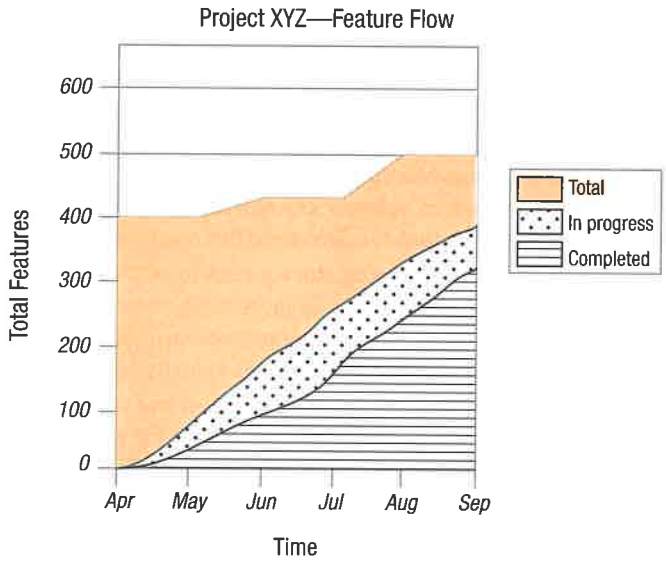

FIGURE 6.19 *Sample cumulative flow diagram*

This figure shows the features completed versus the features remaining for a fictional project that is still in progress. The orange area represents all the planned features to be built. This number rose from 400 to 450 in June and then to 500 in August as additional features were added to the project. The dotted section plots the work in progress, and the striped section shows the total number of features completed on the project.

Outputs of Developing the Schedule

The Develop Schedule process results in the project schedule, the schedule baseline, schedule data, change requests, and updates to any related project documents. The following sections describe these outputs.

Project Schedule The project schedule is the result of the previous planning processes and the schedule network analysis that is performed as part of the Develop Schedule process. As planning progresses, the schedule will be iterated in response to risk management and other parts of project planning until an acceptable and realistic schedule can be agreed upon. The iterated and realistic schedule that results from this effort is called the schedule baseline, which becomes part of the project management plan.

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The project schedule includes project activities with assigned dates for each activity, and includes milestones inserted by the project manager or management. The project schedule may be represented in formats such as bar charts or network diagrams.

The project schedule can be shown with or without dependencies (logical relationships) and can be shown in any of the following presentations created from the schedule model, depending on the needs of the project:

- Network diagram (described earlier in this chapter)
- Milestone chart
- Bar chart

Milestone Charts[31] These are similar to bar charts (described next), but they only show major events. Remember that milestones have no duration; they simply represent the completion of activities. Milestones, which may include "requirements are complete" or "design is finished," are part of the inputs to the Sequence Activities process. Milestone charts are good tools for reporting to management and to the customer. See the example in figure 6.20.

ID	Milestone	December	January	February	March	April
1	Start	◆12/14				
2	Requirements gathered		◆12/31			
3	Design complete		◆1/17			
4	Coding complete			◆2/15		
5	Testing complete				◆3/15	
6	Implementation complete					◆4/4
7	End					◆4/15

FIGURE 6.20 *Milestone chart*

Bar Charts[32] Bar charts are weak planning tools, but they are effective for progress reporting and control. They are not project management plans. Figure 6.21 shows a sample bar chart.

ID	Activity Name	Duration	Start	Finish	August	September	October
1	Start	0 days	Mon 8/26	Mon 8/26	◆		
2	D	4 days	Mon 8/26	Thu 8/29			
3	A	6 days	Mon 8/26	Mon 9/2			
4	F	7 days	Mon 9/2	Tue 9/10			
5	E	8 days	Fri 8/30	Tue 9/10			
6	G	5 days	Wed 9/11	Wed 9/18			
7	B	5 days	Wed 9/11	Wed 9/18			
8	H	7 days	Wed 9/18	Thu 9/26			
9	C	8 days	Fri 9/27	Tue 10/8			
10	Finish	0 days	Tue 10/8	Tue 10/8			◆

FIGURE 6.21 *Bar chart*

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Notice that there are no lines between activities to show interdependencies, nor are assigned resources shown. Bar charts do not help organize the project as effectively as a WBS and network diagrams do. They are completed after the WBS and the network diagram in the project management process.

Understanding the Benefits of Different Presentation Formats No matter how much you know about project management, there are always questions on the exam that will be tricky if you have never thought about them before. The different types of schedule presentations can be one of those areas. Think through the next exercise. Make sure you look for anything you did not know, and organize your knowledge according to the exercise answers. You can get quite a few questions right on the exam if you know what each of the schedule presentations is used for.

6.8 Exercise Test yourself! In your Exercise Notebook, record the answers to the following questions.

1. Under what circumstances would you use a network diagram?
2. Under what circumstances would you use a milestone chart?
3. Under what circumstances would you use a bar chart?

Answer

1. To show interdependencies between activities
2. To report to senior management
3. To track progress; to report to the team

Schedule Baseline The schedule baseline is the version of the schedule model used to manage the project; it is what the project team's performance is measured against. Remember that the baseline can only be changed as a result of formally approved changes. Meeting the schedule baseline is one of the measures of project success. If the project can be done faster than the customer requested, there may be a difference between the schedule baseline and the end date required by the customer. This difference is project float.

Schedule Data Schedule data encompasses all the data used to create the schedule model, including milestones, project activities, activity attributes, duration estimates, dependencies, and the assumptions and constraints used in creating the schedule.

Change Requests This is another planning process with change requests as an output. As the project progresses, any changes to the schedule may necessitate changes to other parts of the project management plan. Change requests are addressed through the integrated change control process.

Project Documents Updates The process of creating a final and realistic schedule could result in updates to project documents including duration estimates, resource requirements, activity attributes, risk register, assumption log, and the lessons learned register.

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Control the Project Schedule PAGE 222

Controlling the project was discussed in the "Processes and Domains" chapter, and is an important part of every knowledge area (scope, schedule, cost, quality, etc.). We will spend a little more time talking about it here. Control means measure; you measure against the plan. You need to stay in control of your project and know how it is performing compared to the plan. Do you do this on your projects? If not, pay particular attention to the concept of monitoring and controlling in this chapter and throughout this book. Make sure you understand that such actions are done as part of basic project management. When answering exam questions, you need to assume proper project management was done unless the question states otherwise. On properly managed projects, a project manager does not have to spend all their time dealing with problems, because most of those problems were prevented through appropriate planning and risk management. Project managers are measuring against the plan and taking action as needed to control the project.

PMBOK® Guide
PG: Monitoring and Control
Process: Control Schedule

ECO
Domain: II
Task: 6

The project (and the project manager) will be unsuccessful if the schedule baseline—the end date agreed to in planning and adjusted for approved changes—is not met. So monitoring and controlling efforts go beyond measuring; they also involve taking corrective and preventive action over and over again during the life of the project to keep the project in line with the plan. Do you do this? If not, why not? Without such work, all the efforts in planning to create a realistic schedule could be wasted.

Schedule control also means looking for the things that are causing changes and influencing the sources, or root causes, of the changes. For example, if there is one person or one piece of work causing a lot of changes, the project manager must do something about it, rather than let the issues and the high number of changes continue. A project manager must be proactive.

If the project can no longer meet the agreed-upon completion date, and achieving the completion date is a critical factor for success of the project, the project manager might recommend the termination of the project before any more company time is wasted. In other words, the project manager might have to influence directors and senior executives in the organization to control the project. Schedule control is more than just issuing updated schedules!

Make sure you really understand what is involved in schedule control. Think of protecting the hard work of all those involved in planning to make sure what was planned occurs as close to the plan as possible. Think of being constantly on the lookout for anything that might be affecting the schedule. This is what it means to control the schedule, and the project.

The following are some additional activities that can be used to control the schedule:

- Access the PMIS to review current work performance data and compare actual progress to what was planned.
- Reestimate the remaining components of the project partway through the project (see the following discussion).
- Conduct performance reviews by formally analyzing how the project is doing (see the "Earned Value Measurement" discussion in the "Cost" chapter).
- Perform data analysis (this can include earned value analysis, trend analysis, variance analysis, and what-if scenario analysis) of project performance.
- Confirm that critical path activities are being completed within the schedule baseline. If they are not, adjust the critical path by taking advantage of available float.
- Adjust future parts of the project to deal with delays, rather than asking for a schedule extension (using schedule compression techniques such as using leads and lags, crashing, and fast tracking).
- Consider making adjustments to optimize resources assigned to activities to improve the performance.
- Continue efforts to optimize the schedule.
- Adjust metrics that are not giving the project manager the information needed to properly understand performance and manage the project. Add new metrics if needed.

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- Adjust the format or required content of reports as needed to capture the information necessary to control and manage the project (see the "Progress Reporting" discussion in the "Cost" chapter).
- Identify the need for changes, including corrective and preventive actions.
- Follow the change control process.

Efforts to control the schedule when the project is using a change-driven approach include:

- Comparing work actually completed to what was predicted to be complete within a given work cycle using an iteration burndown chart
- Holding retrospectives to address possible process improvements
- Reprioritizing the backlog of work
- Identifying and managing changes as they arise

Reestimating One of the roles of a project manager is to make sure the project meets the project objectives. Although you did your best to understand the project well enough to estimate it sufficiently in planning, there are always changes that occur during a project that impact those plans. Therefore, it is standard practice to reestimate the remaining work at least once during the life of the project to make sure you can still satisfy the project objectives within the schedule, budget, and other project constraints, and to adjust the project if you cannot. Again, assume proper project management was done when answering questions on the exam unless the question provides specific information to indicate it was not.

The Control Schedule process results in work performance information, schedule forecasts, and sometimes change requests. For example, a change to the schedule might require additional resources or a change in scope. Such changes must be handled as part of the Perform Integrated Change Control process. Make sure you review this important process in the "Integration" chapter.

This process may also result in updates to the schedule management plan and performance measurement baseline in addition to project documents such as the assumption log, risk register, and lessons learned register, and changes to any other part of the project.

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Practice Exam

1. A project manager is informed midway through project planning that she was given inaccurate data regarding new regulations affecting the required end date of her project. She may need to make a few adjustments, but she thinks she can still manage the project to complete it before the regulations take effect. She confirms this by analyzing the sequence of activities with the least amount of scheduling flexibility. What technique is she using?
   A. Critical path method
   B. Flowchart
   C. Precedence diagramming
   D. Work breakdown structure

2. A design engineer is helping to ensure that the dependencies within her area of expertise are properly defined on the project. The design of several deliverables must be complete before manufacturing can begin. This is an example of what type of dependency?
   A. Discretionary dependency
   B. External dependency
   C. Mandatory dependency
   D. Scope dependency

3. Your sponsor and stakeholders have made it clear they wish to be kept informed on the project status. There are many aspects of the project on which you will report, and you want to choose the most appropriate tool to use in each case. Which of the following are generally illustrated better by bar charts than network diagrams?
   A. Logical relationships
   B. Critical paths
   C. Resource trade-offs
   D. Progress or status

4. A heuristic is best described as a:
   A. Control tool
   B. Scheduling method
   C. Planning tool
   D. Generally accepted rule

5. Lag means:
   A. The amount of time an activity can be delayed without delaying the project finish date
   B. The amount of time an activity can be delayed without delaying the early start date of its successor
   C. Waiting time
   D. The product of a forward and backward pass

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6. A project manager is new to the company but has 10 years of project management experience. She is given a medium-sized project and is asked to plan so it is finished as quickly as possible because the company has a large list of projects to complete in the coming year. She will be given another project to manage as soon as she has this one baselined. She needs to report on the longest time the project will take. Which of the following is the best project management tool to use to determine this?
   A. Work breakdown structure
   B. Network diagram
   C. Bar chart
   D. Project charter

7. Which of the following is correct?
   A. The critical path helps prove how long the project will take.
   B. There can be only one critical path.
   C. The network diagram will change every time the end date changes.
   D. A project can never have negative float.

8. The agile project team you are managing is responsible for developing one of the five different components of a complex enterprise solution. Your PMO representative tells you she's concerned because your team is using a larger story point unit than the other four teams. What should you do?
   A. Tell the PMO that this is the story point your team has chosen, and it doesn't matter how large it is relative to the other teams.
   B. Ask your team lead to coordinate their story point metric with the other teams to ensure that the different components interface smoothly.
   C. Explain to the PMO that the size of each team's story point doesn't matter since this is just a theoretical concept, not a real-world metric.
   D. Show the PMO why your story point has to be larger, since your part of the solution has more complex requirements than the others.

9. A new project manager is walking you through the schedule she has created for her project. She asks you about the duration of a particular milestone, so she knows how to properly schedule it. What will you tell her about a milestone's duration?
   A. It is shorter than the duration of the longest activity.
   B. It is shorter than the activity it represents.
   C. It has no duration.
   D. It is the same length as the activity it represents.

10. Which of the following best describes the relationship between standard deviation and risk?
   A. There is no relationship.
   B. Standard deviation tells you if the estimate is accurate.
   C. Standard deviation tells you how uncertain the estimate is.
   D. Standard deviation tells you if the estimate includes a pad.

11. You have identified a diverse group of stakeholders, and you will need to report information in a variety of ways to meet their different communications needs. When will you use a milestone chart instead of a bar chart?
   A. Project planning
   B. Reporting to team members
   C. Reporting to management
   D. Risk analysis

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12. To help them determine the schedule baseline, the team has drafted a network diagram. The project manager adds the time estimates for each activity to establish the critical path for the project. They discover the project has three critical paths. Which of the following best describes how this discovery will affect the project?
    A. It makes it easier to manage.
    B. It increases the project risk.
    C. It requires more people.
    D. It makes it more expensive.

13. The team is working on a project to develop or procure a customized software package that will be used by delivery drivers for a new chain of pizza restaurants. There are multiple stakeholders on this project. Because of other ongoing projects to design, build, and equip brick-and-mortar restaurant locations, you are informed that there is no rush to complete this software development work. If project time and cost are not as important as the number of resources used each month, which of the following is the best thing to do?
    A. Perform a Monte Carlo analysis
    B. Fast track the project
    C. Perform resource optimization
    D. Analyze the life cycle costs

14. The organization is committed to rolling out a new smartphone accessory at an industry trade show in six months. The sponsor has made it clear that this product, to be created by your project team, must meet a long list of requirements, adhere to high quality standards, and, most importantly, be ready in time for the trade show. The sponsor has promised to commit as many resources as necessary for you to complete the project within these constraints. Your project management plan results in a project schedule that is too long. If the project network diagram cannot change but you have extra personnel resources, what is the best thing to do?
    A. Fast track the project
    B. Level the resources
    C. Crash the project
    D. Perform Monte Carlo analysis

15. A project manager is in the middle of executing a large construction project when he discovers the time needed to complete the project is longer than the time available. What is the best thing to do?
    A. Cut product scope.
    B. Meet with management, and tell them the required date cannot be met.
    C. Work overtime.
    D. Determine options for schedule compression, and present management with the recommended option.

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16. Your team worked hard throughout project planning, thoroughly defining and estimating each activity required to complete the work. The resulting network diagram supported the end date that was approved by the team, management, and the stakeholders. As work has progressed, most milestones have been met. On two occasions, workarounds were needed to deal with the occurrence of unidentified risk events. With continued attention to detail, you have been successful in keeping the project on schedule and within budget. Now, an opportunity is identified that can only be realized if the project is completed two days ahead of schedule. Which of the following is the best thing to do when asked to complete a project two days earlier than planned?
    A. Tell senior management that the project's critical path does not allow the project to be finished earlier.
    B. Tell your manager.
    C. Meet with the team to look at options for crashing or fast tracking the critical path.
    D. Work hard and see what the project status is next month.

17. Although the customer agreed to the original project schedule, they are now asking for an earlier project finish. They are being pressured by their own customers. The project manager's sponsor thinks finishing early is not only a viable option but also a good idea for your organization because it will enable you to start another project sooner. In attempting to complete the project faster, the project manager looks at the cost associated with crashing each activity. The best approach to crashing would also include looking at the:
    A. Risk impact of crashing each activity
    B. Customer's opinion of which activities to crash
    C. Sponsor's opinion of which activities to crash and in what order
    D. Project life cycle phase in which the activity is due to occur

18. Your new project is faced with a challenging deadline and an anxious customer. After consulting with the team, you have assured the customer that the best way to develop the required features on time will be to follow an agile approach. The customer agrees to this somewhat reluctantly, since he isn't familiar with agile. However, the next week he hears that your team has spent "two whole days" doing t-shirt sizing of the product features, and yet they still haven't produced a viable schedule model! He calls you into his office to explain how this is justified, given the limited time available. What do you say?
    A. Agile developers don't plan when the work will be finished, they just start the work and get as much done as they can before the deadline.
    B. Agile teams need to develop quick, coarse-grained estimates to do just enough planning to get the work started.
    C. The agile approach means doing as little planning as possible so the team can focus on what they do best, delivering value.
    D. There is still too much uncertainty about the product features to develop a schedule model yet; the team will do that later.

19. During project planning, you estimate the time needed for each activity and then total the estimates to create the project estimate. You commit to completing the project by this date. What is wrong with this scenario?
    A. The team did not create the estimate, and estimating takes too long using that method.
    B. The team did not create the estimate, and a network diagram was not used.
    C. The estimate is too long and should be created by management.
    D. The project estimate should be the same as the customer's required completion date.

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20. You are a project manager on a $5,000,000 software development project. While working with your project team to develop a network diagram, you notice a series of activities that can be worked in parallel but must finish in a specific sequence. What type of activity sequencing method is required for these activities?
    A. Precedence diagramming method
    B. Arrow diagramming method
    C. Critical path method
    D. Operational diagramming method

21. You are a project manager on a US $5,000,000 software development project. While working with your project team to develop a network diagram, your data architects suggest that quality could be improved if the data model is approved by senior management before moving on to other design elements. They support this suggestion with an article from a leading software development journal. Which of the following best describes this type of input?
    A. Mandatory external dependency
    B. Discretionary external dependency
    C. External regulatory dependency
    D. Heuristic

22. Based on the following, if you needed to shorten the duration of the project, which activity would you try to shorten?

Activity	Preceding Activity	Duration in Weeks
Start	None	0
A	Start	1
B	Start	2
C	Start	6
D	A	10
E	B, C	1
F	C	2
G	D	3
H	E	9
I	F	1
End	G, H, I	0

    A. Activity B
    B. Activity D
    C. Activity H
    D. Activity C

23. Your agile project team is updating a mobile alert aggregator for social media updates and trending news items. The team lead tells you that this week they plan to hold a planning poker session for the user stories in the upcoming release. What does this tell you?
    A. They are trying to find out how long it will take to complete the first iteration.
    B. They are determining when this release will be ready to deploy.
    C. They are estimating how long it will take to develop and test this release.
    D. They are evaluating the relative size in story points of the stories for this release.

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24. You have a project with the following activities: Activity A takes 40 hours and can start after the project starts. Activity B takes 25 hours and should happen after the project starts. Activity C must happen after activity A and takes 35 hours. Activity D must happen after activities B and C and takes 30 hours. Activity E must take place after activity C and takes 10 hours. Activity F takes place after Activity E and takes 22 hours. Activities F and D are the last activities of the project. Which of the following is true if activity B actually takes 37 hours?
    A. The critical path is 67 hours.
    B. The critical path changes to Start, B, D, End.
    C. The critical path is Start, A, C, E, F, End.
    D. The critical path increases by 12 hours.

25. A project manager has received activity duration estimates from his team. Which of the following does he need in order to complete the Develop Schedule process?
    A. Earned value analysis
    B. Schedule change control system
    C. Trend analysis
    D. Reserves

26. A project manager is taking over a project from another project manager during project planning. If the new project manager wants to see what the previous project manager planned for managing changes to the schedule, it would be best to look at the:
    A. Communications management plan
    B. Update management plan
    C. Staffing management plan
    D. Schedule management plan

27. As part of a project manager's due diligence, he reviews the schedule, focusing on each activity as its start time approaches. He also monitors activities as they progress. He is currently looking at an activity that has an early start (ES) of day 3, a late start (LS) of day 13, an early finish (EF) of day 9, and a late finish (LF) of day 19. In all likelihood, this activity:
    A. Is on the critical path
    B. Has a lag
    C. Is progressing well
    D. Is not on the critical path

28. The project is calculated to be completed four days after the desired completion date. You do not have access to additional resources. The project is low risk, the benefit-cost ratio is expected to be 1.6, and the dependencies are preferential. Under these circumstances, what is the best thing to do?
    A. Cut resources from an activity.
    B. Make more activities concurrent.
    C. Move resources from the preferential dependencies to the external dependencies.
    D. Remove an activity from the project.

29. On the two-year agile project you are managing, the team's velocity for the first eight sprints is 43, 24, 47, 35, 24, 34, 30, and 32. Should you be worried about these results?
    A. No; this looks like fairly typical data for an agile team's velocity.
    B. No; velocity is just used to track effort, not to evaluate performance.
    C. Yes, because velocity has been unusually low for the last four sprints.
    D. Yes; the team needs to stabilize their velocity soon so they can start planning.

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30. A project manager for a small construction company has a project that was budgeted for $130,000 over a six-week period. According to the schedule, the project should have cost $60,000 to date. However, it has cost $90,000 to date. The project is also behind schedule, because the original estimates were not accurate. Who has the primary responsibility to solve this problem?
    A. Project manager
    B. Senior management
    C. Project sponsor
    D. Manager of the project management office

31. The WBS, estimates for each work package, and the network diagram are completed. The next thing for the project manager to do is:
    A. Sequence the activities
    B. Validate that they have the correct scope
    C. Create a preliminary schedule and get the team's approval
    D. Complete risk management

32. You are the project manager for a new product development project that has four levels in the work breakdown structure. The network diagram and duration estimates have been created, and a schedule has been developed and compressed. Which schedule management activity should you do next?
    A. Control the schedule
    B. Determine dependencies
    C. Analogously estimate the schedule
    D. Gain approval

33. Senior management is complaining that they are not able to easily determine the status of ongoing projects in the organization. Which of the following types of reports would help provide summary information to senior management?
    A. Detailed cost estimates
    B. Project management plans
    C. Bar charts
    D. Milestone reports

34. Rearranging resources so that a constant number of resources is used each month is called:
    A. Crashing
    B. Floating
    C. Leveling
    D. Fast tracking

35. In managing your first agile project, you are trying to decide how to best keep the sponsor and other key stakeholders updated about the team's progress. You want to use one or more of the agile tools that your team is already maintaining for their own use, rather than asking the team members to create any additional status reports or project documentation. Which agile tool(s) should you use for this purpose?
    A. The project roadmap and story maps
    B. The task board with WIP limits
    C. The velocity burndown matrix
    D. The cumulative flow diagram

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36. The team is helping the project manager estimate activities on their project. They are experienced and skilled, and many members have been with the company for some time. There are several activities they need to estimate that have not been previously done by the company. What is the best method of estimating these activities?
    A. Analogous estimating
    B. Three-point estimating
    C. Monte Carlo analysis
    D. Parametric estimating

37. During project executing, a large number of changes are made to the project. Several of the change requests have come from the customer, significantly changing the functionality of the originally requested product. Six project team members have been reassigned by management to a higher-priority project, and they have been replaced. As project work has progressed, many of the identified risks have occurred and have been successfully mitigated. However, three contingency plans have been adjusted and will be implemented if identified risks recur during the remainder of the project. The project manager should:
    A. Wait until all changes are known, and then print out a new schedule
    B. Make sure the project charter is still valid
    C. Change the schedule baseline
    D. Talk to management before any changes are made

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Answers

1. **Answer** A
Explanation There are only two choices related to scheduling: critical path method and precedence diagramming. Precedence diagramming is a diagramming technique that deals with the relationship between activities, not schedule flexibility. The project manager is analyzing the critical path.

2. **Answer** C
Explanation No mention is made that the dependency comes from a source outside the project, so this is not an external dependency. Scope dependency is not a defined term. The key words in the question are "must be complete." Since the dependency is required, it could not be discretionary and therefore must be mandatory. The question defines a mandatory dependency.

3. **Answer** D
Explanation The bar chart is designed to show a relationship to time. This is best used when demonstrating progress or status as a factor of time.

4. **Answer** D
Explanation A heuristic is a generally accepted rule. Examples are cost per line of code and cost per square foot of floor space.

5. **Answer** C
Explanation Total float and free float are the time an activity can be delayed without impacting the entire project or the next activity. A forward or backward pass refers to a network analysis technique, not waiting time. Waiting time is the correct definition of lag.

6. **Answer** B
Explanation The bar chart may show an end date, but it is not used to determine dates. The project charter also may include a required end date but not a logical determination of how long the project will take. The network diagram shows dependencies between activities on the project activity list. The dependencies allow us to look at the various paths through the diagram to determine the longest duration (critical) path. The network diagram is the best answer.

7. **Answer** A
Explanation This question tests your knowledge about a number of topics. There can often be more than one critical path, but you might adjust the plan in order to decrease risk and have only one critical path. The network diagram may or may not change when the end date changes, depending on the amount of schedule reserve and the reason for the change to the schedule. You can have negative float if you are behind schedule. The critical path helps prove how long the project will take. This is the only correct statement of the choices given.

8. **Answer** A
Explanation This question tests your understanding of story points and relative sizing in an agile setting. The correct answer is to just say that this is the story point your team has chosen, and it doesn't matter what the other teams are doing. The size of a team's story point won't affect the specifications of the solution, so there is no reason to fear that the components won't work together. There is no need to coordinate the size of the story point with the other teams, and in any case an agile team wouldn't change their story point during development since it needs to be kept consistent for tracking and monitoring the work. Although a story point is a relative measure, it is used in tangible ways to estimate, track, and schedule the work. So it isn't just a theoretical concept. A team's story point doesn't need to be smaller or larger based on the amount or type of work being done.

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9. **Answer** C
Explanation A milestone represents the completion of a series of activities or work packages. Milestones represent significant events within the project schedule. They are not work activities, and they have no duration.

10. **Answer** C
Explanation An estimate can have a wide range and still be accurate if the item estimated includes identified risks. There is no such thing as a pad in proper project management. An estimate might be inflated, but it is a calculated reserve to account for risks, not arbitrary padding. The standard deviation tells you the amount of uncertainty or risk involved in the estimate for the activity.

11. **Answer** C
Explanation Both types of charts are used in project planning. Team members need to see details, so they need a bar chart rather than a milestone chart. Risk analysis could make use of both charts. A milestone chart is used instead of a bar chart for any situation where you want to report in a less detailed way. Since bar charts can intimidate people with their complexity—and often show too much detail to be worthwhile on a management level—milestone charts are more effective for reporting to management.

12. **Answer** B
Explanation Although having three critical paths could require more people or cost more, the answer that is always true is that it increases project risk. Because you need to manage three critical paths, there is more risk that something could happen to delay the project.

13. **Answer** C
Explanation Fast tracking affects both time and cost but may not help even out resource usage. Monte Carlo analysis and analysis of life cycle costs do not directly deal with resources. Resource optimization is the only choice that will definitely affect resources.

14. **Answer** C
Explanation Leveling resources generally extends the schedule. Monte Carlo analysis does not directly address the constraints of this situation. To compress the schedule, you could either crash or fast track. However, the situation says that the network diagram cannot change. This eliminates fast tracking, which leaves crashing the project as the best answer.

15. **Answer** D
Explanation This question tests whether you know how to solve problems. Cutting product scope negatively affects the customer, and is therefore not best. A project manager's job is to determine options for meeting any end date; therefore, simply telling management the required date cannot be met is not correct. Working overtime is expensive and unnecessary when there are many other choices that could be considered first. Determining options for schedule compression would have the least negative effect on the project.

16. **Answer** C
Explanation This is another question that asks about problem-solving. Neither telling your manager nor waiting to see the status next month will address the real problem. It would be inaccurate to report that the project cannot be finished earlier. Only meeting with the team to look for options for compressing the schedule (by crashing or fast tracking) relates to problem-solving.

17. **Answer** A
Explanation You may or may not need your customer's or your sponsor's input, but you will definitely need to include an analysis of risk.

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18. **Answer** B
Explanation Agile developers do indeed plan when the work will be finished, since time is typically a critical (and fixed) constraint on change-driven projects. However, there is usually too much uncertainty to prepare a detailed schedule model upfront. Instead, the team can use t-shirt sizing to create quick, coarse-grained estimates—this provides "just enough" planning to get started on the work. So this is the correct answer. While many people have the impression that agile teams don't do much planning, in fact the opposite is true—an agile approach means the team is constantly planning throughout the project. They just don't do as much planning upfront. This iterative approach means that most agile teams never create a formal schedule model, because it is likely to be outdated almost as soon as it is done. Instead, they use easily updated planning tools such as burn charts, task boards, and release maps.

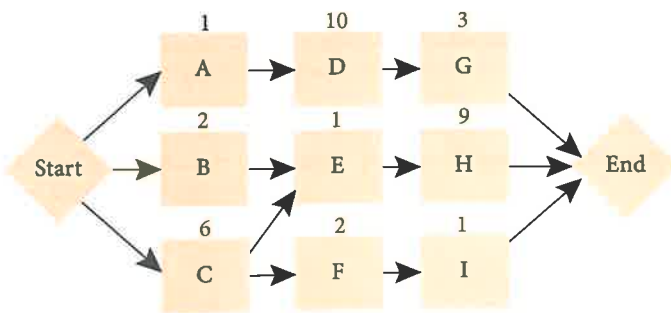
19. **Answer** B
Explanation Time estimates for the activities should be created by the team and should not be added together to create the project estimate. Some activities may take place concurrently; these would be identified in the network diagram.

20. **Answer** A
Explanation The question implies a finish-to-finish relationship between activities. The arrow diagramming method is not a commonly used diagramming method, and it does not support that type of relationship. Critical path is not a diagramming method, and operational diagramming method is a made-up term. The precedence diagramming method is most appropriate in this case.

21. **Answer** B
Explanation A heuristic is a general rule that can be used consistently. This situation is a unique occurrence in which a preferred method is being suggested. Dependencies are often described with two terms, either mandatory or discretionary, and either internal or external. The input in this scenario is discretionary, as it is a suggestion, rather than a required method of doing the work. Since the input comes from a source outside the organization, it is considered external.

22. **Answer** D
Explanation This is an example of a two-stage question you may find on the exam. First you need to draw the network diagram and find the critical path, and then make a decision. The network diagram would be:

Paths	Duration in Weeks
Start, A, D, G, End	14
Start, B, E, H, End	12
Start, C, E, H, End	16
Start, C, F, I, End	9



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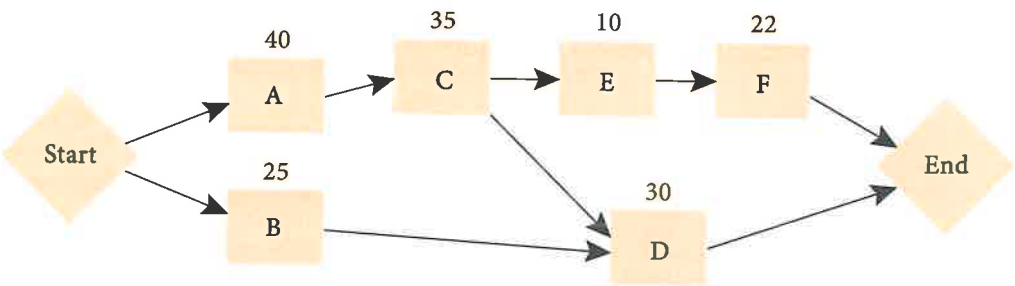
The critical path is 16 (Start, C, E, H, End). Many people immediately look for the longest duration activity on the project to cut. Here activity D is the longest, at 10 weeks. However, that activity is not on the critical path, and cutting it would not shorten the project's duration. You must change the critical path. In this case, both activity C and activity H are on the critical path. If you have a choice, all things being equal, choose the earlier option. Therefore, activity C is the best answer.

23. **Answer** D
Explanation The correct answer is that the team is using planning poker to determine the relative size in story points of the stories for this release. The answer that refers to "how long it will take to complete the first iteration" must be incorrect, since agile iterations are timeboxed; the iteration length isn't dependent on the amount of work. The other two options refer to release planning, which isn't covered by planning poker. (You may also have noticed that the three incorrect options all describe duration. However, planning poker estimates measure effort, not duration.)

24. **Answer** C
Explanation Did you notice how difficult this question was to read? Such wording is intentional—to prepare you for interpreting questions on the real exam. Looking at this situation, you see there are three paths through the network, as shown in the following table. If the duration of activity B changes from 25 to 37, the activity will take 12 hours longer. As the activity is only on the third path, it will only change the duration of that path from 55 to 55 + 12, or 67 hours. Since the duration of the critical path is 107 hours, the delay with activity B will have no impact on the project timeline or the current critical path.

Paths	Duration in Hours
Start, A, C, E, F, End	107
Start, A, C, D, End	105
Start, B, D, End	55



25. **Answer** D
Explanation The Develop Schedule process includes all work and uses all inputs needed to come up with a finalized, realistic schedule. As part of the Estimate Activity Durations process, reserves are created to cover identified and unknown schedule risks. All the other items are parts of Control Schedule and occur after the Develop Schedule process.

26. **Answer** D
Explanation The schedule management plan is the most correct answer. It includes plans for how schedule changes will be managed.

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27. **Answer** D
Explanation There is no information presented about lag or progress. The activity described has float because there is a difference between the early start and late start. An activity that has float is probably not on the critical path.

28. **Answer** B
Explanation Cutting resources from an activity would not save time, nor would moving resources from the preferential dependencies to the external dependencies. Removing an activity from the project is a possibility, but because the dependencies are preferential and the risk is low, the best choice is to make more activities concurrent, as this would have less impact on the project.

29. **Answer** A
Explanation There is no need to be concerned with these results. The velocity data shows a lot of variation over the first five sprints, followed by emerging stability over the next three sprints. This is a typical pattern for an agile team at the start of a project, and nothing to be worried about. (For such a long project, this team's velocity actually seems to be stabilizing quickly.) The fact that velocity has been lower for the last four sprints isn't relevant; the atypical data points are actually the higher numbers during sprints 1 and 3. While velocity is primarily used to track effort, it can also show performance trends that need to be addressed. Although that doesn't seem to be an issue in this scenario, it's incorrect to say that velocity can't be used to evaluate performance. Agile teams don't require stable velocity numbers to begin planning. During upfront planning they estimate their initial velocity, and then as the work continues they adjust their plans based on their track record to date.

30. **Answer** A
Explanation Did you get lost looking at all the numbers presented in this question? Notice that there are no calculations required, simply an understanding of what the problem is. This question describes schedule management, which is a responsibility of the project manager.

31. **Answer** C
Explanation Sequencing the activities is the same thing as creating a network diagram, so that has already been done. The Validate Scope process is done during project monitoring and controlling, not during project planning. Since a schedule is an input to risk management, risk management comes after the creation of a preliminary schedule, and so that is not the next thing to do. Creating the preliminary schedule is next.

32. **Answer** D
Explanation Determining dependencies and analogously estimating the schedule should have already been completed. The situation described is within the Develop Schedule process of schedule management. Control Schedule is the next schedule management process after Develop Schedule, but the Develop Schedule process is not yet finished. Final approval of the schedule by the stakeholders is needed before one has a project schedule.

33. **Answer** D
Explanation Detailed cost estimates have nothing to do with the situation described. Project management plans include more detail than is necessary for the situation described, and may distract from the conversation if used in this situation. Bar charts are most effective for reporting to the team. The best answer is milestone reports, which present the right level of detail for upper management.

34. **Answer** C
Explanation The key to this question is the phrase "constant number of resources used each month." Only leveling has such an effect on the schedule.

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35. **Answer** D
Explanation Out of these answers, the only option for communicating project progress would be the cumulative flow diagram. This diagram will show your stakeholders the product features complete, in progress, and remaining, as well as any changes in total scope. This makes it a powerful tool for tracking and forecasting the delivery of value. There is no such thing as a "velocity burndown matrix," and the other two options don't track progress over time.

36. **Answer** B
Explanation Analogous estimating can be used when you have done similar work previously. Monte Carlo analysis is a schedule development technique. Parametric estimating includes the use of history and productivity rates for the work, which would not be available if you had not done the activity before. Three-point estimating is the best method to use in this case because it allows you to estimate in a range—optimistic, pessimistic, and most likely.

37. **Answer** B
Explanation Waiting until all changes are known and then printing out a new schedule is a common error many project managers make. Instead, the project manager should be controlling the project throughout its completion. The situation in the question does not provide a reason to believe the schedule baseline must be changed. A project manager must be in control of the project, rather than consulting with management before making any changes. Whenever a large number of changes occur on a project, it is wise to confirm that the business case, as stated in the project charter, is still valid.

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Cost

SEVEN

While managing cost the project manager is primarily concerned with estimating and earned value management. Do you create a budget for your projects? Do you have practical experience managing and controlling project costs? The questions on the exam are written to test whether you have such experience. If these efforts are not part of how you manage your real-world projects, make sure you read this chapter carefully and fully understand the concepts discussed.

On the exam, there is a strong connection between cost management and schedule management. Some topics covered in this chapter also apply to the "Schedule" chapter. The "Schedule" chapter includes information on estimating techniques that can be used for both schedule and cost estimating. Earned value analysis is discussed later in this chapter and is another example of a technique that can be used for both cost and schedule management.

The "Schedule" chapter also describes the decomposition of work packages into smaller components, or activities. For many projects, cost estimates are created at the activity level. On some large projects, however, it might be more practical to estimate and control costs at a higher level, called a control account (defined in the "Scope" chapter).

QUICKTEST

- Cost management process
- Earned value analysis
  - PV
  - EV
  - AC
  - CPI
  - SPI
  - BAC
  - EAC
  - ETC
  - VAC
  - CV
  - SV
  - TCPI
- Cost baseline
- Cost budget
- Performance measurement baseline
- Three-point estimating
- Analogous estimating
- Bottom-up estimating
- Parametric estimating
- Inputs to estimating costs
- Cost management plan
- Rough order of magnitude (ROM) estimate
- Definitive estimate
- Budget estimate
- Reserve analysis
- Contingency reserves
- Management reserves
- Variable/fixed costs
- Direct/indirect costs
- Earned value analysis
- Control thresholds
- Progress reporting

The following should help you understand how each part of cost management fits into the overall project management process:

The Cost Management Process	Done During
Plan Cost Management	Planning process group
Estimate Costs	Planning process group
Determine Budget	Planning process group
Control Costs	Monitoring and controlling process group

ECO Domain II: Process
Task 5: Plan and Manage Budget and Resources

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The cost planning and control processes from the *PMBOK® Guide* are put collectively into the *Examination Content Outline* (ECO) as Plan and Manage Budget and Resources (domain II, task 5). While thinking about the process these tables represent, it is worth pointing out again that many of the same estimating and earned value measurement (EVM) tools are also used for schedule management.

Estimating is initially done during planning while EVM is used to control costs and possibly resources and procurement throughout the project. As you balance project constraints to manage costs you will also do activities related to domain I tasks 1 and 8, Manage Conflict and Negotiate Project Agreements. Another area of overlap is promoting team performance through training (domain I, taks 5) and the use of emotional intelligence (domain I, task 14). These support value-driven delivery and cost savings. Can you add to this list of interactions between processes and ECO tasks?

Think about how decisions around funding and financing resources might affect project risks and other project constraints. These decisions will influence how you plan the project across all knowledge areas and how work will be completed. If you haven't had to deal with these concerns on your own projects, it's easy to miss questions on the exam about how cost-related decisions could impact the rest of the project. As you read through this chapter, make sure you truly understand what project management efforts you should be doing when it comes to cost management and what those efforts mean to the project.

Plan and Estimate Project Costs PAGE 235

PMBOK® Guide
PG: Planning
Processes: Plan Cost Management, Estimate Costs, Determine Budget

Besides having a plan for how you will manage costs, you also need to estimate costs and determine the budget. The Plan Cost Management process involves answering questions such as "How will I go about planning cost for the project and who needs to be involved?" and "How will I effectively manage the project to the cost baseline and manage variances?"

The project charter includes a high-level cost constraint as well as other requirements regarding cost management on the project. Organizational process assets used in this process include cost data and lessons learned from previous projects as well as organizational standards and policies for estimating and budgeting.

ECO
Domain: II
Task: 5

Plan Cost Management

In some organizations, cost planning may involve determining whether the project will be paid for with the organization's existing funds or will be funded through equity or debt. It can also include decisions about how to finance project resources—such as choosing whether to purchase or lease equipment. As we get detailed estimates and develop the budget, we will use calculations created for project selection (like net present value, return on investment, payback period, and discounted cash flow) to evaluate whether the project is still feasible within the charter and whether the measurable project objectives can be achieved.

The cost management plan can be formal or informal, but it is part of the project management plan. It may include the following:

- Specifications for how estimates should be stated (in what currency)
- Levels of accuracy and precision needed for estimates
- Approved estimating techniques
- Reporting formats
- Rules for measuring cost performance
- Guidance regarding whether costs will include indirect costs (costs not directly attributable to any one project, such as overhead)
- Guidelines for the establishment of a cost baseline for measuring against
- Control thresholds
- Cost change control procedures
- Information on control accounts or other ways to monitor spending

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- Funding decisions
- Methods for documenting costs
- Guidelines for dealing with potential fluctuations in resource costs and exchange rates
- Roles and responsibilities for various cost activities

Notice the inclusion of control thresholds. These are the amount of variation allowed before you need to act. For example, if an actual cost comes in higher than expected, will you need to act? What if it's a two-dollar difference?

Estimate Project Cost This process involves coming up with cost estimates for all project activities and resources required to complete them, to combine into one time-phased spending plan detailed next in the Determine Budget process.

In the "Schedule" chapter, we included some Tricks of the Trade® titled, "Things to Know about Estimating for the Exam." As noted in that chapter, those concepts apply to both cost and schedule estimating. Take some time now to review that list. It is helpful to have those concepts fresh in your mind before continuing.

So what costs should you estimate? To put it simply, you need to estimate the costs of all the efforts to complete the project. This includes labor, equipment, materials, and training for the project, as well as the following:

- Quality efforts
- Risk efforts
- Project management activities
- Physical spaces used directly for the project
- Overhead costs, as applicable (management salaries, general office expenses)

Types of Cost In the past, the exam has included questions regarding types of cost. A cost can be either variable or fixed, direct or indirect. Notice a variable or fixed cost may also be a direct or indirect cost.

- Variable costs change with the amount of production work. Examples include materials, supplies, and wages.
- Fixed costs do not change as production changes. Examples include setup, rent, utilities, etc.
- Direct costs are directly attributable to the work on the project. Examples are team wages, team travel and recognition expenses, and costs of material used on the project.
- Indirect costs are overhead items or costs incurred for the benefit of more than one project. Examples include taxes, fringe benefits, and janitorial services.

Inputs to Estimating Costs Imagine having access to a repository containing all the previous WBSs for projects similar to yours, along with the estimates and actual costs for each activity. Can you see how that might be helpful in creating more accurate estimates on your own project? Having highly accurate estimates will help you better control the project later and, therefore, save you effort.

Project management plan inputs to cost estimates include the cost and quality management plans and the scope and schedule baselines. Useful project documents include the lessons learned register, risk register, and resource requirements documentation. Organizational process assets include policies and historical records related to estimating, templates and processes including those from past projects, while enterprise environmental factors include corporate governance, marketplace conditions, commercial cost databases, exchange rates, inflation, and supply sources.

How Is Estimating Done? As described in the "Schedule" chapter, estimates should be in a range as it is very unlikely an activity will be completed for the exact amount estimated. It is done using specific tools like analogous estimating, parametric estimating, and three-point estimating. From a more general perspective, you have top-down and bottom-up estimating.

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Accuracy of Estimates Think about someone walking into your office and asking you to estimate the total cost of a new project. The first question you would probably ask is, "How accurate do you want me to be?" In the early part of the project, during initiating, estimates are likely to be top-down. Over time, as you break down project deliverables during planning, you narrow the estimate range as you do bottom-up estimating.

Top-down and bottom-up estimating each have the following advantages and disadvantages:

Advantages of Top-Down (Analogous) Estimating	Disadvantages of Top-Down (Analogous) Estimating
Quick	Less accurate
Activities do not need to be identified	Estimates reflect a limited amount of information about the project or key deliverables
Less costly to create	Requires considerable experience to do well
Cost constraints in project initiating provides data to evaluate high-level project feasibility	There may be infighting to gain the biggest piece of the budget without being able to justify the need
Overall project costs will be capped for a project analogous estimate	Difficult for projects with uncertainty or without similar projects to reference
	Does not consider differences between projects

Advantages of Bottom-Up Estimating	Disadvantages of Bottom-Up Estimating
More accurate (analogous, three-point, or parametric estimating at the activity level)	Takes time and money
Gains buy-in from the team because the team creates estimates they can live with	Tendency for the team to pad estimates unless they understand the use of reserves
Based on a detailed project and deliverables analysis	Requires that the project be defined and well understood
Provides a basis for control and management	Requires time to break project deliverables into smaller pieces

Estimate Ranges The standard ranges of the order of magnitude estimate, budget estimate, and definitive estimate are shown below:

- **Rough order of magnitude (ROM) estimate**[1] Usually made during project initiating, a typical range for ROM estimates is –25 to +75 percent. It varies depending on how much is known about the project.
- **Budget estimate** A budget estimate is in the range of –10 to +25 percent. A best practice is to narrow the range (from ROM) before you begin re-iterating the budget.
- **Definitive estimate** As project planning progresses, the estimate will become even more refined. Some project managers use the range of +/–10 percent, while others use –5 to +10 percent.

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TRICKS OF THE TRADE The concept of ranges often appears on the exam. Make sure you understand that estimates become more detailed as project planning progresses. Remember that organizations have different rules for the acceptable range of estimate for an activity or the project and that what you see here may be different than your experience. It is wise to estimate in a range, based on the level of uncertainty remaining in the estimate. Even the approved baseline may be expressed as a range, for example: $1,000,000 (–5 to +10 percent).

Determining Resource Cost Rates Although many project managers do not have access to this information on their projects, the exam assumes a project manager knows the actual cost of labor when performing detailed cost estimating. Resources are not limited to internal human resources. The work of estimating resource costs might also involve estimating the work of consultants, sellers, and suppliers.

Other tools and techniques particular to cost estimating are estimating spreadsheets and software within the PMIS that can speed up calculation and analysis and integrate finance and accounting. Quality risk and scheduling tools are useful here as well. Alternatives analysis, resources analysis, and decision making (all discussed in the "Schedule" chapter) may also be used as part of the Estimate Costs process.

The Estimate Costs process results in cost estimates and an explanation of how those estimates were derived (the basis of estimates). It can also result in project document updates, such as the risk register, assumption log, and lessons learned register.

Determine Budget In this part of cost management, the project manager calculates the total cost of the project to determine the budget. Meeting the cost baseline will be a measure of project success, so the budget should be in a form the project manager can use to control costs while the work is being done.

To begin the Determine Budget process, it's important to review the business case and the benefits management plan. The business case may be expressed in financial terms, such as expected return on investment. The benefits management plan can be used to finalize the budget and compare it to the economic benefits expected from the project.

On adaptive projects, project teams help determine the budget based on the project scope. This typically requires the team to break down the scope using techniques such as T-shirt sizing, planning poker, and affinity estimating, for example. The team will then plan releases using story maps. Refer to the "Schedule" chapter for a review of these concepts, if necessary. Teams on adaptive projects may also use retrospectives to determine the accuracy of budget estimates, and if any adjustments should be made to the budget. For instance, if a team's retrospective uncovers a recurring pattern of underestimating costs, the team may decide to try more analysis before they ultimately determine the budget.

Two outputs from Estimate Costs—cost estimates and the basis of estimates—are essential inputs to this process. Many of the inputs to Estimate Costs are used here as well: the cost management plan, the scope baseline, the project schedule, the risk register, existing policies on cost control and cost budgeting, and resource requirements documentation (for how long and at what rates for particular resources, for example). Agreements regarding the purchase of services or products for the project are also inputs.

To create a budget, activity cost estimates are rolled up to work package cost estimates. Work package costs are then rolled up to control account costs and finally to project costs. This process is called cost aggregation. After risk management planning, contingency reserves are added to determine the cost baseline. These are shown at the project level, as described here and depicted in figure 7.1, but note it is also possible to add contingency reserves at the activity level. In the final step, the management reserves are added. Note that it is the management reserves that make the difference between the cost baseline and the budget.

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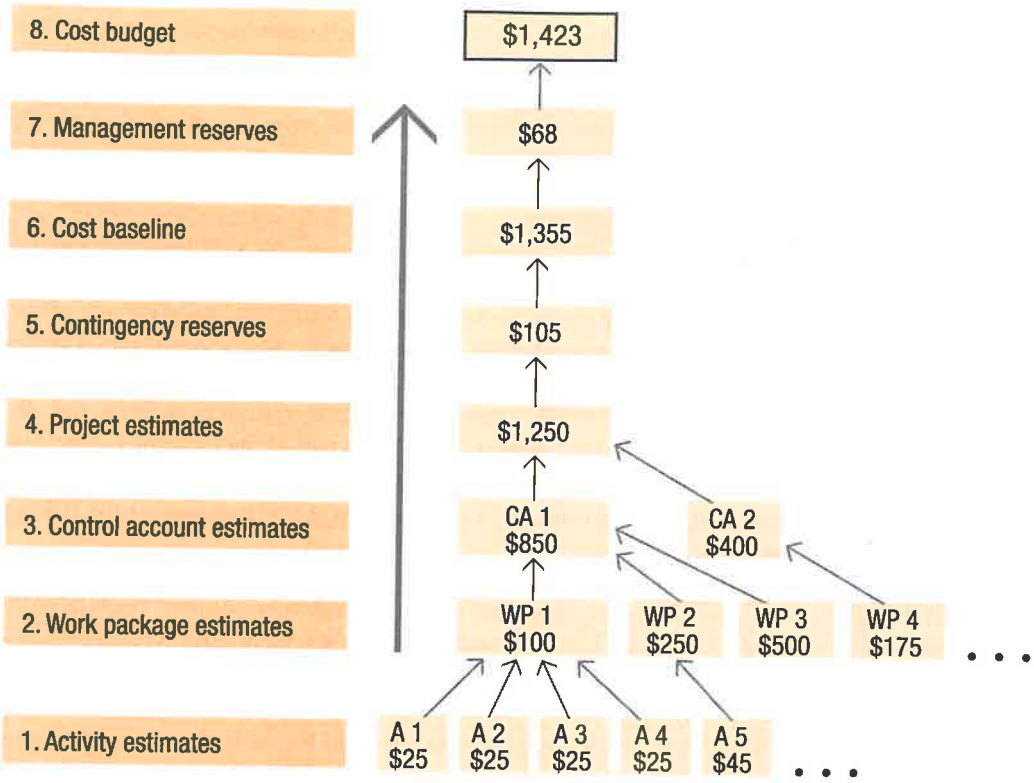

FIGURE 7.1 *Creating a budget*

After the cost baseline and budget are estimated, the project manager may compare these numbers to parametric estimates or to expert judgment, or perform an historical information review, comparing their estimates to those of past, similar projects. For example, a general rule for a high-level parametric estimate in some industries is that design should be 15 percent of the cost of construction. Other industries estimate the cost of design to be 60 percent of the project budget. The project manager needs to investigate and justify any significant differences between the project estimates and the reference data to ensure the estimates are reasonable and as accurate as possible.

The next thing to check is cash flow (part of funding limit reconciliation[2]). For example, if equipment costing $500,000 is scheduled to be purchased on June 1 but the money for the purchase is not available until July 1, the activities dependent on that equipment will have to be moved to later points in the schedule. The cost baseline, therefore, is time-phased.

A special note on the term "financing," as it relates to project management. Financing refers to obtaining the needed funds for a project. This means all funds, both internal and external. External funds are obtained from sources outside the performing organization (through loans) and are typically needed for major long-term projects.

As we discussed in the "Schedule" chapter, agile teams use velocity to help create a project schedule based on story point estimates, but velocity can help anticipate future budgetary issues as well. For instance, let's say the team is averaging 50 story points per month and there are 500 story points left in the backlog. You would need 10 more months to complete the project. Here, the project manager can look at the budget and decide if they have correctly estimated a budget for 10 months of the team's monthly burn rate.

Are you familiar with the term "burn rate"? Did you know that on adaptive projects, teams are often stable and consistent as more value is placed on retaining project knowledge and developing stable working relationships? This leads to consistent burn rates for teams and simplified cost estimating. If the burn rate

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for a team is $50,000 per month, you can quickly estimate the cost for the next six months is likely to be 6 × $50,000 = $300,000. Project managers on adaptive projects do the majority of their cost estimating for projections and estimates at completion based on extrapolation of burn rates.

The project budget must be reconciled with any cost constraints in the charter. If the project estimate exceeds the constraints, the project manager must meet with management, explain why their cost requirement cannot be met, and propose options to decrease costs. Pay particular attention to that last sentence. As with the schedule, project managers have a professional responsibility to reconcile the budget in this way.

When the Determine Budget process is complete, the cost baseline, including all funding requirements, is established. Naturally, many of the inputs to the process will be updated, such as the cost estimates, the risk register, and the project schedule.

Manage Costs PAGE 257

PMBOK® Guide
PG: Monitoring and Controlling
Process: Control Costs

ECO
Domain: II
Task: 5

Start this section by completing the following exercise and imagine how this would apply to real-world projects. When completing this exercise, keep in mind that you need to continuously look for anything that can cause a project to be terminated.

TRICKS OF THE TRADE Think of yourself as a detective looking for anything that can get in the way of project success. This mindset will help you select the best choice when answering questions that seem to have more than one correct answer.

7.1 Exercise In your Exercise Notebook, list the actions a project manager may take to control costs. (This is an important topic, so be sure to take your time to think about this question.)

Answer

- Follow the cost management plan for how to control costs
- Tailor control activities to the needs of the project
- Consider policies, procedures, tools and reporting templates and formats related to controlling costs (selected from organizational process assets during planning)
- Measure project performance and compare it against the plan
- Determine if variances require change, including preventive and corrective action
- Request changes
- Implement approved changes
- Prevent unnecessary changes
- Look for the root cause of factors causing costs to rise
- Conduct reserve analysis
- Conduct earned value measurement
- Aggregate data, analyze it, and produce reports

Controlling costs is an important responsibility for project managers, but you must also understand and plan for potential budget variations. For instance, your team worked overtime to complete a new feature for an upcoming sponsor demo. While the new feature was completed on time, the overtime work means your monthly budget goal for payroll will be missed. As the project manager, you weighed the value of this through a simple analysis of benefits and costs. The benefit outweighed the cost, so you approved the

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overtime, but you must also keep this decision in mind while forecasting future monthly budgets. Was this month's higher payroll atypical or has your team consistently needed overtime hours to complete the necessary work? Should you adjust the budget for future months or adjust the schedule to avoid unnecessary overtime?

There can be a lot of unplanned scenarios that impact the overall budget of a project, and these costs may not be avoidable. As the project manager, you should look for likely costs, anticipate the potential risks, and plan ahead. You will never be able to foresee everything, but if you try to imagine the unplanned costs on your project, you will have a much easier time planning a realistic budget.

Progress Reporting Progress reports convey information based on data analysis. The project manager uses information about project progress to help control the schedule and costs and to assess whether the project is on track through earned value analysis (described later in this section). Some project managers use alternative means of determining progress, such as asking team members to estimate percent complete for deliverables. Simply asking for percent complete does not result in a realistic estimate of progress. You can more carefully track progress without using earned value analysis by accurately measuring deliverable completion at the work package level based on cost and schedule estimates. For example, with a WBS, 80 hours is a small enough work increment to track progress against and still have accurate data. For the exam, remember that projects using proper project management make use of a WBS, and activities to produce work packages are broken down to an appropriate level for controlling.

Reserve Analysis Reserve analysis allows you to identify and apply lessons learned in controlling costs. Remember the contingency reserves that get factored into the cost baseline to address known risks? Part of cost control is analyzing where those contingency reserves are still necessary or where new reserves are required. For example, let's say a project team identifies a highly ranked risk and sets aside a contingency reserve to address it. If the risk does not occur and is no longer a threat, the contingency reserve can be removed from the cost baseline. Or, a risk review on a project may identify new risks, which could lead to a decision to increase the contingency reserves. Both of these examples require a change request being submitted through integrated change control. A change request is also required to move management reserve funds into the cost baseline for a similar purpose. It may also be necessary to reassess the amount of management reserve that was set aside to address unknown risks.

Earned Value Measurement[3] Earned value measurement is a data analysis technique used to measure project performance against the performance measurement baseline (the scope, schedule, and cost baselines). The resulting measurements indicate whether there are any potential deviations from the performance measurement baseline. Many project managers manage project performance by comparing planned to actual results. With this method, however, you could easily be on time but over budget. Earned value analysis integrates cost, time, and scope and can be used to forecast future performance and project completion dates and costs.

Earned value measurement is on the exam and questions often contain formulas. Are you worried about it? Don't be. We are going to make it easier. First, think about this: How valuable would it be to know how your project is really going? Could you sleep better at night? Would you be able to spend your time in more productive ways than worrying? If you currently rely on hope, guesses, or a general percent complete estimate to assess how your project is faring, you probably know from experience that these methods do not tell you much, nor are they very accurate. Keep the benefits of earned value as an analysis technique in mind as you read this section and go through it slowly if it seems confusing.

Using the work performance information gathered through earned value analysis, a project manager can create reports, including forecasts, and other communications related to the project's progress. Earned value analysis may also result in change requests to the project.

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Terms to Know Here are the earned value terms you need to know.

Acronym	Term	Interpretation
PV	Planned value	As of today, what is the estimated value of the work planned to be done?
EV	Earned value	As of today, what is the estimated value of the work actually accomplished?
AC	Actual cost (total cost)	As of today, what is the actual cost incurred for the work accomplished?
BAC	Budget at completion (the cost baseline)	How much did we budget for the total project effort?
EAC	Estimate at completion	What do we currently expect the total project to cost (a forecast)?
ETC	Estimate to complete	From this point on, how much more do we expect it to cost to finish the project (a forecast)?
VAC	Variance at completion	As of today, how much over or under budget do we expect to be at the end of the project?

Formulas and Interpretations to Memorize The exam focuses not just on calculations but also on knowing what the numbers mean. Therefore, you should know all the formulas in the following table. Note that most exam questions relating to these formulas will refer to cumulative analysis data from the beginning of the project to the point in time when it is being measured.

Name	Formula	Interpretation
Cost variance (CV)	EV – AC	Negative is over budget; positive is under budget.
Schedule variance (SV)	EV – PV	Negative is behind schedule; positive is ahead of schedule.
Cost performance index[4] (CPI)	$\frac{EV}{AC}$	We are getting $ _____worth of work out of every $1 spent. Funds are or are not being used efficiently. Greater than one is good; less than one is bad.
Schedule performance index (SPI)	$\frac{EV}{PV}$	We are (only) progressing at _____ percent of the rate originally planned. Greater than one is good; less than one is bad.
Estimate at completion (EAC)		As of now, how much do we expect the total project to cost? $_____.
	AC + Bottom-up ETC	This formula calculates actual costs to date plus a revised estimate for all the remaining work. It is used when the original estimate was fundamentally flawed.

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Name	Formula	Interpretation
EAC (continued) NOTE: *There are many ways to calculate EAC, depending on the assumptions made. Notice how the purpose of the formulas really is to create forecasts based on past performance of the project. Exam questions may require you to determine which EAC formula is appropriate. Pay attention to the information provided in the question. It will help you determine which formula to use.*	$\frac{BAC}{CPI^C}$	This formula is used if no variances from the BAC have occurred or if you will continue at the same rate of spending (as calculated in your cumulative CPI or based on the trends that have led to the current CPI).
	$AC + (BAC - EV)$	This formula calculates actual costs to date plus remaining budget. It is used when current variances are thought to be atypical of the future. It is essentially AC plus the remaining value of work to perform.
	$AC + \frac{(BAC - EV)}{(CPI^C \times SPI^C)}$	This formula calculates actual to date plus the remaining budget modified by performance. It is used when current variances are thought to be typical of the future and when project schedule constraints will influence the completion of the remaining effort. So for example, it might be used when the cumulative CPI is less than one and a firm completion date must be met.
To-complete performance index (TCPI)	$\frac{(BAC - EV)}{(BAC - AC)}$	This formula divides the value of the work remaining to be done by the money remaining to do it. It answers the question "To stay within budget, what rate do we need to meet for the remaining work?" Greater than one is bad; less than one is good.
Estimate to complete (ETC) NOTE: *You can determine ETC by either using the formula listed here or reestimating the cost of the work remaining.*		How much more will the project cost?
	$EAC - AC$	This formula calculates the total project cost as of today minus what has been spent to date.
	Reestimate	Reestimate the remaining work from the bottom up.
Variance at completion (VAC)	$BAC - EAC$	How much over or under budget will we be at the end of the project?

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TRICKS OF THE TRADE

Make sure you understand and memorize the following about CV, SV, CPI, and SPI:

- EV comes first in each of these formulas. Remembering this one fact alone should help you get about half the earned value questions right.
- If it is a variance (difference), the formula is EV minus AC or PV.
- If it is an index (ratio), the formula is EV divided by AC or PV.
- If the formula relates to cost, use AC.
- If the formula relates to schedule, use PV.
- For variances interpretation: negative is bad and positive is good. Thus a –200 cost variance means you spent more than planned (over budget). A –200 schedule variance means you are behind schedule. This also applies to VAC.
- For indices interpretation: greater than one is good and less than one is bad. Remember, this only applies to CPI and SPI. The opposite is true of TCPI.

People often incorrectly answer questions requiring them to interpret earned value terms or acronyms because they fail to understand the meanings of the terms. Figure 7.2 illustrates some of the differences. Notice that planned value (PV; what the value was expected to be at this point in the project according to the plan) and actual cost (AC; what the cost has actually been on the project to this point) look backward at the project. Budget at completion (BAC), estimate to complete (ETC), and estimate at completion (EAC) look forward. BAC refers to the project's planned budget; it indicates what the end cost of the project would be if everything went according to plan. ETC and EAC forecast future performance based on what has actually occurred on the project, taking into account any variances from the plan the project has already experienced. ETC is an estimate of how much more the remainder of the project will cost to complete. EAC indicates what the total project cost is forecasted to be.

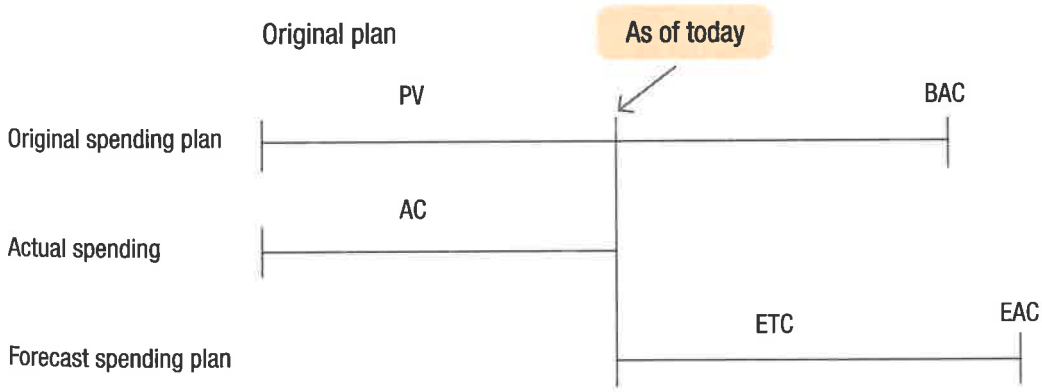

FIGURE 7.2 *Understanding earned value concepts by looking backward and forward on a project*

Earned Value in Action Earned value is an effective tool for measuring performance and determining the need to request changes. The following is a sample team meeting conversation on this subject.

The project manager calls a team meeting and says, "We are six months into this million-dollar project, and my latest analysis shows a CPI of 1.2 and an SPI of 0.89. This means we are getting 1.2 dollars for every dollar we put into the project, but only progressing at 89 percent of the rate originally planned. Let's look for options to correct this problem."

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The network specialist suggests that she could be removed from the project team and replaced with someone less expensive. The IT coordinator suggests either removing the purchase of new computers from the project or telling the customer the project will be two weeks late.

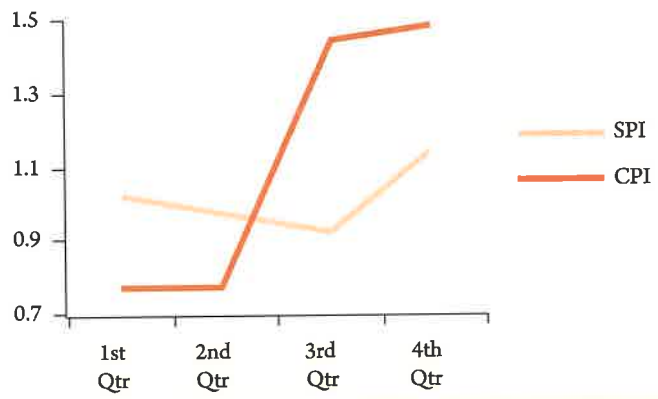
The project manager looks at the network specialist and says, "It would sadden me to lose you, and your suggestion would improve costs but not schedule. You are the company's best network specialist. Someone else would not be as proficient as you in completing the work." To the IT coordinator's suggestion, they respond that canceling the new computers would save money but not time. "Let's focus on time."

Another team member suggests that since the project is doing well on cost, the project manager could bring in another programmer from the IT department to work on the project to get the next two activities completed more quickly.

The project manager says, "That sounds like the most effective choice in this situation. Let's see if we can find someone who will improve performance, at the lowest cost. Thanks for your help."

The best way to learn the earned value analysis technique is to use it. The following exercises are designed to give you a chance to practice both calculations and interpretation. Earned value questions on the exam have generally required fewer calculations per question than these exercises.

7.2 Exercise The cost performance index (CPI) and the schedule performance index (SPI) can be charted each month to show the project trends. Based on the diagram, what would you be more concerned about—cost or schedule—if you were taking over this project from another project manager? Write the answer in your Exercise Notebook.



Answer Since these calculations were made in the past, the data in the chart is historical data. The last, most current measurement was in the fourth quarter, which shows both SPI and CPI being above one (good). As of the fourth quarter, the SPI is lower. Therefore, the answer is schedule. An easy way to answer performance index questions that ask whether cost or schedule should concern you most is to pick the option with the lowest index.

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7.3 Exercise The Fence #1 You have a project to build a new fence. The fence will form a square, as shown at right. Each side is to take one day to build, and $1,000 has been budgeted per side. The sides are planned to be completed one after the other. Today is the end of day 3.

Using the information in the project status chart, calculate the following in your Exercise Notebook. Calculate to three decimal points. Interpretation is also important on the exam. Can you interpret what each answer means?

1. PV=	5. CV=	9. EAC=
2. EV=	6. CPI=	10. ETC=
3. AC=	7. SV=	11. VAC=
4. BAC=	8. SPI=	

Project Status Chart

Activity	Day 1	Day 2	Day 3	Day 4	Status End of Day 3
Side 1	S---------F				Complete, spent $1,000
Side 2		S--------PF	----F		Complete, spent $1,200
Side 3			PS--S---PF		50% done, spent $600
Side 4				PS--------PF	Not yet started

Key S = Actual Start, F = Actual Finish, PS = Planned Start, and PF = Planned Finish

Answer The Fence #1

What Is:	Calculation	Answer	Interpretation of the Answer
1. PV	$1,000 plus $1,000 plus $1,000	$3,000	We should have done $3,000 worth of work.
2. EV	Complete, complete, and half done; or $1,000 plus $1,000 plus $500	$2,500	We have actually completed $2,500 worth of work.
3. AC	$1,000 plus $1,200 plus $600	$2,800	We have actually spent $2,800.
4. BAC	$1,000 plus $1,000 plus $1,000 plus $1,000	$4,000	Our project budget is $4,000.
5. CV	$2,500 minus $2,800	−$300	We are over budget by $300.
6. CPI	$2,500 divided by $2,800	0.893	We are only getting about 89 cents out of every dollar we put into the project.
7. SV	$2,500 minus $3,000	−$500	We are behind schedule.
8. SPI	$2,500 divided by $3,000	0.833	We are only progressing at about 83 percent of the rate planned.
9. EAC	$4,000 divided by $0.893	$4,479	We currently estimate that the total project will cost $4,479.
10. ETC	$4,479 minus $2,800	$1,679	We need to spend an additional $1,679 to finish the project.

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What Is:	Calculation	Answer	Interpretation of the Answer
11. VAC	$4,000 minus $4,479	−$479	We currently expect to be $479 over budget when the project is completed.

Did you select the correct EAC formula? If not, did you miss information in the question that could have guided you to the correct formula? In this example, side 2 cost $1,200. Side 3 is 50 percent complete and has cost $600. This suggests a trend that indicates side 4 is likely to cost $1,200 when complete. When there is a trend and no other information to indicate the trend will not continue, it's most appropriate to use the BAC/CPI formula.

On the real exam, round the results of your calculations to two decimal places when you are ready to check your answers against the choices provided.

7.4 Exercise The Fence #2 You have a project to build a new fence. The fence will form a square, as shown at right. Each side is to take one day to build, and $1,000 has been budgeted per side. The sides were planned to be completed one after the other; however, circumstances changed on the project, and work on the sides was able to proceed in parallel. Assume therefore that the sides have a finish-to-finish relationship instead of a finish-to-start relationship, so more than one side can be worked on at the same time. Today is the end of day 3.

Using the information in the project status chart, calculate the following in your Exercise Notebook. Calculate to three decimal points.

1. PV=	5. CV=	9. EAC=
2. EV=	6. CPI=	10. ETC=
3. AC=	7. SV=	11. VAC=
4. BAC=	8. SPI=	

Project Status Chart

Activity	Day 1	Day 2	Day 3	Day 4	Status End of Day 3
Side 1	S---------F				Complete, spent $1,000
Side 2		S----F----PF			Complete, spent $900
Side 3		S----	PS-------PF		50% done, spent $600
Side 4			S----	PS--------PF	75% done, spent $600

Key S = Actual Start, F = Actual Finish, PS = Planned Start, and PF = Planned Finish

Answer The Fence #2

What Is:	Calculation	Answer	Interpretation of the Answer
1. PV	$1,000 plus $1,000 plus $1,000	$3,000	We should have done $3,000 worth of work.
2. EV	Complete, complete, half done, and 75% done, or $1,000 plus $1,000 plus $500 plus $750	$3,250	We have actually completed $3,250 worth of work.

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What Is:	Calculation	Answer	Interpretation of the Answer
3. AC	$1,000 plus $900 plus $600 plus $600	$3,100	We have actually spent $3,100.
4. BAC	$1,000 plus $1,000 plus $1,000 plus $1,000	$4,000	Our project budget is $4,000.
5. CV	$3,250 minus $3,100	$150	We are under budget by $150.
6. CPI	$3,250 divided by $3,100	1.048	We are getting about $1.05 out of every dollar we put into the project.
7. SV	$3,250 minus $3,000	$250	We are ahead of schedule.
8. SPI	$3,250 divided by $3,000	1.083	We are progressing at about 108 percent of the rate planned.
9. EAC	$4,000 divided by $1.048	$3,817	We currently estimate that the total project will cost $3,817.
10. ETC	$3,817 minus $3,100	$717	We need to spend an additional $717 to finish the project.
11. VAC	$4,000 minus $3,817	$183	We currently expect to be $183 under budget when the project is completed.

In this example, you are looking for the value of the work that has actually been done. The finish-to-finish relationship allowed the team to work on more than one side at the same time. In this case, work is being done on both sides 3 and 4 at the same time. Since the value of each side is $1,000, we look at how much of each side is complete and apply that percent to the value. Here sides 1 and 2 are completed, so each receives a value of $1,000. It doesn't matter what it actually cost—just the value. Side 3 is 50 percent done and receives a value of $500 (50 percent of $1,000). Side 4 is 75 percent done and receives a value of $750 (75 percent of $1,000). The earned value to date is $3,250.

Understanding the meaning of the results of each calculation is as important as knowing how to calculate them.

Expect questions on the exam such as: "The CPI is 0.9, and the SPI is 0.92. What should you do?" You will need to interpret this and other data in the question and then determine which choice would address the issue(s) described. In the fence example, there are both cost and schedule problems.

You may also see questions on the exam that require you to perform multiple calculations (for example, you need to perform one calculation to come up with a result that can be used as an input for a second calculation). We have a few exercises coming up that will help you understand how to answer these questions, but it's helpful to first consider the following useful tip.

TRICKS OF THE TRADE

Here's a quick trick for finding EV when a question provides partial information. Depending on the information you're given in a question, you can reverse the formulas you know for CV, SV, CPI, or SPI so you can isolate EV on its own side of the equation, which will make it much easier to solve. For example, say a question gives you CV and AC and asks you to solve for EV. You already know that CV = EV – AC, so now you can reverse this formula by adding AC to both sides of the equation as follows:

$$CV = EV - AC$$
$$CV + AC = EV - AC + AC$$
$$CV + AC = EV$$

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Do you understand why we added AC to both sides of the equation? You're trying to isolate EV on one side of the equation. By adding AC to the right side of the equation, you cancel out the –AC, so you end up with EV on its own. But whatever you do on the right-hand side of the equation, you have to do on the left-hand side as well. (Here's a little algebra refresher: you can perform an operation—such as adding, subtracting, dividing, or multiplying—on one side of the equation so long as you do the exact same thing on the other side as well. This allows you to manipulate an equation to make it easier to solve.)

So now, to solve for EV, all you have to do is add CV and AC.

Similarly, say a question gives you CPI and AC and asks you to determine EV. You already know the formula for CPI (CPI = EV/AC), but how can you isolate EV on one side of the equation? Instead of adding AC to both sides of the equation, in this case, you would multiply both sides by AC:

$$\text{CPI} = \frac{\text{EV}}{\text{AC}}$$

$$\text{CPI} \times \text{AC} = \frac{\text{EV}}{\text{AC}} \times \text{AC}$$

$$\text{CPI} \times \text{AC} = \text{EV}$$

You can also simply memorize the reverse formulas in the following table:

Original Formula	Reverse Formula to Determine EV
CV = EV – AC	EV = CV + AC
SV = EV – PV	EV = SV + PV
$\text{CPI} = \frac{\text{EV}}{\text{AC}}$	EV = CPI × AC
$\text{SPI} = \frac{\text{EV}}{\text{PV}}$	EV = SPI × PV

Just keep in mind that this quick trick for reversing the formula only works for EV. Although you can reverse other earned value formulas, to do so would generally require multiple steps.

7.5 Exercise What is the EV if your CPI is 1.1, your SPI is .92, and your AC is $10,000? Which reverse formula would you use? Write the answer in your Exercise Notebook.

Answer Since the question gives us the CPI and AC, we can reverse the CPI formula to get to the EV. So the reverse formula would be EV = CPI × AC, or EV = 1.1 × $10,000, which works out to $11,000. For this question, there was no need to use the SPI information.

7.6 Exercise What is the SPI if the CV is $10,000, the SV is –$3,000, and the PV is $100,000? Write the answer in your Exercise Notebook.

Answer To find the SPI, you actually need to perform two calculations here. The formula for SPI is SPI = EV/PV; we know what the PV is, but we don't know the EV. Luckily, we can figure it out using the information given in the question. We're given the SV and PV, so we can use the following reverse formula to determine EV.

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EV = SV + PV

EV = −$3,000 + $100,000

EV = $97,000

We can then plug the PV and EV into the SPI formula as follows.

$$SPI = \frac{EV}{PV}$$

$$SPI = \frac{\$97,000}{\$100,000}$$

SPI = .97

If your equation requires you to solve for something other than EV (for example, AC or PV), the math will be slightly more complicated, but don't worry: we've got an exercise to help you understand what to do.

7.7 Exercise Using the information from the previous exercise, determine AC. Write the answer in your Exercise Notebook.

Answer We need to look at the information from the previous exercise to determine what formula to use to figure out AC. We know the CV is $10,000 and the EV is $97,000 (from the calculation we performed in the previous exercise). With this information, we can determine the AC by using the formula CV = EV – AC. To do this, we first plug the information we know into the formula:

CV = EV − AC

$10,000 = $97,000 − AC

To solve for AC, we need to get AC alone on one side of the equation. First, add AC to both sides of the equation:

$10,000 + AC = $97,000 − AC + AC

$10,000 + AC = $97,000

The –AC and +AC on the right-hand side of the equation canceled each other out. But we still need to isolate AC on the left-hand side of the equation. To do this, we're going to subtract $10,000 from both sides.

$10,000 + AC − $10,000 = $97,000 − $10,000

AC = $87,000

7.8 Exercise In the latest earned value report for your project, you see the CPI is 1.2, the SPI is 0.8, the PV is $600,000, and the SV is –$120,000. You can't find the CV in the report, so you need to calculate it based on the information given. What is the CV? Write the answer in your Exercise Notebook.

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Answer The formula for CV is CV = EV – AC. Therefore, we need to find EV and AC to calculate CV. We can do this by using one of the reverse formulas we learned earlier. Since we know the values for SPI (0.8) and PV ($600,000), we can use EV = SPI × PV (this is the reverse formula for SPI = EV/PV).

EV = SPI × PV

EV = 0.8 × $600,000

EV = $480,000

Now we need AC, which we can get from the EV we just determined and the CPI given in the question (1.2).

The formula is $CPI = \frac{EV}{AC}$ or $1.2 = \frac{\$480,000}{AC}$.

We need to isolate AC on one side of the equation to figure out what it is. Start by multiplying both sides of the equation by AC.

$$1.2 \times AC = \frac{\$480,000}{AC} \times AC.$$

The resulting equation is:

1.2 × AC = $480,000

To get AC on its own, we need to divide both sides by 1.2.

$$\frac{(1.2 \times AC)}{1.2} = \frac{\$480,000}{1.2}$$

The resulting equation is:

$$AC = \frac{\$480,000}{1.2}$$

So, AC = $400,000.

Now that we know the EV and the AC, we can figure out what the CV is:

CV = EV – AC

CV = $480,000 – $400,000

CV = $80,000

In summary, earned value analysis enables the project manager and team to identify and analyze trends in performance and variances that may require action to bring the project in line with what was planned. It also includes monitoring the use of contingency reserves to ensure the amount of reserves remaining is adequate. It may identify the need to request additional reserve funds through integrated change control.

The Control Costs process provides measurements that indicate how the work is progressing and allow the project manager to create reliable forecasts and take action to control the project. This process may result in requested changes to the cost management plan, performance measurement baseline, and other parts of the project management plan, recommended corrective or preventive actions, and updates to project documents.

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Practice Exam

1. One common way to compute estimate at completion (EAC) is to take the budget at completion (BAC) and:
   A. Divide by SPI.
   B. Multiply by SPI.
   C. Multiply by CPI.
   D. Divide by CPI.

2. The finance department requires that you keep them updated on the costs being spent on the capital project you are leading. You were required to submit a funding plan, and monthly forecasts are necessary so that any changes to the funding plan can be requested in advance and evaluated. Exceeding the budget limit is unacceptable as it will impact the stock value. You have successfully implemented processes and practices to anticipate funding changes, and you evaluate them to minimize problems and increase the efficient use of funds. You have employed a variety of reporting and analysis techniques to meet the finance department requirements. One of them is EAC, which is a periodic evaluation of:
   A. The cost of work completed
   B. The value of work performed
   C. The anticipated total cost at project completion
   D. What it will cost to finish the project

3. If earned value (EV) = 350, actual cost (AC) = 400, and planned value (PV) = 325, what is the cost variance (CV)?
   A. 350
   B. –75
   C. 400
   D. –50

4. The customer responsible for overseeing your project asks you to provide a written cost estimate that is 30 percent higher than your estimate of the project's cost. He explains that the budgeting process requires managers to estimate pessimistically to ensure enough money is allocated for projects. What is the best way to handle this?
   A. Add the 30 percent as a lump sum contingency fund to handle project risks.
   B. Add the 30 percent to your cost estimate by spreading it evenly across all project activities.
   C. Create one cost baseline for budget allocation and a second one for the actual project management plan.
   D. Ask for information on risks that would cause your estimate to be too low.

5. You've recently been assigned to manage a marketing project to brand a sustainable development program. Even though you are just starting your efforts, the sponsors are concerned about the likelihood of reaching planned milestones during the project. They are wondering how you will go about estimating. Analogous estimating:
   A. Uses bottom-up estimating techniques
   B. Is used most frequently during project executing
   C. Uses top-down estimating techniques
   D. Calculates estimates using actual detailed historical costs

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6. Management has asked you to update the projected cost of running your agile team through the end of the project based on the latest project data. What information will you need from the team to update this estimate?
   A. Resource management plan
   B. Release plans
   C. Burndown graph
   D. Product backlog

7. You have been working with the subject matter experts to estimate the activity durations and costs on the project. All the following are outputs of the Estimate Costs process except:
   A. An understanding of the cost risk in the work that has been estimated
   B. The prevention of inappropriate changes from being included in the cost baseline
   C. An indication of the range of possible costs for the project
   D. Documentation of any assumptions made during the Estimate Costs process

8. During the course of your hybrid project, changes and additions have gradually moved the total project scope upward. The original scope was 400 story points, but at this point the total project scope is 620 story points. The team's average velocity has stabilized at 20 story points per iteration, and they have already completed 120 story points worth of scope. The team's burn rate is $16,000 per week. The original cost estimate for the team was $256,000, based on the initial scope and the team's initial velocity estimate of 25 story points per iteration. What is the remaining cost of running the team on this project?
   A. $496,000
   B. $400,000
   C. $320,000
   D. $200,000

9. You're managing a project to develop a new mobile application for the inventory tracking and-control system of a restaurant franchise organization. Schedule is the highest-priority constraint for the leadership team, but the franchise owners are most concerned about cost and the quality of the application. If there are bugs and errors in the system, they will pay higher costs on waste or lost sales. But investing a lot of effort into delivering great functionality could be expensive. It was decided that an adaptive approach to the project life cycle would likely be the best way to balance the competing priorities and deliver a working, cost-effective application. The franchise decision team has been meeting with the development team. The groups feel good about the project's progress, but they are hearing concerns from other stakeholders about what the impact will be to the bottom line and whether the system will be ready for launch. These concerns were anticipated in planning, and will be managed with cost performance measurement. Cost performance measurement is best done through which of the following?
   A. Asking for a percent complete from each team member and reporting that in the monthly progress report
   B. Calculating earned value, and using indexes and other calculations to report past performance and forecast future performance
   C. Using the 50/50 rule, and making sure the life cycle cost is less than the project cost
   D. Focusing on the amount expended last month and what will be expended the following month

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10. A cost performance index (CPI) of 0.89 means:
    A. At this time, we expect the total project to cost 89 percent more than planned.
    B. When the project is completed, we will have spent 89 percent more than planned.
    C. The project is progressing at 89 percent of the rate planned.
    D. The project is getting 89 cents out of every dollar invested.

11. Which of the following is an example of a parametric estimate?
    A. Dollars per module
    B. Learning bend
    C. Bottom-up
    D. CPM

12. A rough order of magnitude (ROM) estimate is made during which project management process group?
    A. Planning
    B. Closing
    C. Executing
    D. Initiating

13. For each activity on your project, you have worked with designers, engineers, technical experts, and consultants to come up with details on the resources needed to complete the activity. For some of the activities the lists are quite long, as you need raw and finished materials, equipment, and people. You have a limited amount of warehousing available, so you have to coordinate the deliveries and work so that the materials and equipment are delivered as close to the start of an activity as possible. You and the project management team have identified the amount of time and money needed for each of the activities, which you have then aggregated and analyzed with their help. These efforts will eventually result in the creation of a cost baseline for the project. A senior manager is trying to better understand the work of project management and has asked which process produces the cost baseline. What is the correct response?
    A. Estimate Activity Resources
    B. Estimate Costs
    C. Determine Budget
    D. Control Costs

14. Project setup costs are an example of:
    A. Variable costs
    B. Fixed costs
    C. Overhead costs
    D. Opportunity costs

15. The quality efforts on the project have gone through some changes during the first four months of project work. Two processes in particular have undergone extensive change. The customer is happy with the work to date, but has heard that the competition is working on a similar product. The team has been asked to analyze and create options for the customer. Value analysis is performed to get:
    A. More value from the cost analysis
    B. Management to buy into the project
    C. The team to buy into the project
    D. A less costly way of doing the same work

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16. The project management team is busy breaking down deliverables, and the procurement department has started looking for possible sellers to help produce the deliverables. There are departmental concerns that the project could go over budget because the scope will be iterated and the planning and development will be done in increments. At a recent company gathering, the sponsor asked questions of the project manager and the project management staff team about how changes in scope will affect the estimates. The sponsor wanted to know how the project estimates could be relied upon, given that they were planning to iterate the scope. The project manager reassured them that the team has the right tools with which to provide accurate estimates, and will utilize the tools throughout the project. Which of the following is not needed in order to come up with a project estimate?
    A. A WBS
    B. A network diagram
    C. Risks
    D. Change requests

17. Which estimating method tends to be most costly for creating a project cost estimate?
    A. Bottom-up
    B. Analogous
    C. Parametric
    D. 50/50

18. To gain a clear indication of how the project is progressing, the buyer expects periodic reporting that includes analysis of the work that has been accomplished according to plan, the dollars that have been spent and how they reflect the planned expenses, the accepted deliverables, and evaluation of the risk events that have occurred. Which of the following represents the estimated value of the work actually accomplished?
    A. Earned value (EV)
    B. Planned value (PV)
    C. Actual cost (AC)
    D. Cost variance (CV)

19. The team's velocity for the first eight two-week sprints of your 46-week hybrid project are 30, 60, 57, 44, 33, 48, 41, and 49. Should you be concerned about how these results will impact the cost of the project? What should you do about this?
    A. Yes, there is too much variation for reliable cost projections. Consult with your project's budget office.
    B. Possibly. Compare these velocity rates to the team's original estimates at the start of the project.
    C. No. There is no need for action since team velocity has no impact on the cost of a project.
    D. Probably. But before taking action, convene a meeting and ask the team members what is happening.

20. Which of the following are all items included in the cost management plan?
    A. The level of accuracy needed for estimates, rules for measuring cost performance, and specifications for how duration estimates should be stated
    B. Specifications for how estimates should be stated, rules for measuring cost performance, and the level of accuracy needed for estimates
    C. Rules for measuring team performance, the level of accuracy needed for estimates, and specifications for how estimates should be stated
    D. Specifications for how estimates should be stated, the level of risk needed for estimates, and rules for measuring cost performance

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21. Your project has a medium amount of risk and is not very well defined. The sponsor hands you a project charter and asks you to confirm that the project can be completed within the project cost budget. What is the best method to handle this?
    A. Develop an estimate in the form of a range of possible results.
    B. Ask the team members to help estimate the cost based on the project charter.
    C. Based on the information you have, calculate a parametric estimate.
    D. Provide an analogous estimate based on past history.

22. You are leading a project to introduce a new healthcare appointment scheduling application. As you are creating plans detailing how the team will respond to possible events that may impact the project, you and the team determine the amount of cost contingency reserve needed. The cost contingency reserve should be:
    A. Hidden to prevent management from disallowing the reserve
    B. Added to each activity to provide the customer with a shorter critical path
    C. Maintained by management to cover cost overruns
    D. Added to the cost of the project to account for risks

23. You are having difficulty estimating the cost of a project. Which of the following best describes the most probable cause of your difficulty?
    A. Inadequate scope definition
    B. Unavailability of desired resources
    C. Lack of historical records from previous projects
    D. Lack of company processes

24. Your cost forecast shows you will have a cost overrun at the end of the project. Which of the following should you do?
    A. Eliminate risks in estimates and reestimate.
    B. Meet with the sponsor to find out what work can be done sooner.
    C. Cut quality.
    D. Decrease scope.

25. Early in the life of your project, you are having a discussion with the sponsor about what estimating techniques should be used. You want a form of expert judgment, but the sponsor argues for analogous estimating. It would be best to:
    A. Agree to analogous estimating, as it is a form of expert judgment.
    B. Suggest life cycle costing as a compromise.
    C. Determine why the sponsor wants such an accurate estimate.
    D. Try to convince the sponsor to allow expert judgment because it is typically more accurate.

26. You have just completed the initiating processes of a small project and are moving into project planning when a project stakeholder asks you for the project's budget and cost baseline. What should you tell her?
    A. The project budget can be found in the project charter, which has just been completed.
    B. The project budget and baseline will not be finalized and accepted until the planning processes are completed.
    C. The project management plan will not contain the project's budget and baseline; this is a small project.
    D. It is impossible to complete an estimate before the project management plan is created.

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27. The project manager is working with cost estimates in order to establish a baseline for measuring project performance. What process is this?
    A. Cost Management
    B. Estimate Costs
    C. Determine Budget
    D. Control Costs

28. Monitoring cost expended to date in order to detect variances from the plan occurs during:
    A. The creation of the cost change control system
    B. Recommending corrective actions
    C. Updating the cost baseline
    D. Project performance reviews

29. You're thinking through what approach will make it easiest for the team to take responsibility for providing work performance data for all aspects of the project. As part of this approach, you believe it will be helpful to make sure the team understands how and why the data will be analyzed. You explain to the team that the cost management plan contains a description of:
    A. The project costs
    B. How resources are allocated
    C. The budgets and how they were calculated
    D. The WBS level at which earned value will be calculated

30. A manufacturing project has a schedule performance index (SPI) of 0.89 and a cost performance index (CPI) of 0.91. Generally, what is the most likely explanation for why this occurred?
    A. The scope was changed.
    B. A supplier went out of business, and a new one needed to be found.
    C. Additional equipment needed to be purchased.
    D. A critical path activity took longer and needed more labor hours to complete.

31. Although the stakeholders thought there was enough money in the budget, halfway through the project the cost performance index (CPI) is 0.7. To determine the root cause, several stakeholders audit the project and discover the project cost budget was estimated analogously. Although the activity estimates add up to the project estimate, the stakeholders think something was missing in how the estimate was completed. Which of the following describes what was missing?
    A. Estimated costs should be used to measure CPI.
    B. SPI should be used, not CPI.
    C. Bottom-up estimating should have been used.
    D. Past history was not taken into account.

32. In analyzing problems that have occurred during testing, the team discovered that cause-and-effect diagramming is helpful in identifying the best place to focus their efforts. Their coordination of the interrelationships of the deliverables has improved, and the team has discovered efficiencies that have been shared with other projects and the organization for process improvement. This has made a difference in how well the project is aligning to the performance measurement baseline. Stakeholders are anticipating that control efforts and reporting on future projects will be easier. Earned value analysis is the basis for:
    A. Performance reporting
    B. Planning control
    C. Ishikawa diagrams
    D. Integrating the project components into a whole

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33. The replacement of the inventory management and portion control system for an international restaurant chain has been prioritized as a key strategic objective for the organization. Stakeholders are very concerned about many aspects of the project. They have shared these concerns and ideas in workshops, focus groups, emails, and surveys. Identified risks are:
    A. An input to the Estimate Costs process
    B. An output of the Estimate Costs process
    C. Not related to the Estimate Costs process
    D. Both an input to and an output of the Estimate Costs process

34. There is confusion among some of the stakeholders about how the cost forecasts will be calculated on the project. They also have concerns about whether enough money has been set aside to cover the cost of risk responses. You are planning to share information in the upcoming team meeting and in reports to stakeholders to clear up the confusion. You are referencing the stakeholder and communications management plans to determine how best to communicate with the stakeholders. You will explain that the difference between the cost baseline and the cost budget can be best described as:
    A. The management reserves
    B. The contingency reserves
    C. The project cost estimate
    D. The cost account

35. You provide a project cost estimate for the project to the project sponsor. He is unhappy with the estimate, because he thinks the price should be lower. He asks you to cut 15 percent off the project estimate. What should you do?
    A. Start the project and constantly look for cost savings.
    B. Tell all the team members to cut 15 percent from their estimates.
    C. Inform the sponsor of the activities to be cut.
    D. Add additional resources with low hourly rates.

36. Cost risk means:
    A. There are risks that will cost the project money.
    B. The project is too risky from a cost perspective.
    C. There is a risk that project costs could go higher than planned.
    D. There is a risk that the cost of the project will be lower than planned.

37. A project manager is analyzing the project to find ways to decrease costs. It would be best if the project manager looks at:
    A. Variable costs and fixed costs
    B. Fixed costs and indirect costs
    C. Direct costs and variable costs
    D. Indirect costs and direct costs

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Answers

1. **Answer** D
   Explanation The formula BAC/CPI is used to calculate EAC if no variances from the BAC have occurred or if you will continue at the same rate of spending (as calculated in your cumulative CPI).

2. **Answer** C
   Explanation When you look at earned value, many of the terms have similar definitions. This could get you into trouble. EAC means the estimate at completion. What it will cost to finish the project is the definition of ETC, or estimate to complete.

3. **Answer** D
   Explanation The formula is CV = EV – AC. Therefore, CV = 350 – 400, or CV = –50. PV is not a factor in this calculation.

4. **Answer** D
   Explanation Presenting anything other than your original estimate (allocating more to the budget) is inaccurate and calls into question your competence and integrity as a project manager. The customer should list potential changes and risks related to your estimate. If the costs and risks are justified, you can ethically increase the budget.

5. **Answer** C
   Explanation Analogous estimating is used most frequently during project initiating and planning, not project executing. Parametric estimating involves calculations based on historical records. Analogous estimating early in the project uses top-down estimating techniques.

6. **Answer** C
   Explanation Since agile emphasizes keeping teams stable, the team's burn rate should be consistent over time. So all you need to update your projection is the latest estimate of how long the project is expected to take. Of the options offered here, the only one that will show you a projected completion date based on the latest project data is the burndown graph. The release plans might tell you when the project was originally expected to finish, but that information might be out of date. The product backlog and the resource management plan won't show completion dates. (Also, the resource management plan is prepared by the project manager, not the team.)

7. **Answer** B
   Explanation This question is asking, "When you finish estimating costs, what do you have?" Many people who do not realize that estimates should be in a range choose that option. Documentation of assumptions is included in the basis of estimates, which is an output of Estimate Costs. The prevention of inappropriate changes is more correctly part of the cost management plan and the change control system.

8. **Answer** B
   Explanation Based on the data provided, we can project that the total cost of the team for this project will be $496,000 (620 story points / 20 points per week x $16,000 per week). However, the question asks for the remaining cost of running the team, and they have already completed 120 story points over 6 weeks, at a cost of $96,000 (120 / 20 x $16,000). So the correct answer is $400,000. (A simpler way of finding this answer is to subtract the completed work from the total scope, and just calculate the burn rate based on that number: 620 – 120 = 500; 500 / 20 x $16,000 = $400,000.) Note that the information about the original cost estimate isn't necessary for answering the question, although it does provide a way to check your calculation by comparing it to the original cost estimate.

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9. **Answer** B
Explanation Asking percent complete is not a best practice since it is usually a guess. If the easiest work is done first on a project, it can throw off any percentage calculations of work remaining. The life cycle cost cannot be lower than the project cost, as the life cycle cost includes the project cost. Focusing on the amount spent last month and what will be spent in the next month is often done by inexperienced project managers. Not only does this provide little information, but the data cannot be used to predict the future. Earned value analysis and other calculations is the best answer since this choice looks at the past and uses that information to estimate future costs.

10. **Answer** D
Explanation The CPI is less than one, so the situation is bad. The project is only getting 89 cents out of every dollar invested.

11. **Answer** A
Explanation Parametric estimates use a mathematical model to predict project cost or time.

12. **Answer** D
Explanation This estimate has a wide range. It is done during project initiating, when very little is known about the project.

13. **Answer** C
Explanation A cost baseline is an output of the Determine Budget process.

14. **Answer** B
Explanation Setup costs do not change as production on the project changes. Therefore, they are fixed costs.

15. **Answer** D
Explanation Value analysis seeks to decrease cost while maintaining the same scope.

16. **Answer** D
Explanation You need the WBS to define the activities, the network diagram to see the dependencies, and the risks to determine contingencies. NOTE: These are high-level risks, not the detailed risks that are identified later in project planning. Change requests are not required to obtain estimates, although they could cause existing estimates to be adjusted. Without the other three choices, you cannot develop good estimates.

17. **Answer** A
Explanation Because you need project details to estimate this way, the effort expended will be greater with bottom-up estimating.

18. **Answer** A
Explanation It can be confusing to differentiate earned value terms from each other. The estimated value of the work actually completed is the definition of EV, or earned value.

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19. **Answer** B
Explanation A team's velocity does impact the cost of the project, since it determines how long the team will need to complete the work. The longer the team is working on the project, the longer the project has to pay for the team's burn rate. However, there is no need to convene a team meeting to understand these results; they show a typical pattern for a change-driven team early in a long-term project—initial variation followed by emerging stability. (This team's velocity actually seems to be stabilizing pretty quickly.)

So the variation isn't a problem. However, to understand the impact on project cost, we need a key piece of information that isn't provided: What was the team's original velocity estimate? For example, let's say that the total scope is 780 points, and the team originally projected an average velocity of 60 points. That would mean they were originally expecting to complete the work in 13 two-week sprints. But it looks like this team's average velocity is converging around 45 points per sprint. At that rate, it will take them 18 two-week sprints to complete the work—in other words it will add ten more weeks to the project, which will increase the cost. On the other hand, if the team originally estimated an average velocity of 40 points, then these results would indicate that the project cost is running below the original estimate (at least as far as the team's burn rate is concerned).

20. **Answer** B
Explanation Notice how one item in each of the incorrect options makes the entire choice incorrect. Duration estimates are created during schedule management, and measuring team performance is part of resource management. There is no level of risk required for estimates. Specifications for how estimates should be stated, rules for measuring cost performance, and the level of accuracy needed for estimates are all parts of the cost management plan.

21. **Answer** A
Explanation With such limited information, it is best to estimate in a range. The range can be narrowed as planning progresses and risks are addressed.

22. **Answer** D
Explanation Hiding the reserve is an inappropriate action. Adding cost to each activity will not shorten the critical path, and is an incorrect statement. Management reserves, not contingency reserves, are maintained by management to cover cost overruns. During the risk management process, you determine appropriate contingency reserves to cover the cost of identified risks. These costs are included in the project cost baseline.

23. **Answer** A
Explanation Although all choices could cause difficulty, only inadequate scope definition makes estimating impossible.

24. **Answer** A
Explanation Look for the choice that would have the least negative impact on this situation. You would not need to meet with the sponsor to determine which work can be done sooner, and changing the order of activities is unlikely to eliminate the cost overrun. Cutting quality and decreasing scope always have negative effects. The choice with the least negative impact is to eliminate risks in estimates and reestimate.

25. **Answer** A
Explanation This is a tricky question. Determining why the sponsor wants such an accurate estimate sounds like a good idea at first. However, analogous estimates are less accurate than other forms of estimating, as they are prepared with a limited amount of detailed information. Reading every word of this choice helps eliminate it. To pick the best answer, you need to realize that analogous estimating is a form of expert judgment.

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26. **Answer** B
Explanation The overall project budget may be included in the project charter but not the detailed costs. Even small projects should have a budget and schedule. It is not impossible to create a project budget before the project management plan is created. However, it is not wise to do so, as the budget will not be accurate. The project budget and baseline are not finalized and accepted until the planning processes are completed.

27. **Answer** C
Explanation Cost Management is too general. The estimates are already created in this situation, so the answer is not Estimate Costs. The answer is not Control Costs, because the baseline has not yet been created. The work described is the Determine Budget process.

28. **Answer** D
Explanation Recommending corrective actions and possible updates to the cost baseline result from project performance reviews; they are not concurrent with them. Monitoring costs is part of change control, but not part of creating the change control system. The correct choice is project performance reviews.

29. **Answer** D
Explanation The exam may ask you what the management plans include in order to test whether you really understand them. The cost management plan identifies the WBS level at which earned value will be calculated.

30. **Answer** D
Explanation To answer this question, you must look for a choice that would take longer and cost more. Notice one of the choices says scope was changed, but that does not necessarily mean it was added to. If the change was to reduce the scope, it might also have reduced cost. Although it would take time to handle the issue of the need to find a new supplier, the impacted activity might not be on the critical path and might not affect time. Purchasing additional equipment definitely adds cost, but not necessarily time. A critical path activity taking longer and requiring more labor hours to complete would negatively affect both time and cost.

31. **Answer** C
Explanation Actual costs are used to measure CPI, and there is no reason to use SPI in this situation. Using past history is another way of saying "analogous." The most detailed way to estimate is bottom-up. Such estimating would have improved the overall quality of the activity estimates.

32. **Answer** A
Explanation Earned value is a great way to communicate the value of work already accomplished. With it, you can show where you stand on budget and schedule, as well as provide forecasts for the rest of the project.

33. **Answer** D
Explanation Identified risks are listed in the risk register, an input to the Estimate Costs process. In completing the Estimate Costs process, additional risks may be uncovered. These are added to the risk register as project documents updates.

34. **Answer** A
Explanation The costs of activities are included in the project cost estimate, and the contingency reserves (to cover identified risks) are added to that to come up with the cost baseline. Thereafter, the management reserves (to cover unknown, or unidentified, risks) are added to come up with the cost budget. The management reserves make up the difference between the cost baseline and the cost budget.

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35. **Answer** C
Explanation To answer the question, you must first realize that it is never appropriate for a project manager to just cut estimates across the board. You should have created a project estimate based on realistic work package estimates that do not include padding. Then, if costs must be decreased, you can look to cut quality, decrease risk, cut scope, or use cheaper resources (and at the same time closely monitor the impact of changes on the project schedule).

One of the worst things a project manager can do is to start a project knowing that the schedule or cost for the project is unrealistic. Did you notice the choice of adding additional resources? Even though they have lower hourly rates, that would add cost. Evaluating, looking for alternatives, and then reporting the impact of cost cutting to the sponsor is the best action to take.

36. **Answer** C
Explanation While it is true that risk will cost the project money, that is not the definition of cost risk. Stating that the project is too risky from a cost perspective assumes the risk is too great to do the project. Cost risk is the risk that project costs could go higher than planned.

37. **Answer** C
Explanation Direct costs are directly attributable to the project, and variable costs are costs that vary with the amount of work accomplished. It is best to look at decreasing these costs on the project.

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Quality

EIGHT

Before you read this chapter, think about the quality management plan on your project. If you do not have a quality management plan, or if you do not manage quality now, this could be a difficult topic for you on the exam. This chapter will help you understand quality and its role in the project management process.

Projects and organizations determine their approach to quality management. For some, that may mean simply responding to customer complaints about the quality of deliverables. Others inspect their deliverables for quality before they reach the customer. More informed organizations not only inspect their deliverables, but also evaluate and adjust their quality management processes in an effort to identify the causes of defects. An even better approach includes these quality management and process improvements, as well as planning quality into projects. Ideally, an organization embraces all these efforts as part of a total commitment to providing the required level of quality. This chapter will improve your understanding of the efforts required to address quality at the most effective level.

If asked, "Is it better to plan in quality or to inspect to find quality problems?" almost everyone will answer correctly that it is better to plan in quality. Exam questions focus on situations to see if you know how to apply this knowledge. For example:

> The project manager finds that one of his team members has created their own process for installing hardware. What should the project manager do?

Beginning project managers might choose a response that relates to thanking the team member for the effort. More experienced project managers might select a choice that relates to finding out if the process was a good one. The more experienced project managers who also understand these quality processes

QUICKTEST

- Quality management process
- Definition of quality
- Gold plating
- Prevention over inspection
- Continuous improvement
- Just in time (JIT)
- Responsibility for quality
- Interviews, brainstorming, and benchmarking
- Cost-benefit analysis
- Impact of poor quality
- Cost of quality
- Costs of conformance and nonconformance
- Marginal analysis
- Logical data models
- Flowcharts
- Test and inspection planning
- Checklists
- Quality metrics
- Quality management plan
- Cause-and-effect diagrams
- Histograms
- Pareto charts
- Scatter diagrams
- Document analysis
- Alternatives analysis
- Design of experiments
- Process analysis
- Root cause analysis
- Failure analysis
- Multicriteria decision analysis
- Affinity diagrams
- Audits
- Design for X
- Problem-solving
- Test and evaluation documents
- Quality reports
- Mutual exclusivity
- Probability
- Normal distribution
- Statistical independence
- Standard deviation
- 3 or 6 sigma
- Checksheets
- Statistical sampling
- Questionnaires and surveys
- Performance reviews
- Inspection
- Control charts
  - Assignable cause/ special cause variation
  - Control limits
  - Mean
  - Specification limits
  - Out of control
  - Rule of seven

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select the choice that relates to investigating the quality management plan to determine if a standard process should have been followed.

Expect to see exam questions that refer to different project environments (for example, the project manager works for a manufacturer of tables). This does not mean you have to learn about all industries. Industry-specific exam examples are designed so they tend to be understandable to all. Focus on the situation that is being described. Also expect questions about the quality management process and how quality relates to project constraints, as defined in this book.

Imagine a project to build a stadium. The concrete part of the work is two-thirds done when the buyer arrives one day and tests the strength of the concrete. The buyer finds that the concrete does not meet the clearly stated quality requirements for strength in the contract. You can imagine the problems when the buyer says, "Rip out the concrete; it is not acceptable." Whose fault is this? Why did this occur?

Could we say it is the buyer's fault for not testing the concrete sooner? You might argue that case, but isn't the real fault with the seller for not testing the quality throughout the project? Where was their quality plan? They should have noted the requirement and determined when and how they would confirm they had met it. Lack of attention to quality in this scenario needlessly added considerable risk to the project, which resulted in a tremendous amount of rework and additional expense.

Here is something else to consider. Have any of your customers ever said one of your deliverables was not acceptable, even though they had not provided you with a definition of what was acceptable? It is important to know—in advance—what acceptable quality is and how it will be measured on the project. You can then determine what you will do to make sure the project meets those requirements. It is the project manager's responsibility to make sure that quality is defined in the plan. If you do not take these steps, you will have unclear acceptance criteria, such as "the customer likes it." Performing the quality management process well helps you avoid many issues later in the project.

The following should help you understand how each part of quality management fits into the overall project management process.

The Quality Management Process	Done During
Plan Quality Management	Planning process group
Manage Quality	Executing process group
Control Quality	Monitoring and controlling process group

ECO Domain II: Process
Task 7: Plan and Manage Quality of Products/Deliverables

These tables indicate that the *PMBOK® Guide* process maps directly to the *Examination Content Outline* (ECO) domain 2 task 7 (Plan and Manage Quality of Products/Deliverables). In addition, when managing procurements, you will need to ensure that the seller's project manager has the same understanding of the quality process. The procurement process from the *PMBOK® Guide* and ECO domain 2 task 11 (Plan and Manage Procurement) would impact the quality management process as well. Can you see how other tasks from domain 2 can affect quality management, like stakeholder engagement and communications? What if two team members disagree on how to approach building a deliverable? The quality management plan needs to reflect the best, agreed upon and bought-into approach. People (domain 1) tasks and the skills needed to come to the best solution are invaluable, like conflict management and team leadership. Negotiation and team-building skills also support the best quality management plans and overall quality control. Take time now to review the ECO and think about these connections.

Before we start discussing these processes further, let's look at some basic quality management concepts that you should understand for the exam.

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Definition of Quality What is quality? Quality is defined as the degree to which the project fulfills requirements. Nothing more, nothing less. Memorize this definition; it may help you get more questions right on the exam.

Here is a story about quality. A student in one of RMC's classes looked out the window during class and noticed someone painting the limestone of an old building white. The student said, "That is not quality!" Let's think about the student's statement for a moment. Why would such painting not be "quality"? If the painting contract required the painter to use a certain kind of paint and follow painting standards, and he was doing so, the work met the quality requirements. The issue the student really had was that the wonderful old stone was being painted instead of cleaned. In other words, this was a disagreement with the requirements, not the quality of the work.

Let's examine another example of an issue with requirements. Imagine a project in which a large group of truck drivers are required to use tablets with touch-sensitive screens. Prior to fleet deployment and during the test process, the project manager received the following comments in relation to some back-and-forth exchanges between the product owner and the drivers: "Give it here, look, like this, you don't need to tap the screen so hard..." and "It's not doing anything, it doesn't work." The project manager realized the truck drivers' hands were too rough and calloused for the capacitive touchscreens to work correctly. Here, the requirements were gathered and initial development had been done with the product owner alone, who has knowledge and understanding of supply chain and logistics, but did not have direct experience with drivers, who might have been able to provide insight relating to touchscreen technology during requirements gathering.

Let's review the definition of quality again: the degree to which the project fulfills requirements. In a plan-driven, or predictive environment, can you achieve quality if you do not have all the stated and unstated requirements defined in the project scope statement and requirements documentation? Of course not. This makes the requirements-gathering effort, the requirements documentation, and the project scope statement very important to the quality management effort. In a change-driven, or adaptive environment a project manager would capture quality requirements and acceptance criteria in user stories. As user stories are prioritized, quality efforts will be planned in detail for releases and iterations. Short, time-boxed iterations ensure frequent retrospectives and daily stand-up meetings provide frequent opportunities to identify and rectify quality issues. In either case, you must be sure to have all stakeholders represented in the requirements-gathering process.

You may see situational questions on the exam that use the term "grade" in discussing quality. Grade and quality are not the same concepts. Whereas quality is the degree to which a project (or deliverable) fulfills requirements, grade refers to a general category or classification of a deliverable or resource that indicates common function but varying technical specifications. For example, a low grade of concrete that supports limited weight might be sufficient for a project's needs and could be of acceptable quality if it meets the established quality requirements, such as having zero defects. Likewise, a high grade of concrete intended to sustain more weight could be of unacceptable quality if it is mixed or poured to low standards, or otherwise fails to meet the established quality metrics.

Definition of Quality Management Quality management includes creating and following organizational policies and procedures and tailoring them to ensure the project also meets the needs of the customer. We could also say it means ensuring a project is completed in compliance with the project requirements. Quality management includes the processes of Plan Quality Management, Manage Quality, and Control Quality.

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TRICKS OF THE TRADE

Quality-Related PMI-isms Quality-related questions can be confusing because many of the topics on the exam are not covered in the *PMBOK® Guide*. The exam may test your understanding of the need to satisfy project requirements as opposed to giving the customer extras. Apply this approach to quality management in order to answer exam questions correctly. Know the following PMI-isms related to quality:

- Quality means meeting requirements, not adding extras.
- Quality should be checked before an activity or work package is completed.
- Quality should be considered whenever there is a change to any of the project constraints.
- Some quality activities may be performed by a quality department.
- The project manager should :
  - Determine the metrics to be used to measure quality before the project work begins.
  - Define quality management processes for the project and have a plan for continuous improvement.
  - Recommend improvements to the organization's standards, policies, and processes, which are expected and welcomed by management.
  - Ensure that authorized approaches and processes are followed.
  - Ensure the quality standards and processes on the project are adequate to meet quality requirements.

Quality Management in the Real World Many people getting ready for this exam have limited quality management experience, so they struggle with envisioning how quality management efforts fit into managing a project in the real world. The following scenario, along with the diagram in figure 8.1, will help clarify these concepts:

1. The customer determines their requirements.
2. The project team clarifies those requirements.
3. The project team defines what work will be done to meet those requirements (project scope).
4. The project manager determines the existing standards, policies, and procedures that might be available for the project. The quality department might assist in identifying the relevant standards.
5. The project manager creates other standards and processes that may be needed.
6. The project manager develops the quality management plan, encompassing relevant standards and processes.
7. The project manager integrates quality with other knowledge area plans to get an approved project management plan.
8. The team begins executing the project management plan.
   - 8a. The team or the quality department audits the project work periodically as part of the executing process, looking for indications that the standards, policies, plans, and procedures are not being followed or need to be changed. (Manage Quality)
   - 8b. The team or the quality department evaluates the quality of project deliverables against planned metrics and standards. (Control Quality)
   - 8c. Results are analyzed.
9. Deliverables are verified.
10. Lessons learned are documented and shared.
11. Change requests, including corrective and preventive action and defect repair, are sent to integrated change control.

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12. Change requests, including corrective and preventive action and defect repair, are approved or rejected in integrated change control.
13. The team adjusts plans as needed to accommodate approved or rejected changes and returns to step 8 until project deliverables are complete and verified.
14. New organizational process assets, including lessons learned, are shared with the organization.
15. Verified deliverables are accepted by the customer, the project is completed, quality targets are reached, and the customer is happy.

The quality management process is represented by the shaded area of figure 8.1.

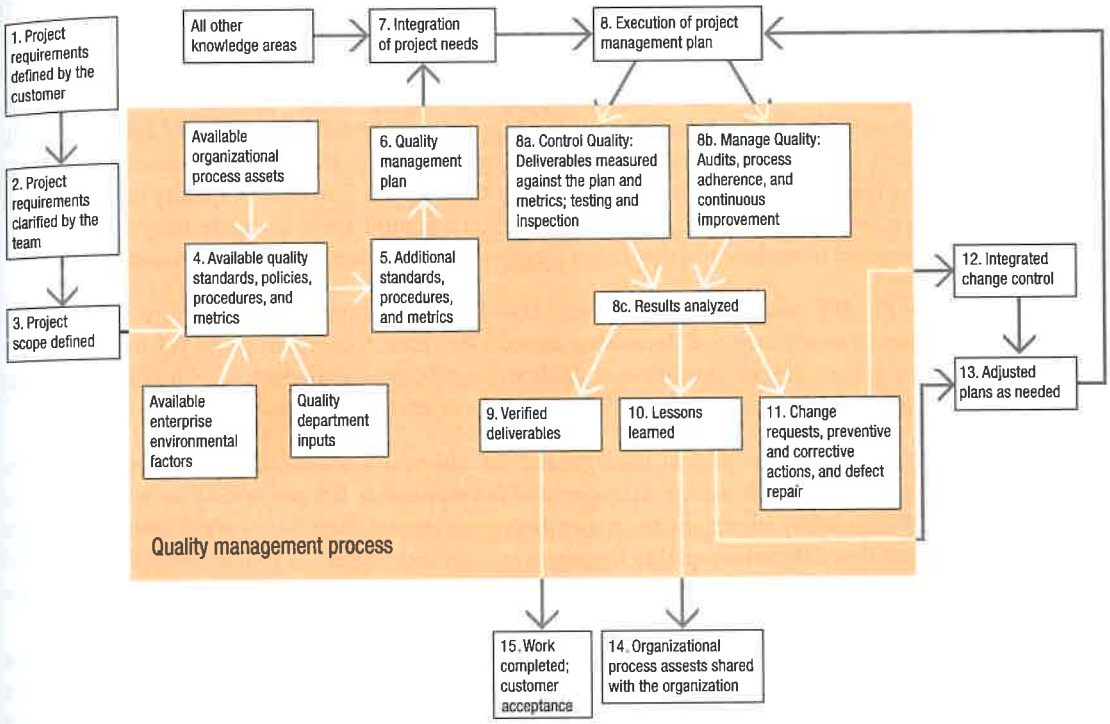

FIGURE 8.1 *Quality management*

Gold Plating[1] Do you remember a time on a project when one of your team members delivered more than what was needed? Can you think of a time when you've had trouble keeping a project from producing the Taj Mahal when all you needed was a garage, for example? Gold plating refers to giving the customer extras (extra functionality, higher-quality components, extra scope, or better performance). Gold plating is often the team's impression of what is valued by the customer, and the customer might not agree. Since most projects have difficulty meeting the project objectives, all available effort should go into achieving those objectives, instead of into gold plating.

Sometimes gold plating is not planned, but rather arises out of a team member's efforts to do their best. The project manager must be on the lookout for team members providing more than is required for the project.

Prevention over Inspection Is it better to inspect work to find problems or to prevent them in the first place? Which takes less effort and is less costly? Remember that quality must be planned in, not inspected in! The concept of prevention over inspection was advocated by quality theorist Philip Crosby. You may see exam questions that test your understanding that failure to plan quality into a project will lead to problems later in the project.

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Continuous Improvement Continuous improvement involves continuously looking for ways to improve the quality of work, processes, and results. Within an organization it can include analysis of how quality management is planned and utilized on projects. There are several approaches to continuous improvement relevant to the exam.

- **Kaizen**[2] The terms "continuous improvement" and "Kaizen" are taken to mean the same thing on the exam; however, in Japan, Kaizen means to alter (kai) and make better or improve (zen). Kaizen is a general term, while continuous improvement is a quality movement. In the United States and most of Western Europe, continuous improvement focuses on major improvements. In Japan, the emphasis is on smaller improvements.
- **Total Quality Management (TQM)**[3] TQM encourages companies and their employees to focus on finding ways to continuously improve the quality of their products and their business practices at every level of the organization.
- **Six Sigma**[4] This is a methodology for achieving organizational process improvement and high levels of correctness with extremely reduced variances. Sigma (another name for standard deviation) indicates how much variance from the mean has been established as permissible in a process. The higher the sigma, the fewer deviations (or less variance) in the process. The level of quality required by an organization is usually represented by 3 or 6 sigma. You will not have to calculate standard deviation, but will be required to understand that larger ranges represent more deviations (or more variance).

Just in Time (JIT)[5] JIT means having suppliers deliver resources just before they are needed, thus decreasing inventory to nearly zero and decreasing unnecessary cost. A company using JIT must achieve a high level of quality in their practices; otherwise, there will not be enough materials or equipment to meet requirements because of waste and rework. A JIT system forces attention on quality as well as schedule.

Responsibility for Quality The project manager has the ultimate accountability for the quality of the product of the project, although senior management is responsible for promoting an organizational approach that supports quality efforts and team members must inspect their own work. This often includes a quality department that determines quality management methodologies the project manager is required to follow. Work should meet the project requirements, and testing should be done whenever appropriate before submitting the work.

Quality problems on a project are typically attributable to the management environment and the system in which the team works. Therefore, senior management is responsible for promoting an organizational approach that supports quality efforts. This often includes a quality department that determines quality management methodologies the project manager is required to follow.

Understanding the Differences between Plan, Manage, and Control Quality One of the major challenges people have while studying this topic is understanding the differences between Plan, Manage, and Control Quality. Some of this confusion may be a result of differences between the ECO and the *PMBOK® Guide*.

Remember that the current ECO doesn't have three distinct quality processes. Domain 2 task 7 states that you plan and manage the quality of products and/or deliverables. The *PMBOK® Guide*, however, specifies three quality processes:

- **Plan Quality Management** This process focuses on defining quality for the project, the product, and project management, and planning how it will be achieved.
- **Manage Quality** The Manage Quality process is focused on how work is being done. Its purpose is to ensure the team is following organizational standards, policies, and processes as planned to produce the project's deliverables. The project manager also evaluates whether the quality management plan or processes need to be improved.
- **Control Quality** Control Quality includes examining the actual deliverables produced on the project to ensure they are correct and meet the planned level of quality, evaluating variances, finding the source of problems, and recommending ways to address them.

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TRICKS OF THE TRADE The following chart presents a trick for understanding the three quality management processes. Study it now to gain a clearer understanding of the focuses of each process before reading the rest of this chapter. In the detailed descriptions, you will see combinations of actions and outputs. Can you spot them? You may want to review this chart after you read the in-depth discussions of each of the processes.

Plan Quality Management	Manage Quality	Control Quality
	Process Group	
Project planning	Project executing	Project monitoring and controlling
High-Level Description of What Each Process Focuses On		
• What is quality? • How will we ensure it?	• Are we following the policies, metrics, procedures, and processes as planned? • Are the procedures and processes giving us the intended results? • Will we meet the quality objectives?	• Are the results of our work meeting the standards and required metrics? • Is the variance within acceptable limits, or do we have to take action?
More Detailed Description of What Each Process Focuses On		
• Review management plans and project documents to understand quality requirements on the project. • Identify quality practices as well as internal and external standards relevant to the product, project, and project management efforts (OPAs and EEFs). • Create additional project-specific processes, standards, and metrics. • Determine the processes that will be used on the project.	• Use measurements from Control Quality to confirm that: – Policies and processes are being followed. – Policies, metrics, and processes are still appropriate for the project. – Policies and processes are effective in achieving planned quality results. • Use data-representation techniques to analyze results of quality testing. • Determine the root cause of quality problems/variances from plan.	• Inspect and measure the quality of deliverables to determine whether they meet requirements. • Use the PMIS to track deviations from planned quality. • Identify the need for quality improvements (corrective or preventive action, and defect repair). • Complete checklists and checksheets, perform tests, and evaluate results. • Graphically document results of testing and evaluation using data-representation techniques.
• Determine what work you will do to meet the standards. • Determine how you will measure to make sure you meet the standards. • Plan for process improvement.	• Perform continuous improvement to increase efficiency and effectiveness. • Create test and evaluation documents for use in Control Quality.	• Verify deliverables. • Validate approved changes. • Recommend improvements to testing processes.

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Plan Quality Management	Manage Quality	Control Quality
More Detailed Description of What Each Process Focuses On		
• Perform cost of quality, cost-benefit, and other analysis work to make certain the appropriate level of quality will be planned in. • Determine roles and responsibilities for achieving quality requirements and objectives. • Plan for testing and inspection to check that requirements, performance, reliability, and quality goals and objectives are achieved. • Interface the quality management plan with other management plans to balance the needs of quality with scope, cost, time, risk, resources, and customer satisfaction requirements. • Finalize a quality management plan as part of the project management plan.	• Determine if project activities comply with organizational and project policies, processes, and procedures—perform a quality audit. • Solve problems. • Produce reports. • Share good practices with others in the organization. • Submit change requests. • Update the project management plan and project documents.	• Use and update lessons learned. • Submit change requests. • Update the project management plan and project documents.

Plan Quality Management PAGE 277

PMBOK® Guide
PG: Planning
Process: Plan Quality Management

ECO
Domain: II
Task: 7

The objectives of the Plan Quality Management process are to identify all relevant organizational or industry practices, standards, and requirements for the quality of the project and its product, and then to plan how to meet those standards and requirements. The main outcome of this process is a quality management plan.

The level of quality efforts should be appropriate to the needs of the project and quality must be balanced with the other project constraints. That sounds easy, right? Often it is not. In many organizations, practices are not standardized. If this is true on your projects, take some time now to imagine what standardized practices would be ideal for your projects and how they might be helpful to you.

Standardization can come from within the organization or from an external resource. The performing organization or the project may adopt these practices as they apply to the work of the project. As part of planning quality management, the project manager needs to look for any such standards that will help the project achieve the required level of quality. Other available external standards include ISO 9000[6] (from the International Organization for Standardization), OSHA (from the Occupational Safety and Health

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Administration), and the United Nations Convention on Contracts for International Sale of Goods (CISG).[7]

As an example, a construction company could establish a standardized practice for installations on home construction projects. Imagine all the installers within that organization putting together their best ideas to improve the installation work on future projects. That would be a valuable effort that could improve quality and safety while saving time and money.

Inputs to Plan Quality Management Organizational process assets can help identify relevant standards, policies, and procedures and include lessons learned from previous projects. A project manager may create additional project-specific standards and procedures that are needed on how quality is defined for each piece of work. For the exam, you should understand that this effort could also include defining processes for how project management activities should be done, and suggesting improvements to existing processes.

The customer's quality standards might be outlined in an agreement (contract) or need to be discovered as part of the Collect Requirements process. Quality requirements are documented, analyzed, and prioritized according to the requirements management plan. Examples of such standards are the acceptable number of software bugs per module, the strength of concrete, or the average time per installation. These measures of quality will later be used to manage and control quality.

Management plans and documentation that aid in quality planning include the stakeholder engagement plan and stakeholder register, a list of the major project deliverables (requirements management plan), risk thresholds (risk management plan), and approval requirements (project charter). The scope baseline helps the project manager maintain the proper perspective and plan quality to the appropriate level. The assumption log provides insight into the level of quality that is assumed to be acceptable on the project. The requirements traceability matrix shows the origin of requirements related to quality and will be used to confirm that quality requirements, including external compliance requirements, have been achieved.

Outcomes of Plan Quality Management Remember that the purpose of planning quality management is to determine what quality is for a particular project and to create a plan to deliver that level of quality. Most quality management plans include the standard practices already discussed, along with who will help lead the quality management effort, what their duties are and what processes they will follow. Meetings to hold, reports and metrics that will be used are included, along with what parts of the project or deliverables will be measured and at what intervals. Strategies for analysis and improvement of processes and procedures are included in the quality management plan.

Throughout this book, there is an underlying theme that the project manager must know how the project is performing compared to what was planned and be able to determine when to request changes. The only way to effectively do this is to determine metrics in advance and (in most cases) decide what range of variation is acceptable. The following are some examples of quality metrics:

- The number of changes (to help measure the quality of the project management planning process)
- The variance related to resources utilization
- The number of items that fail inspection
- The variance of the weight of a product produced by the project compared to the planned weight
- The number of bugs found in software that is being developed as part of the project

Planning quality management will also result in iterations of other project management artifacts. For example, quality management work added to the project is documented in the scope baseline (WBS and WBS dictionary) as well as in the requirements traceability matrix, and may necessitate adjustments to the project activity list, schedule, budget, and resource assignments. Risks related to quality may be added to the risk register, and risk management added to the project management plan.

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Manage Quality PAGE 288

PMBOK® Guide
PG: Executing
Process: Manage Quality

ECO
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A project manager should manage and control quality while the project work is being done. A group outside the project team, such as a quality department, often helps with this work on a project. The efforts of this process focus on making certain that the project work, the processes followed, and the deliverables that are produced conform to the quality management plan. Manage Quality focuses on processes and procedures while Control Quality focuses on the deliverables.

Cost of conformance to quality is listed among the tools of quality covered later in this chapter. This refers to the work of managing and controlling quality; for example, quality training, measuring interim deliverables, and ensuring the project team understands and follows the accepted processes.

Processes to ensure quality standards will be met are reviewed to make sure they are effective and are being followed correctly. Quality audits, failure analysis, and design of experiments (described later in this chapter) may be done to see if the quality management plan standards, metrics, processes, and procedures may need to change.

In Manage Quality, test and evaluation documents are prepared for use in Control Quality. In turn, this process analyzes measurements gathered in Control Quality and uses the quality management plan, including quality requirements, to answer the following questions:

- Are we following the procedures and processes as planned?
- Are the quality requirements, organizational policies, and processes identified in the quality management plan giving us the results we intended?
- Can the processes and procedures be improved? How can we increase efficiency and prevent problems?
- Based on what we know now, is the work we planned the right quality work for this project and the right work to meet customer requirements?

The process of managing quality also includes evaluating all aspects of the product design to confirm that the end result will meet quality requirements and identifying possible improvements to the design. For tools and techniques of Manage Quality, see the tools and techniques section later in this chapter.

Outputs of Manage Quality Test and evaluation documents for use in Control Quality, such as control charts, checklists, and test plans provide a format with which to evaluate whether quality objectives have been met. Project documents such as a requirements traceability matrix may also be updated here. Quality reports interpret and document the results of both Manage and Control Quality activities. They can present information in different formats and are used to identify necessary changes to plans, policies, and processes (for Manage Quality) and to the product (for Control Quality) to ensure that quality requirements will be met throughout the life of a project.

Control Quality PAGE 298

PMBOK® Guide
PG: Monitoring and Controlling
Process: Control Quality

ECO
Domain: II
Task: 7

Control Quality addresses the quality of the product, service, or result of a project. Control means measure, and that is the major function of this process. Aspects of products, services, or results are measured to determine whether they meet the quality standards. This process helps ensure customer acceptance, as it involves confirming and documenting the achievement of agreed-upon requirements.

Inputs to this process include the quality management plan, quality metrics (agreed-upon measures of quality developed in planning), test and evaluation documents (developed in Manage Quality), work performance data and deliverables (from Direct and Manage Project Work in integration management), approved change requests from integrated change control, and project documents.

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Although a project manager and the team must be involved and concerned about quality control, a quality department may complete much of this work in large companies. The department then informs the project manager about quality issues through change requests, which are accompanied by any necessary documentation and reports to detail the quality issues. The project manager must be able to read and understand quality measurement reports.

It is during Control Quality that the height of doors in a manufacturing process or the number of bugs per module will be measured. Quality control helps answer the following questions:

- Are the results of our work meeting agreed-upon standards and thereby meeting requirements?
- What are the actual variances from the standards?
- Are the variances from standards or processes within acceptable limits?
- What changes in the project should be considered?

Outcomes of Control Quality Outputs include measurements, work performance information, verified deliverables and possibly change requests as well as updates to the quality management plan, issue log, test and evaluation documents, lessons learned, and the risk register.

To better understand questions relating to Control Quality, you should be familiar with the following terms.

- **Mutual Exclusivity** The exam may reference statistical terms such as "mutual exclusivity." Two events are said to be mutually exclusive if they cannot both occur in a single trial. For example, flipping a coin once cannot result in both a head and a tail.
- **Probability** This term refers to the likelihood that something will occur. Probability is usually expressed as a decimal or a fraction.
- **Normal Distribution** A normal distribution is the most common probability density distribution chart. It is in the shape of a bell curve and used to measure variations (see the example in Exercise 8.1 in this chapter).
- **Statistical Independence** Statistical independence means the probability of one event occurring does not affect the probability of another event occurring. For example, the probability of rolling a six on a die is statistically independent from the probability of getting a five on the next roll.
- **Standard Deviation (or Sigma)** As we've already discussed, one measure of a range is its standard deviation. It denotes what would be considered a statistically stable process or output. This concept is also sometimes stated as a measure of how far you are from the mean (not the median). (Remember (P – O)/6 is the beta distribution formula for standard deviation, using pessimistic and optimistic estimates, as described in the "Schedule" chapter.)

Quality Management Tools and Techniques

Understanding both predictive and adaptive tools and techniques for quality management can help you get several questions right on the exam. The tools and techniqes used to manage quality have been combined in this section to make it easier for you to understand them and to distinguish what tools are used in each of the three quality management processes in the *PMBOK® Guide*. Notice that some tools and techniques can be used in more than one quality process, and pay special attention to the agile tools as they can be used to tailor the overall process of quality management.

PMBOK® Guide
PG: Monitoring and Controlling
Process: Control Quality

Planning Quality Tools and Techniques The following tools and techniques are used for quality management planning. Note that meetings can be used for any process.

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Interviews, Brainstorming, and Benchmarking[8] You may recall learning about these techniques in the "Scope" chapter. Interviews and brainstorming can help identify appropriate ways to measure quality and the metrics or processes to be used. Benchmarking is utilized to review methodologies used by comparable projects or organizations to establish quality metrics and acceptable variance ranges, and to measure quality.

Decision-making An important aspect of planning is determining priorities and choosing between options. For planning, key decisions might include selecting the most critical metrics or prioritizing quality requirements. Decision-making tools and techniques for planning quality include multicriteria decision analysis and prioritization matrices.

Cost-Benefit Analysis[9] Using this data analysis technique, the project manager analyzes the benefits versus the costs of quality efforts to determine the appropriate quality level and requirements for the project. As noted in the "Integration" chapter, this technique can also be used in project selection and in other planning efforts, including assessing the costs and benefits of potential risk responses.

The exam will test your knowledge about the effects of quality efforts, or the lack thereof. Note that if you have poor quality, you might also have increased costs, decreased profits, low morale, low customer satisfaction, increased risk, and rework. These possibilities make the cost-benefit analysis and cost of quality important tools for consideration.

Cost of Quality (COQ)[10] Evaluating the cost of quality means making sure the project is not spending too much to achieve a particular level of quality. It involves looking at what the costs of conformance and non-conformance[11] to quality will be on the project and creating an appropriate balance. The following table provides some examples of the costs of conformance and nonconformance to quality.

Cost of Conformance	Cost of Nonconformance
Quality training	Rework of deliverables not meeting quality standards
Studies	Scrap
Measuring quality of interim deliverables	Inventory costs
Customer satisfaction surveys (and work to respond to issues raised)	Warranty costs
Efforts to ensure everyone knows the processes to use to complete their work	Lost business

Cost of quality is planned and then monitored and measured throughout the project life cycle. A term related to this concept is marginal analysis,[12] which is focused on finding the point at which the benefits or revenue to be received from improving quality equals the cost to achieve it. Sometimes added attention to quality does not produce added value. When that point is reached, you stop trying to improve quality.

Logical Data Models The logical data model can be presented using an entity relationship diagram—a method of representing and analyzing data. A logical data model contains a description of the quality needs of the project. It is used to understand the requirements, clarify business rules, and define processes. It can be used to create and refine quality plans that best meet the needs of the project.

Matrix Diagrams[13] A matrix diagram is a visual representation of the relationship between two or more sets of items. In planning, matrix diagrams can be used to sort quality requirements and identify those that are most critical to the project. Appropriate metrics may then be planned to track and measure project progress. Examples of matrix diagrams follow:

- A prioritization matrix can numerically rank available options and is useful for decision analysis about quality management plan components (organizational policies, processes requirements).
- The probability and impact matrix shown in the "Risk" chapter as a tool of qualitative risk analysis.

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Mind Mapping As discussed in the "Scope" chapter, a mind map is a diagram of ideas or notes to help generate, classify, or record information. It is used here to facilitate the gathering of quality requirements and illustrate their impacts on other parts of project planning.

Flowcharts Flowcharts may also be referred to as process flows or process maps, and can be used in many parts of project management. They show how a process or system flows from beginning to end, how the elements interrelate, alternative paths the process can take, and how the process translates inputs into outputs. Flowcharts can be planned in to be used to:

- Show the connections between the supplier, input, process, output, and customer in a process (called the SIPOC model).
- Help determine the cost of quality by mapping the expected monetary value of pursuing paths of conformance and nonconformance to quality.
- Determine how processes will be measured for conformance and effectiveness.
- Define and communicate processes that will be used on the project.

You can also use this flowcharting in planning to visualize a process and find potential quality problems or quality control issues. Imagine that work results are passed to four departments for approval. Might this lead to quality problems? What about an unfinished, fragile product in a manufacturing environment? Would the quality of the product be reduced if it needed to be passed by hand from person to person?

A generic example of a flowchart is shown in figure 8.2.

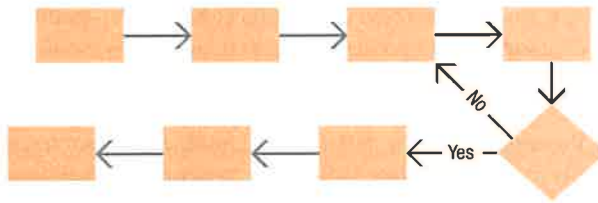

FIGURE 8.2 *Flowchart*

Test and Inspection Planning Planning quality in includes determining how the team will confirm that the required level of quality has been achieved in the completed project deliverables, as well as how the deliverables will be evaluated for performance and reliability. Testing methods, which vary depending upon the type of product, service, or result being created by the project, are used to control quality. The quality management plan is created to prevent quality issues.

Manage Quality Tools and Techniques

The following are tools and techniques of Manage Quality in the *PMBOK® Guide*.

Checklist A checklistcan be used to confirm that the steps of a process have all been completed. It may also be used to analyze defects discovered in quality inspections, looking for issues within the process, and to assess whether a deliverable meets the acceptance criteria.

Cause-and-Effect (Fishbone, Ishikawa, or Why-Why) Diagrams[14] A team can use cause-and-effect diagrams to confirm that policies and procedures are being followed and that metrics are being used correctly, and that they were adequate to produce the required level of quality in project deliverables. Figure 8.4 is an example of a cause-and-effect diagram.

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Histograms[15] In this process, histograms are used to analyze the type and frequency of defects in order to identify where the quality plan and processes may need improvement as the project progresses. Figure 8.5 and figure 8.6 are examples of histograms.

Scatter Diagrams[16] This diagram tracks two variables to determine their relationship to the quality of the results. Figure 8.7 shows three examples of scatter diagrams.

Document Analysis Document analysis involves reviewing the results of testing and other quality reports to identify ways in which the quality management plan and processes may not be supporting the production of deliverables that meet the project quality requirements.

Alternatives Analysis It is important to consider all the ways to solve an issue or problem. In Manage Quality, alternatives analysis may be used to evaluate which action would best impact the results of quality management efforts or processes. For example, would a new automated testing tool be more beneficial than redefining the testing process?

Design of Experiments (DOE)[17] This technique can be used for alternatives analysis and can quickly discover optimal conditions in which to produce a quality deliverable. Experimentation is performed to determine statistically what variables will improve quality. For example, DOE can be used to look for ways to deliver the same level of quality for less cost. DOE is a fast and accurate technique that allows you to systematically change the important factors in a process and see which combinations have an optimal impact on the project deliverables. For example, designers might use DOE to determine which combination of materials, structure, and construction will produce the highest-quality product. Performing individual experiments for each variable in a process to assess their impacts on quality can be time-consuming and can overlook interactions among variables.

Process Analysis[18] Process analysis is part of the continuous improvement effort and focuses on identifying improvements that might be needed in project processes. Have you ever worked on a project where some of the activities or work packages were repeated? This often happens when projects have multiple installations, such as a project to install software onto hundreds of computers. The lessons learned on the first few installations are used to improve the process for the remaining installations. Though this often happens naturally, planning it into certain points in the project improves results.

Root Cause Analysis Root cause analysis in Manage Quality seeks to identify the processes, procedures, and policies within the plan that may not be working or that may need adjustment. Identifying the root cause of a quality problem or defect helps the team determine how to prevent it from recurring.

Failure analysis This is a specific type of root cause analysis. It analyzes failed components of deliverables or failed processes to determine what led to that failure. Corrective action or change requests are likely outcomes of this type of analysis.

Multicriteria Decision Analysis The project manager must facilitate a number of decisions regarding quality. A decision-making technique, multicriteria decision analysis is a complex method of numerically assessing options based on criteria such as time, cost, and quality. It can be used throughout a project to help the team reach agreement regarding the best way to solve a problem or improve quality. In Manage Quality, the team may use this technique when considering whether to adjust the quality management plan or specific processes or procedures. A prioritization matrix (described earlier under Matrix Diagrams) is a simpler decision-making technique.

Flowcharts[19] In Manage Quality, flowcharts may be used to study the steps of a process leading to a quality defect. This analysis might uncover confusion among the team or point out ways the process needs to be adjusted to make it more effective.

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Affinity Diagrams We first saw this technique in the Collect Requirements process. In Manage Quality, affinity diagrams can help you organize and group the results of root cause analysis. For example, in Control Quality you may have determined the cause of a variance, product defect, or a deliverable not meeting requirements. You can use this information in the Manage Quality process to determine whether a change to the policies, procedures, and standards in the quality management plan would best address the root cause of the problems.

Audits Imagine a team of auditors walking into your office one day to check up on you and the project. Their job is to see if you are complying with company policies, processes, practices as defined in the quality management plan, and to determine whether those being used are efficient and effective. This scenario represents a quality audit. Do not think of a quality audit as a negative event. Instead, a good quality audit will look for new lessons learned and effective practices that your project can contribute to the performing organization. The work of a project is not only to produce the product of the project; it could also contribute to the best practices within the organization, making the organization better.

If you do not have a team of auditors from the quality department coming to see you on your projects, do you take on the responsibility of looking for opportunities to identify lessons learned and best practices on your projects? Although quality audits are usually done by the quality department, the project manager can lead this effort if the performing organization does not have such a department.

Design for X Design for X is another way of analyzing variables to evaluate both the effectiveness of the quality management plan and the team's ability to meet objectives. The X in the name can represent an attribute of quality, such as reliability, security, or serviceability. If the plan is not delivering the intended results in relation to the variable being analyzed, Design for X can help determine what changes or adjustments are needed.

Problem-Solving Think of how important this technique might be when you encounter quality problems. Gaining a good understanding of the real problem is the first step towards finding an effective and long-lasting solution. Problem-solving can be used when considering quality improvements or to determine how best to respond to deficiencies identified in quality audits.

The following are the steps used to analyze quality (and other) problems:

1. Define the real or root problem—not what is presented to you or what appears to be the problem.
2. Analyze the problem.
3. Identify solutions.
4. Pick a solution.
5. Implement a solution.
6. Review the solution, and confirm that the solution solved the problem.

Control Quality Tools and Techniques There are many tools and techniques that may be used to control quality. Regardless of the method used, the ultimate goal is to test (verify) that each deliverable meets the metrics and requirements as stated in the plan, including the customer's acceptance criteria, and that it is ready to move to the Validate Scope process.

Checklists Information about the quality of interim deliverables can be gathered using quality checklists. A quality checklist can be a list of items to inspect, a list of steps to be performed, or a picture of the item to be inspected, with space to note any defects found.

In Control Quality, checklists are used to determine that all required features and functions are included, and that they meet acceptance criteria. Checklists may be part of the test and evaluation documents created in Manage Quality.

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Checksheets A checksheet is a type of checklist that can be used to keep track of data, such as quality problems uncovered during inspections, as well as to document how often a particular defect occurs, as illustrated in figure 8.3.

Defect	Frequency
Too long	~~||||~~ ||
Too narrow	|||
Too wide	~~||||~~ |||
Too short	||

FIGURE 8.3 *Checksheet*

Statistical Sampling Let's think about the process of manufacturing doors. There would likely be some allowable variation in the height and weight of the doors being manufactured. Even so, the doors must be checked to see if they meet quality standards on the project. What if inspecting each door would cause damage or take too much time? Then you may need to take a statistically valid sample. It is best to take a sample of a population if you believe there are not many defects, or if studying the entire population would take too long, cost too much, or be too destructive.

The sample size and frequency of measurements are determined in planning; the sampling is done in control. Keep in mind that statistical sampling can also be done for project management activities. For example, you may initially check the on-time status for 5 out of 50 of a group's activities. If you find issues in those 5, you can assume there will be more issues in the remaining 45 activities.

Questionnaires and Surveys Questionnaires and surveys may be used in Control Quality to gather data on details of problems or defects, or to confirm that customers or end users are satisfied with deliverables that have been deployed on the project. The results can be used to determine whether conformance to quality has been achieved.

Performance Reviews The project manager or quality department may conduct periodic performance reviews to formally assess how the project is doing in terms of meeting quality requirements. Such a review involves comparing the results of control measurements to metrics identified in the quality management plan. It may bring to light changes necessary to achieve quality requirements.

Root Cause Analysis Root cause analysis is used to identify the cause of quality problems, including defects, to determine how they can be remedied.

Inspection Inspections are used to verify that deliverables meet the requirements. Inspections may be referred to as walkthroughs and generally include measurement of project deliverables. Checklists and control charts may be used to capture the data. Inspections are also used to check that previously approved changes have been made correctly, and that the changes have provided the intended results (validated changes).

Control Charts[20] Control charts are established in Manage Quality, and the parameters such as the mean, specification limits, and control limits (all defined later in this section) are determined. Control charts are used in Control Quality to help determine if the results of a process are within acceptable limits.

To better understand the need for control charts, imagine a door manufacturer is undertaking a project to create a new production line. To make sure the production facility will create doors that meet quality standards, it's essential to monitor the processes and output so the new production line can become an ongoing business operation. Would each door be the same exact height? Weight? Not likely. Instead

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there is a range, however small, that is acceptable. Each door should be within the range of normal and acceptable limits.

During the Control Quality process, samples are taken and plotted on the chart (see the small squares shown on the control chart in Exercise 8.1). The control chart shows whether the samples are within acceptable limits. If the data does not fall within the acceptable range, the results are considered to be "out of control," which indicates a problem that needs to be handled.

A control chart can also be used to represent and monitor data on project performance, such as cost and schedule variances.

Now that we have discussed the basic concepts of a control chart, let's look at some of the related terms you should know for the exam. The following can be indicated on a control chart.

Upper and Lower Control Limits[21] Control limits are often shown as two dashed lines and are the acceptable range of variation of a process or measurement's results. Control limits indicate what is stable versus unstable (out of control). Every process is expected to have some variation in its results, as in the door size example. The team and stakeholders determine the appropriate upper and lower control limits for quality metrics. Data points within this range are generally thought of as "in control," excluding the rule of seven (described later in this section) and are an acceptable range of variation. Data points outside this range indicate the process is out of control.

Note that outside of control charts a project manager can have control limits for many things. How about for a work package? Is one hour late in its delivery a problem? How about one day? Control limits help the project manager know when to act.

Mean (Average) The mean is indicated by a line in the middle of the control chart. It shows the middle of the range of acceptable variation. A normal distribution curve represents the acceptable range of variance around a mean, and it falls within the boundaries of the control limits.

Specification Limits[22] While control limits represent the performing organization's standards for quality, specification limits represent the customer's expectations—or the contractual requirements—for performance and quality on the project. Specification limits are characteristics of the measured process and are not inherent. In other words, specification limits are not calculated based on the control chart; instead, they are inputs from the customer. Therefore, they can appear either inside or outside the control limits.

To meet the customer's specification limits, the performing organization's standards for quality (control limits) must be stricter than those of the customer. Agreeing to do a project when your work does not meet the customer's quality standards adds waste and extra management to the project to sort out acceptable items. On the exam, assume that specification limits are outside the upper and lower control limits.

Out of Control The process is out of a state of statistical control under either of two circumstances:

- A data point falls outside of the upper or lower control limit.
- There are nonrandom data points; these may be within the upper and lower control limits, such as the rule of seven (described next).

Think of "out of control" as a lack of consistency and predictability in the process or its results. Also be aware that "out of control" is sometimes referred to as "out of tolerance" and control limits may be called "tolerances" in agile environments.

Rule of Seven[23] The rule of seven is a general rule, or heuristic. It refers to a group or series of nonrandom data points that total seven on one side of the mean. The rule of seven tells you that, although none of these points are outside of the control limits, they are not random and the process is out of control. The project manager should investigate this type of situation and find a cause.

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Assignable Cause/Special Cause Variation[24] An assignable cause or special cause variation signifies that a process is out of control. If there is an assignable cause or special cause variation, it means a data point, or a series of data points, requires investigation to determine the cause of the variation. The project manager could use additional tools, such as a cause-and-effect diagram, to try to uncover the root cause of the variation.

8.1 Exercise Now try this exercise. In your Exercise Notebook, match the items labeled on the control charts (A, B, C, D, etc.) with items 1-10 on the following list. The pictures represent two different control charts. Note that each chart will not have all items from the list, and some of the items labeled on the chart can be an answer more than once on each chart.

When you are able to pick out all the items on the control charts, you should be ready to answer questions about control charts on the exam.

NOTE: The questions on the exam relating to control charts may be easier to answer if you can picture a control chart in your mind. It is unlikely one will be shown to you on the exam. Instead, the exam will use the terms in situational questions, and you will need to know what they mean. (For example: "A team member tells you that one sample is outside the lower control limit. What should you do?"). This exercise is designed to help you visualize control charts and make sure you understand these tools so you can answer questions about them.

Identify the following on the charts:

1. Upper control limit
2. Lower control limit
3. Assignable cause/special cause
4. The process is out of control
5. Normal and expected variation in the process
6. Rule of seven
7. Specification limits
8. Three sigma
9. Six sigma
10. Normal distribution curve

Chart 1:

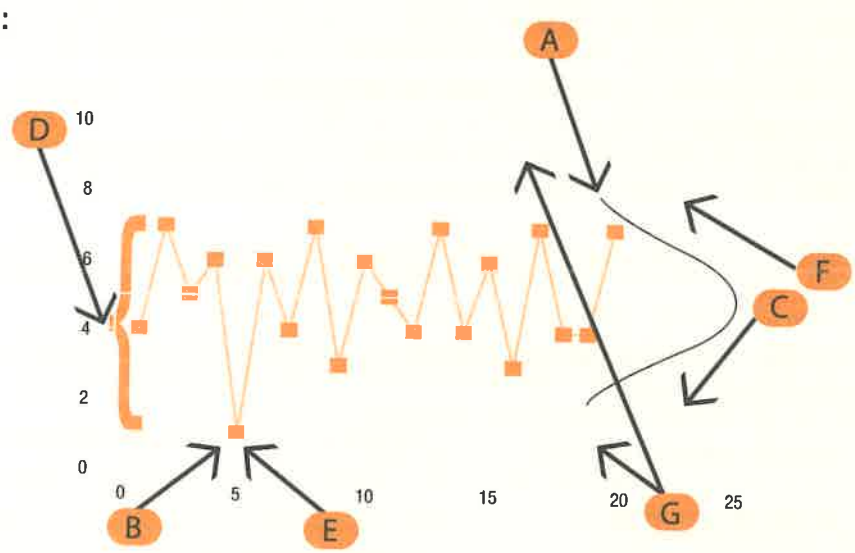

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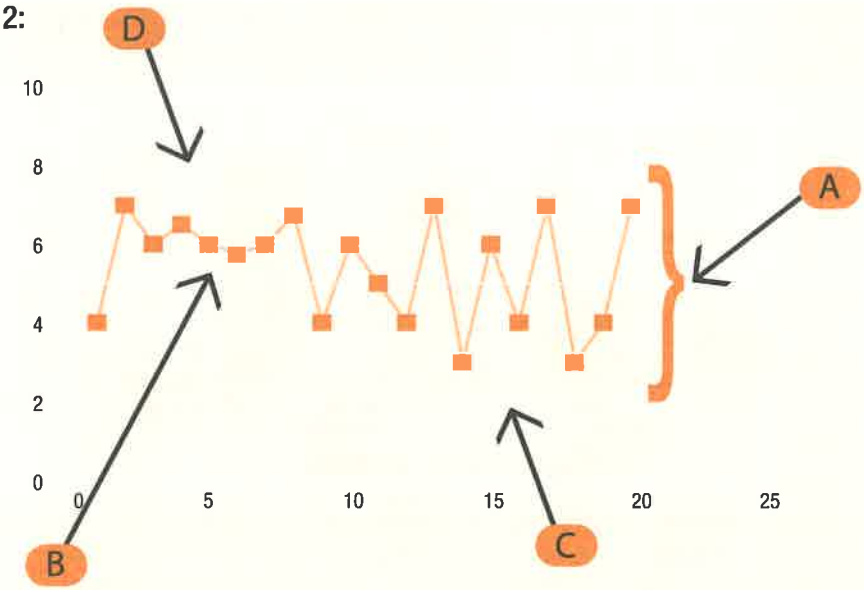
Chart 2:



Answer

Chart 1:

1. F
2. C
3. B
4. E
5. not applicable
6. not applicable
7. G
8. D*
9. D*
10. A

**Answer D is the range between the upper and lower control limits; created based on the company's quality philosophy, usually 3 or 6 sigma.*

Chart 2:

1. D
2. C
3. B
4. B
5. A*
6. B
7. not applicable
8. not applicable
9. not applicable
10. not applicable

** Answer A is the range between the upper and lower control limits on both charts 1 and 2.*

Cause-and-Effect (Fishbone, Ishikawa, or Why-Why) Diagrams Is it better to fix a defect or get to the root cause of the defect? Think about this question for a moment. The answer is that you should do both, and a cause-and-effect diagram can help you. In Manage Quality, we discussed the application of the cause-and-effect diagram in determining the root cause of quality issues relating to plans, processes, or procedures. In Control Quality, this tool can be used to look backward at what may have contributed to quality problems on the project, as well as to analyze the impact of defects on the quality and acceptability of a deliverable.

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Figure 8.4 shows the defect "system will not install" on the right and then lists the potential causes, such as hardware issues, software issues, etc. Various subcauses of each potential cause are also listed in an effort to find the root cause of the defect.

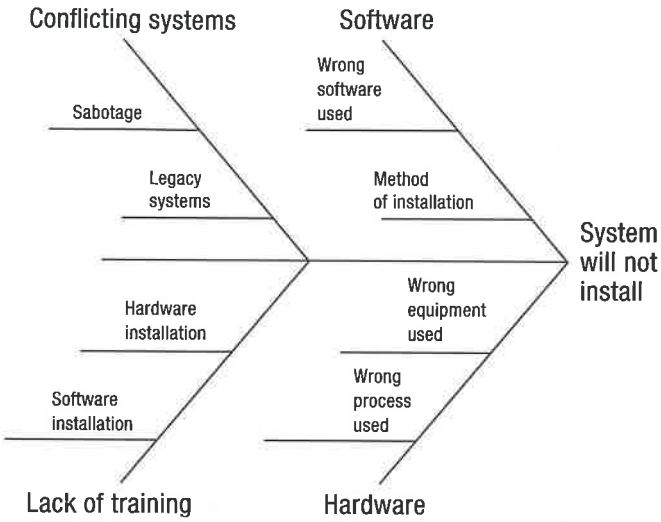

FIGURE 8.4 *Cause-and-effect diagram*

Examples of phrasing the exam may use to describe cause-and-effect diagrams include the following:

- A creative way to look at the causes of a problem
- Helps stimulate thinking, organize thoughts, and generate discussion

Histograms As shown in figure 8.5, a histogram shows data in the form of bars or columns. A typical histogram presents data in no particular order and without reference to time. The results of measurements taken in Control Quality are displayed on a histogram to determine the problems that need the most immediate attention or that are most likely to prevent the project from achieving its quality requirements. The Manage Quality process will analyze these problems and defects to determine if the cause is related to processes or the quality management plan.

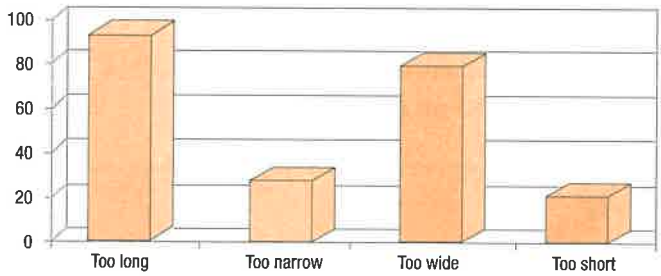

FIGURE 8.5 *Histogram*

Pareto Charts[25] A Pareto diagram or Pareto chart is a commonly used type of histogram that arranges the results from most frequent to least frequent to help identify which root causes are resulting in the most problems. Joseph Juran adapted Vilfredo Pareto's 80/20 rule to create the 80/20 principle (also known as the Pareto Principle), which states that 80 percent of problems are due to 20 percent of the root causes. Addressing the root cause of the most frequent problems makes the greatest impact on quality.

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In planning, you can identify potential problems (using, for example, historical information from past projects) and document them on a Pareto diagram, as shown in figure 8.6. In Control Quality, you measure the data and represent it on the diagram to help analyze the situation and determine where to focus corrective action.

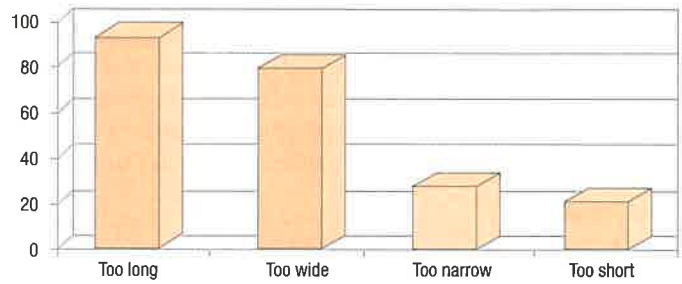

FIGURE 8.6 *Pareto diagram*

Scatter Diagrams As mentioned in Manage Quality, a scatter diagram is used to determine the relationship between variables and the quality of the results. In Control Quality, a scatter diagram can be used to compare actual results to what was anticipated, and to estimate and forecast future outcomes of the process.

A scatter diagram tracks two variables to determine their relationship. Imagine that our door manufacturer has a project to develop a new painted door product line. Scatter diagrams may be used to determine the relationship of independent variables, such as paint quantity, dryer fan speed, and door weight, to the dependent variable of drying time, or to correlate defects to other variables in the process.

A regression line (or trend line) is calculated to show the correlation of variables, and can then be used for estimating and forecasting. Figure 8.7 depicts the possible resulting patterns: a proportional or positive correlation of paint quantity to drying time, an inverse or negative correlation of dryer fan speed to drying time, and no correlation between door weight and drying time.

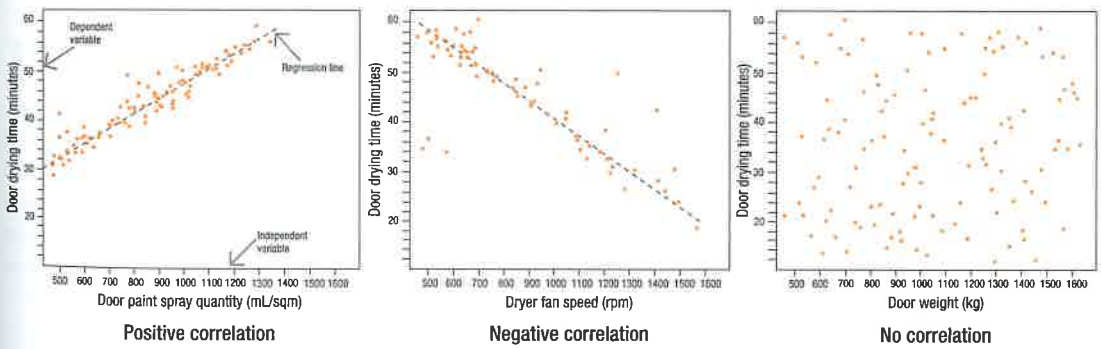

FIGURE 8.7 *Scatter diagrams*

Agile and Hybrid Quality Management Concepts Approaches to quality management are not mutually exclusive between plan-driven development life cycles and the life cycles of agile and hybrid projects. The following section describes agile tools that may be used throughout the life of a project. It's important to understand these terms and concepts as you may see exam questions that will test your knowledge of adaptive techniques.

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Cost of Change Discovering quality issues as soon as possible typically allows them to be resolved more quickly, which means less rework and added costs that may impact the project. As shown in the cost of change curve below, issues that are found in software deployed in a test environment for evaluation (point 1) are much cheaper to fix than issues found during production (point 2).

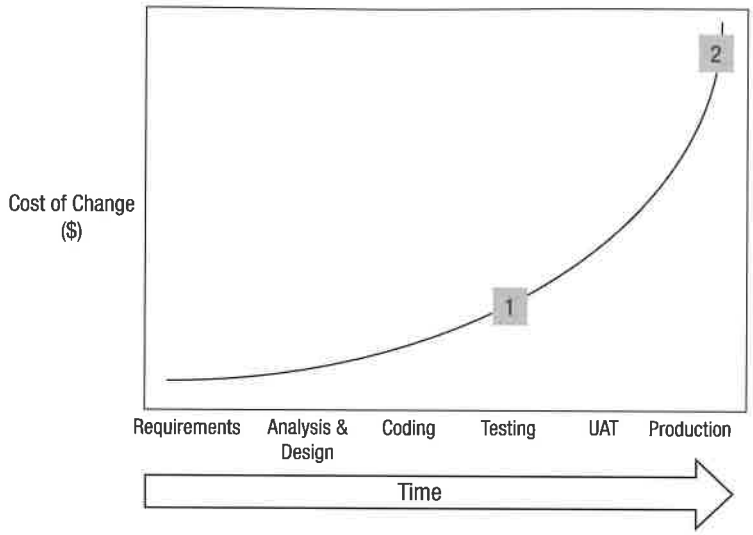

FIGURE 8.8 *Cost of change*
Image copyright ©Scott W. Ambler, www.agilemodeling.com

Iterative and Incremental Development Hybrid and agile approaches make use of iterative and incremental development and short iterations. This allows the project manager to evaluate and get feedback on small increments of the evolving product as soon as possible. Learning about quality issues early, when they are usually still small and minor, allows them to be corrected while they are still low on the cost of change curve.

Frequent Verification and Validation Agile uses regular testing, checkpoints, and reviews to address issues. This practice is referred to as frequent verification and validation, which is an effective antidote to both the fact that making mistakes is part of being human and the mismatch of expectations that arises when the team interprets the customer's end goal differently than intended. The figure below illustrates the cycles of verification and validation that take place in an XP software development project.

As depicted in figure 8.9, an XP project includes many overlapping testing and verification cycles that can range from a few seconds to several months:

- The shortest feedback cycles take place during the XP practice of pair programming. When two developers are working together and the "reviewer" spots an error as the "coder" is writing, the issue can be resolved almost immediately.
- At the next level, XP developers run unit tests every few minutes to verify that the code is achieving the desired outcome and validate that the existing functionality is working properly.
- At the next level, customer collaboration should occur frequently. This provides feedback on whether the team's designs are correct and the customer's objectives are being met.
- In their daily stand-up meetings, the team will validate who is working on what and when the code should be done and is ready to integrate.
- Acceptance tests then verify the exact agreed-upon behavior the deliverable should exhibit, that business requirements are met, and that the "definition of done" has been satisfied.
- Every few weeks the team holds an iteration review meeting with the customer to demo the new work they have completed and validate that they are building the right product so far.

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- Every few months (typically), at the end of each release, the customer reviews the deliverable to validate that it is "done" and ready for release.

Although the above examples are derived from a software development environment, the same principles apply to other kinds of agile projects; only the specifics differ. Let's take the example of a group of instructional designers who are creating the lesson plan for a new course. They start by collaborating on the course goals, exchanging ideas in real time. While writing the modules, they meet frequently to review the modules and coordinate their efforts. Once they have a first draft of the modules, they conduct a small sample test to get feedback from a volunteer group. Even after the course goes live, they continue to ask for student feedback via anonymous surveys or other techniques to ensure the course works for the intended audience.

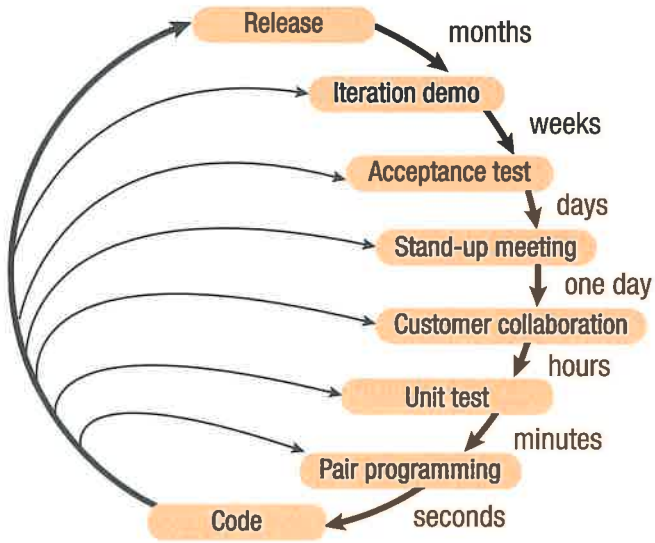

FIGURE 8.9 *Frequent verification and validation in XP*

Retrospectives A retrospective is a meeting that may be held after a release, or even the entire project. However, this term most often refers to the meeting that is held at the end of each short, time-boxed iteration of product development. Regardless of which part of the project is being reviewed, this meeting is an opportunity for the members of the development team to inspect and improve their methods and teamwork. During the retrospective, the following questions may be discussed:

- What is going well?
- What areas could use improvement?
- What should we be doing differently?

Daily Stand-up[26] A daily stand-up meeting is also an important mechanism for identifying quality problems. Note that the key question in this meeting asks whether there are any problems or impediments to project work. The purpose of this question is to bring potential issues and problems to the surfaceearly—rather than waiting until an issue or schedule delay occurs. When a concern is mentioned in a daily stand-up meeting, it is the responsibility of the project manager to further investigate the issue and resolve it.

Lead and Cycle Time Lead time is a diagnostic tool that can be used to help identify and diagnose problems. This concept measures how long something takes to go through the entire process, for example, from design to shipping, or from requirements gathering through development to deployment.

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Cycle time is a subset of lead time that measures how long something takes to go through part of the process, such as from product assembly to painting, or from coding to testing. For example, the cycle time for building a user story begins when the team starts working on it and ends when that item is finished, accepted, and begins delivering business value.

Figure 8.10 illustrates the difference between lead time and cycle time on a Kanban board:

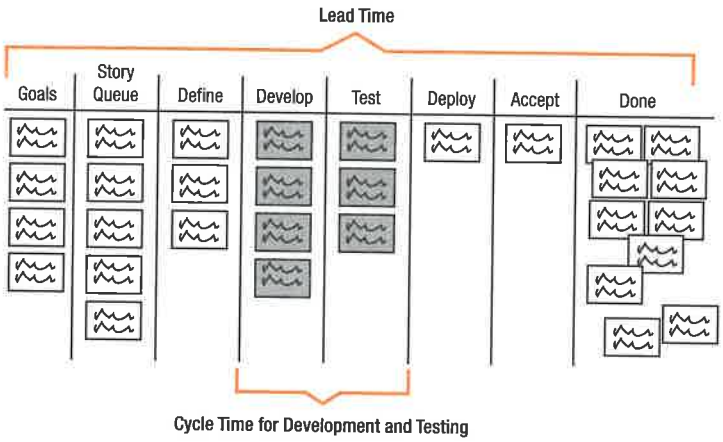

FIGURE 8.10 *Lead time and cycle time illustrated on a kanban board*

In figure 8.10 the lead time for a new feature in a software project spans the entire life cycle, from goal-setting through development and acceptance, until it is done. You can also see the cycle time for its development and testing, which is a component of its lead time. So lead time is how long it takes for the entire process, and cycle time is how long it takes for one component of that process.

Cycle Time, WIP and Throughput[27] WIP is Work in Progress – how many things you are working on but not finished yet. Throughput is the amount of work that can be processed through a system in a given amount of time—such as the amount of work the team can get done in one iteration. (This can also be expressed as their average completion time.) Cycle time is a function of WIP and throughput and can be calculated by using the following formula:

$$\text{Cycle time} = \frac{\text{WIP}}{\text{Throughput}}$$

Example:
Cycle Time = 18/27 = .66 (or 6.6 days for a 2-week iteration)

To illustrate, let's say a development iteration is 2 weeks (10 working days). The velocity (how many story points can be completed) is 27 points per iteration – this is the throughput. The WIP is 18 points. So, 18 divided by 27 equals a cycle time of 6.6 working days.

Let's look at the relationship between cycle time and work in progress (WIP) to see why this link is so important for quality in agile. Excessive WIP is associated with a number of problems:

- It represents money that has been invested but isn't producing any return yet.
- It hides bottlenecks and masks efficiency issues.
- It carries the risk of potential rework if quality issues are discovered.

It is because of these risks that agile and hybrid approaches place a big emphasis on limiting WIP. And in order to do so, the project manager must pay close attention to cycle time, since long cycle times lead to increased amounts of WIP. This is why agile and hybrid approaches break the project work down into small batches and focus on finishing items and getting them accepted by the customer as soon as possible.

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These types of practices, which are common (in some form) to all agile methods, result in a reduction in cycle time on agile projects compared to non-agile approaches. For example, on a traditional predictive project, the analysis, design, code, and test steps for a given piece of functionality might take months—or even years. This represents a very long cycle time, which leads to high levels of WIP and all the risks and quality issues associated with it.

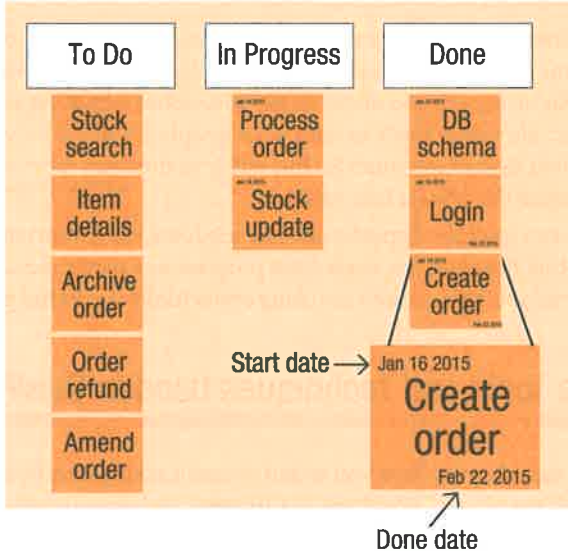

FIGURE 8.11 *Using task boards to track cycle time*

Defects Did you know that cycle time is also useful for finding and fixing defects? Defect cycle time is the period between the time the defect was introduced and the time it was fixed. The length of the defect cycle time dictates how far up the cost of change graph the defect will go.

To help minimize the cost of fixing defects, some project teams actively track their average defect cycle time and set goals for the quick resolution of defects, as shown below.

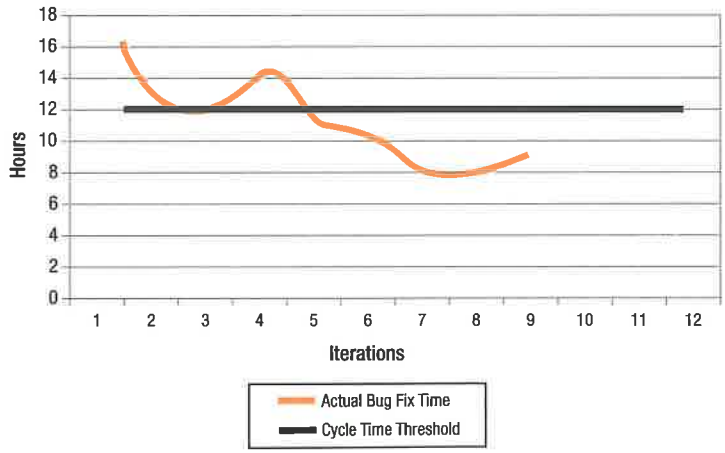

FIGURE 8.12 *Average defect cycle time (hours)*

In this example, the team's cycle time threshold is 12 hours. This means that, on average, their goal is to have all reported defects fixed within 1.5 business days. For the first five iterations, the team's "bug fix" time was usually above 12 hours. But as the project continued they were able to improve their defect cycle time—and in later iterations, the average dropped below that threshold, eventually going as low as 8 hours.

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By tracking both their defect cycle time and their cycle time for creating new work, agile and hybrid teams can minimize both the potential for rework and the cost of any rework that is required.

Create a Safe and Open Environment Creating a safe and open environment will help the project team feel comfortable not just to do their work but to admit their problems, failures, and mistakes and ask for help so that the project can recover as quickly as possible.

In an environment where a problem is treated as a personal failure or lack of competence, people will try to fix their own problems before admitting they have a problem and asking for help. That's understandable; if you're supposed to be an expert, you might think twice about admitting you're stuck on a small issue on day 10 of a new project. However, that's exactly what people should do—when someone gets stuck, they should share it with their teammates quickly. This will give the team more options to fix the issue and try different approaches before the project falls behind.

The project manager can look for opportunities to reinforce the importance of asking for help. For example, if a demo shows that the team has made little progress in a particular area, maybe they are facing a problem they haven't shared yet. This can be a coaching opportunity to remind people to share issues early.

Understanding the Tools and Techniques Used in Quality Management

As you have read through this chapter, have you found yourself asking questions like, "Now, when are all these tools and techniques used?" or "What are the differences between the three parts of the quality management process again?" People tend to struggle with these concepts. The following exercises will help.

8.2 Exercise Take a moment to research in this book the different tools and techniques that are created or used in each of the quality management processes. Then, in your Exercise Notebook, identify whether the following tools are used in Plan Quality Management, Manage Quality, or Control Quality. Remember that some tools and techniques are used in more than one quality management process. Think about the ways they are used for different purposes in each process.

1. Affinity diagrams
2. Alternatives analysis
3. Benchmarking
4. Brainstorming
5. Cause-and-effect diagrams
6. Checklists
7. Checksheets
8. Control charts
9. Cost of quality
10. Cost-benefit analysis
11. Design for X
12. Document analysis
13. Flowcharts
14. Histograms
15. Inspection
16. Interviews
17. Logical data model
18. Matrix diagrams
19. Meetings
20. Mind mapping
21. Multicriteria decision analysis
22. Performance reviews
23. Problem-solving
24. Process analysis
25. Questionnaires and surveys
26. Root cause analysis
27. Scatter diagrams
28. Statistical sampling
29. Test and inspection planning
30. Testing/product evaluations

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Answer

	Tool	Used in Plan Quality Management	Used in Manage Quality	Used in Control Quality
1.	Affinity diagrams		X	
2.	Alternatives analysis		X	
3.	Benchmarking	X		
4.	Brainstorming	X		
5.	Cause-and-effect diagrams		X	X
6.	Checklists		X	X
7.	Checksheets			X
8.	Control charts			X
9.	Cost of quality	X		
10.	Cost-benefit analysis	X		
11.	Design for X		X	
12.	Document analysis		X	
13.	Flowcharts	X	X	
14.	Histograms		X	X
15.	Inspection			X
16.	Interviews	X		
17.	Logical data model	X		
18.	Matrix diagrams	X	X	
19.	Meetings	X		X
20.	Mind mapping	X		
21.	Multicriteria decision analysis	X	X	
22.	Performance reviews			X
23.	Problem-solving		X	
24.	Process analysis		X	
25.	Questionnaires and surveys			X
26.	Root cause analysis		X	X
27.	Scatter diagrams		X	X
28.	Statistical sampling			X
29.	Test and inspection planning	X		
30.	Testing/product evaluations			X

TRICKS OF THE TRADE

Here is a trick: If the situation is looking forward in time, it is most likely a planning function. If it is looking back in time at processes and procedures, it is most likely part of a managing function. If it is looking back in time at project results, it is most likely part of a control function.

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8.3 Exercise Now take what you have learned and see if you can apply it in a different way. For each situation listed below you will write in your Exercise Notebook the answers to these questions:

A. What tool/technique is being referred to?

B. What part of the quality management process are you are in?

This exercise should help prepare you for questions on the exam, regardless of how they are written.

Situation
1. Looking at the project practices of comparable projects
2. Measuring 4 of the doors produced, rather than all 400
3. Evaluating the factors that influence particular variables in a product or process
4. Analyzing a chart of problems to find the most frequent one(s) to determine whether processes need to be improved
5. Comparing the expense of quality efforts to the return on that investment
6. Determining what will be an acceptable range of performance
7. Comparing what was done to what was documented in the plans
8. Graphically representing a process to determine where a process that is achieving low-quality results might need adjustment
9. Taking measurements and comparing them to the upper and lower thresholds of acceptable variance
10. Collecting data about defects discovered during inspection
11. Analyzing a graphic displaying issues that might have caused a defect, to determine whether the proper process was followed
12. Showing data in the form of bars to measure and plot how frequently a problem occurred
13. Collecting many data points to look at the pattern of relationships or correlation between two variables
14. Using a bar chart to show how many problems occurred for each cause and arranging them according to the frequency at which the problems occurred
15. Creating a list of items to be checked during inspections
16. Reviewing a graphic displaying issues or potential issues that might have led to a defect or problem
17. Examining a work product to make sure it meets standards

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Answer Remember that the tools and techniques can be described in many ways on the exam. Get used to the idea that the exam will ask questions indirectly, and be able to differentiate between the tools or techniques and their uses.

	A. What Tool/ Technique Is Being Referred To?	B. What Part of the Quality Management Process Are You In?
1.	Benchmarking	Plan Quality Management
2.	Statistical sampling	Control Quality
3.	Design of experiments (part of process analysis)	Manage Quality
4.	Histograms	Manage Quality
5.	Cost-benefit analysis	Plan Quality Management
6.	Control charts	Plan Quality Management
7.	Checklists	Control Quality
8.	Flowcharts	Manage Quality
9.	Control charts	Control Quality
10.	Checksheets	Control Quality
11.	Cause-and-effect diagrams	Manage Quality
12.	Histograms	Control Quality
13.	Scatter diagrams	Control Quality
14.	Histograms (Pareto diagram)	Control Quality
15.	Checklists	Plan Quality Management
16.	Cause-and-effect diagrams	Control Quality
17.	Inspection	Control Quality

Putting It All Together

Do you think you understand quality management now? The following exercises will help you review the information you have learned. Take this opportunity to solidify your understanding of what quality management is and how it fits into the overall project management process.

8.4 Exercise In your Exercise Notebook, list the actions required to ensure quality on a project. Include as many predictive and agile and hybrid components of quality management as possible.

Answer There are a lot of possible answers. Did you come up with any of the following actions?

- Make sure you know and understand the customer's definition of quality.
- Identify quality standards and processes that are applicable to the project.
- Identify the desired levels of performance in the product and its components.
- Identify at what level you should control the project (examples: work package, activity, story level).
- Determine quality standards and processes to use, when, and on what parts of the project.

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- Set standards to reach the level of desired performance for activities and the project.
- Set metrics to measure quality from the customer's and the organization's perspective.
- Decide what you will do to make sure the processes are followed and the standards are met.
- Determine how you will improve the processes on the project.
- Test the validity of assumptions before they result in problems.
- Make sure team members understand what "quality" means for their work.
- Inspect work as it is being done, not after.
- Review baselines and other project artifacts as they relate to quality on the project.
- Review problems and errors to determine what can be done to prevent them from reoccurring.
- Perform quality reviews.
- Measure performance against standards.
- Hold meetings, issue reports, measure, and perform calculations to evaluate variances.
- Reassess the quality standards for continuous improvements.
- Request changes, including corrective and preventive actions and defect repairs.
- Update organizational process assets with information learned from quality improvement efforts.
- Include quality issues in lessons learned; feed lessons learned back into the project.

8.5 Exercise Are you still unsure about the difference between Plan Quality Management, Manage Quality, and Control Quality? Think through what you have learned in this chapter, and see if you can recreate the chart shown earlier. In your Exercise Notebook draw three columns with the headings: Plan Quality Management, Manage Quality, Control Quality. Then list the Process Group for each; the high-level description of what each process focuses on; and a more detailed description of what each process focuses on. Your table can be organized like the following table.

Plan Quality Management	Manage Quality	Control Quality
Process Group		
High-Level Description of What Each Process Focuses On		
More Detailed Description of What Each Process Focuses On		

When you are finished, check your answers against the chart on pages 259-260. Having a clear understanding of what happens in each process will make it easier for you to answer quality-related questions on the exam.

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Practice Exam

1. To what does the following definition refer? "A type of analysis focused on finding the point at which the benefits or revenue to be received from improving quality equals the incremental cost to achieve that quality."
   A. Quality control analysis
   B. Marginal analysis
   C. Standard quality analysis
   D. Conformance analysis

2. A project has faced major difficulties in the quality of its deliverables. Management now states that quality is the most important project constraint. If another problem with quality were to occur, what would be the best thing for the project manager to do?
   A. Fix the problem as soon as possible.
   B. Allow the schedule to slip by cutting cost.
   C. Allow cost to increase by fixing the root cause of the problem.
   D. Allow risk to increase by cutting cost.

3. On an agile project, who is responsible for ensuring the quality of the end product?
   A. The project manager should check the quality of the product before release.
   B. The customer should review the product as it is built to ensure that it is fit for business purpose.
   C. The development team should verify, validate, and test the product while it is being built.
   D. The users should try out the first release and send feedback and bug reports to the team.

4. A manager notices that a project manager is holding a meeting with some of the team and some stakeholders to discuss the quality of the project. The project schedule has been compressed, and the CPI is 1.1. The team has worked hard on the project and has been rewarded according to the reward system the project manager put in place. Overall, there is a strong sense of team. The manager suggests that the project manager does not have enough time to hold meetings about quality when the schedule is so compressed. Which of the following best describes why the manager is wrong?
   A. Improved quality leads to increased productivity, increased cost effectiveness, and decreased cost risk.
   B. Improved quality leads to increased productivity, decreased cost effectiveness, and increased cost risk.
   C. Improved quality leads to increased productivity, increased cost effectiveness, and increased cost risk.
   D. Improved quality leads to increased productivity, decreased cost effectiveness, and decreased cost risk.

5. Quality is:
   A. Meeting and exceeding the customer's expectations
   B. Adding extras to make the customer happy
   C. The degree to which the project meets requirements
   D. Conformance to management's objectives

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6. All the following are tools and techniques of Control Quality except:
   A. Inspection
   B. Cost of quality
   C. Histogram
   D. Cause-and-effect diagram

7. A project manager is experiencing a great deal of frustration because a lot of rework has been required. It seems as though the team has significant differences of opinion related to interpretation of the requirements. The project manager is trying to determine what changes need to be made to meet the quality requirements and reduce future rework. He seeks the advice of his manager, who asks if he has created a histogram. Histograms help the project manager:
   A. Focus on the most critical issues to improve quality.
   B. Focus on stimulating thinking.
   C. Analyze the cause of a quality problem.
   D. Determine if a process is out of control.

8. A control chart helps the project manager:
   A. Focus on the most critical issues to improve quality.
   B. Focus on stimulating thinking.
   C. Analyze the cause of a quality problem.
   D. Determine if a process is functioning within established metrics.

9. Cost has been determined to be the highest priority constraint on a project to design and produce a new tool that will be used in restaurant kitchens. The project team has included random sampling of these tools in their quality plan. Although cost is a key factor, the product must also meet high quality standards. All the following are examples of the cost of nonconformance except:
   A. Rework
   B. Quality training
   C. Scrap
   D. Warranty costs

10. When managing a change-driven project, how do you ideally want any coding errors to be identified and corrected?
   A. The QA team finds the errors during alpha testing.
   B. The developers find the errors in automated unit testing.
   C. The customer finds the errors when reviewing the product increment.
   D. The users find the errors on the first day of release.

11. Standard deviation is a measure of:
   A. How far the estimate is from the highest estimate
   B. How far the measurement is from the mean
   C. How correct the sample is
   D. How much time remains in the project

12. All the following result from quality audits except:
   A. Determination of whether project activities comply with organizational policies
   B. Improved processes to increase productivity
   C. Creation of quality metrics
   D. Confirmation of the implementation of approved change requests

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13. A control chart shows seven data points in a row on one side of the mean. What should the project manager do?
    A. Perform a design of experiments.
    B. Adjust the chart to reflect the new mean.
    C. Find an assignable cause.
    D. Nothing. This is the rule of seven and can be ignored.

14. As the project manager, what can you do to support your agile team's efforts to improve quality?
    A. Investigate and try to quickly resolve any impediments mentioned in the team's daily stand-up.
    B. Carefully follow their progress and assign improvement initiatives at the iteration retrospectives.
    C. Monitor their work to ensure that the development cycle time doesn't fall too rapidly.
    D. Leave the team alone as much as possible to allow them to build their problem-solving skills.

15. You are managing a project in a just in time environment. This will require more attention because the amount of inventory in such an environment is generally:
    A. 45 percent
    B. 10 percent
    C. 12 percent
    D. 0 percent

16. There are several executing activities underway on your project. You are beginning to get concerned about the accuracy of the progress reporting your team members are doing. How could you verify whether there is a problem?
    A. Perform a quality audit.
    B. Create risk quantification reports.
    C. Perform regression analysis.
    D. Perform Monte Carlo analysis.

17. A project manager and team from a firm that designs railroad equipment are tasked to design a machine to load stone onto railroad cars. The design allows for 2 percent spillage, amounting to over two tons of spilled rock per day. In which of the following does the project manager document this for the project?
    A. Quality management plan
    B. Quality policy
    C. Control charts
    D. Quality audit documentation

18. You are a project manager for a major information systems project. Someone from the quality department comes to see you about beginning a quality audit of your project. The team, already under pressure to complete the project as soon as possible, objects to the audit. You should explain to the team that the purpose of a quality audit is:
    A. To check whether measurements of project deliverables are within specification limits
    B. To check if the customer is following the quality process
    C. To identify inefficient and ineffective policies
    D. To check the accuracy of costs submitted by the team

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28. The project manager notices that the project activities being completed by one department are all taking slightly longer than planned. To date, none of the activities in the work packages have been on the critical path. The project manager is bothered by the problem, since four of the next five critical path activities are being completed by this department.

    After making three calls, the project manager is finally able to talk with the department manager to determine what is going on. The conversation is slow because both speak different native languages, and they are trying to converse in French, a shared language. To make communication easier, the project manager frequently asks the department manager to repeat back what has been said.

    The department manager communicates that his staff is following a company policy that requires two levels of testing. During the conversation, the department manager also makes a comment that leads the project manager to believe the policy may include excessive work. This is the fourth time the project manager has heard such a comment. What is the best thing to do?

    A. Create a better communications management plan that requires one universal language on the project and have translators readily available on a moment's notice.
    B. Contact someone else in the department who speaks the project manager's native language better to confirm the department manager's opinion.
    C. Find out if the upcoming activities should be reestimated.
    D. Work on increasing the effectiveness of the performing organization by recommending continuous improvement of the policy in question.

29. In reviewing your team's increment before the iteration review, you discover a major error in the code written by the lead developer on your agile team. What should you do?

    A. Call HR to arrange a training course to improve the developer's coding skills.
    B. Bring it up in the team's next retrospective as an example of what not to do.
    C. Alert the testing department to watch out for similar issues in the rest of the code.
    D. Discuss the issue with the developer without telling the other team members.

30. As the project manager, you are preparing your quality management plan. You are looking for a tool that can demonstrate the relationship between events and their resulting effects. You want to use this tool to depict the events that cause a negative effect on quality. Which of the following is the best choice for accomplishing your objective?

    A. Scatter diagram
    B. Pareto diagram
    C. Why-why diagram
    D. Control chart

31. Which of the following explains why quality should be planned in and not inspected in?

    A. It reduces quality and is less expensive.
    B. It improves quality and is more expensive.
    C. It reduces quality and is more expensive.
    D. It improves quality and is less expensive.

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32. Work on a project is ongoing when the project manager overhears two workers arguing over what a set of instructions means. The project manager investigates and discovers that the instructions for the construction of the concrete footings currently being poured were poorly translated between the different languages in use on the project. Which of the following is the best thing for the project manager to do first?
    A. Get the instructions translated by a more experienced party.
    B. Look for quality impacts of the poor translation of the instructions for the footings.
    C. Bring the issue to the attention of the team, and ask them to look for other translation problems.
    D. Inform the sponsor of the problem in the next project report.

33. While performing quality planning for the design and manufacture of a new medical device, the team has identified the need to keep variances to a minimum because the end product must be of the highest quality possible. They are researching the practices of comparable projects for ideas on how to achieve this requirement. The team is using which of the following techniques?
    A. Benchmarking
    B. Pareto analysis
    C. Design for X
    D. Cost-benefit analysis

34. In a meeting to gain approval of the quality management plan, a stakeholder points out what he believes to be an error in the plan. He notes that the plan includes using some of the same techniques in more than one of the quality processes. Which of the following quality management techniques can be used in two of the three quality management processes?
    A. Cause-and-effect diagrams
    B. Interviews
    C. Checksheets
    D. Logical data model

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Answers

1. **Answer** B
   Explanation This is the definition of marginal analysis. Know the term so you will be able to answer questions that deal with this concept. The other choices may sound good, but they are made-up terms.

2. **Answer** C
   Explanation If a problem with quality were to occur again, many people would opt to fix the problem as soon as possible. It is proactive, but some other project constraint(s) must change to accommodate fixing the root cause of the problem. It may not be necessary to allow the schedule to slip, because the project manager might be able to compress the schedule in other areas. Cutting cost does not necessarily cause the schedule to slip, nor would that necessarily fix the problem at hand. Allowing risk to increase by cutting cost is not the best choice, because a quality problem is most likely to create additional cost, rather than cut cost. Allowing the cost to increase by fixing the root cause of the problem addresses both the need to find the cause and the probable impact of dealing with the problem.

3. **Answer** C
   Explanation In an agile setting, the development team is responsible for completing the majority of the quality assurance efforts as they build the solution. (Some quality assurance may also be done by a separate testing team, but that option wasn't listed here.) To do this, the team follows an iterative process that includes many overlapping cycles of verification and validation. Meanwhile, the customer will be giving them regular feedback to ensure that their work is fit for business purpose. However, the customer's reviews aren't intended to uncover testing or quality assurance issues. The two answer options that involve checking quality just before or just after release are incorrect because they take place too late. Due to the cost of change curve, it is very costly to "add on" quality to a finished product; instead, quality should be "built in" during development.

4. **Answer** A
   Explanation Did you notice there is a lot of data not relevant to answering the question? Expect distractors to appear in many questions on the exam. Quality efforts should produce a decrease rather than an increase in cost risk as a result of less rework. Quality efforts should also provide increased cost effectiveness due to less rework. This leaves the best answer: "Improved quality leads to increased productivity, increased cost effectiveness, and decreased cost risk."

5. **Answer** C
   Explanation There can be a cost impact (as well as an impact on other project constraints) of exceeding expectations or adding extras. Quality is the degree to which the project meets requirements.

6. **Answer** B
   Explanation Inspection, histograms, and cause-and-effect diagrams are all tools that can be used in Control Quality. Cost of quality is part of Plan Quality Management, making sure the project is not spending too much to achieve a particular level of quality.

7. **Answer** A
   Explanation Cause-and-effect (or why-why) diagrams are often used to stimulate thinking and to analyze the cause of quality problems. Determining whether a process is out of control is a function of control charts. Only focusing on critical issues to improve quality relates to histograms.

8. **Answer** D
   Explanation Focusing on the most critical issues to improve quality relates to histograms. Stimulating thinking and analyzing the cause of quality problems relate to cause-and-effect diagrams. Only determining if a process is functioning within established metrics relates to control charts.

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9. **Answer** B
Explanation Quality training is a cost of conformance to quality. All the other choices are costs of nonconformance to quality.

10. **Answer** B
Explanation Although this question asks how you want the errors to be identified, it is actually testing your understanding of when you ideally want to find and fix the errors. Because of the cost of change curve, the sooner an issue can be found, the better. So we are looking for the answer that is the earliest time to identify an error—and here the earliest option would be for the developers to find the problem in automated unit testing. (Even if you aren't sure what unit testing is, you should be able to deduce that it happens during the development process, before the other options listed.)

11. **Answer** B
Explanation Standard deviation is the measurement of a range around the mean.

12. **Answer** C
Explanation Quality metrics are an output of the Plan Quality Management process. They are an input to the Manage Quality process, the process in which quality audits take place.

13. **Answer** C
Explanation The rule of seven applies here. If you have seven data points in a row on the same side of the mean, statistically the mean has shifted, calling for action to correct the problem.

14. **Answer** A
Explanation One of the ways that a project manager can help an agile team improve quality is to promptly investigate and try to quickly resolve any impediments raised in the team's daily stand-up. A project manager shouldn't assign improvement initiatives to an agile team, since they develop that collectively as part of their "inspect and adapt" continuous improvement process. The team's iteration retrospectives should be run by the team and any action items should be arrived at through a collaborative process. Agile teams aim to minimize their cycle time, which is why an overly long cycle time may indicate a problem. So if their cycle time falls, it isn't likely to indicate a problem; they are probably just working more efficiently. While it may be tempting to leave the team alone on the grounds that agile teams should learn to be self-organizing, ignoring your team isn't consistent with servant leadership. A proactive servant leader will be interacting with the team members regularly to see if they need any support and to catch any emerging issues and impediments.

15. **Answer** D
Explanation In a just in time environment, supplies are delivered when you need them and not before. Therefore, you have little or no inventory.

16. **Answer** A
Explanation Quality audits are a necessary part of the Manage Quality process. They help you assess whether the processes are being followed correctly on the project.

17. **Answer** A
Explanation The defined level of acceptable spillage would be documented in the quality management plan. The quality policy and control charts are components of a quality management plan. Quality audit documentation is created in Manage Quality, while the work of the project is being done. The amount of acceptable spillage would have been determined in the Plan Quality Management process.

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18. **Answer** C

Explanation Control charts show whether measurements of project deliverables are within specification limits, and are used in the Control Quality process. The seller cannot generally control or review the customer's quality process. Checking the accuracy of costs submitted by the team is more representative of a cost audit than a quality audit, so that option cannot be the best choice. Manage Quality, of which an audit is part, focuses on processes, procedures, and standards. One purpose of a quality audit is to identify inefficient and ineffective policies.

19. **Answer** A

Explanation If your team's cycle time starts to go up, that is a cause for concern, not celebration. While a root-cause analysis might well be the best option, an agile retrospective is a collaborative process, so it wouldn't be appropriate to just tell the team what to do. So the best approach is to start by opening the topic for discussion and brainstorming. You wouldn't want to congratulate the team or ask them to build on this trend, since it isn't a positive development.

20. **Answer** C

Explanation Assuring management that it was determined in planning that the project would meet quality standards is not productive, since it does not solve the problem. An analogous estimate looks at the past history of other projects. This would not be appropriate to determine how the current project is going. The quality management plan does not provide results. The quality team could help to determine whether the team is following the correct process to satisfy the relevant quality standards.

21. **Answer** C

Explanation Agile teams aim to minimize their work in progress for several reasons, one of which is to improve the delivery of value, since work in progress represents money that has been invested but isn't producing any return yet. The other answer options don't make sense since they assume that the sponsor's concerns are warranted. A long cycle time, lack of prompt feedback, and variable velocity could certainly lead to problems. Still, if the team isn't working efficiently (due to those or other issues), it would tend to increase their work in progress, not decrease it.

22. **Answer** D

Explanation Focus groups are a tool of the Collect Requirements process, and would not be useful in Control Quality. The other choices are all tools and techniques of the Control Quality process.

23. **Answer** C

Explanation Although quality problems may lead to quality improvement efforts, they are not a prerequisite for quality improvement. Quality improvement is a result of Manage Quality and Control Quality, not an input. Rework (or requested defect repair) can be an output of Control Quality. That leaves only quality control measurements, which are inputs to the Manage Quality process.

24. **Answer** B

Explanation Completion of work packages is done after project planning. Since Validate Scope is a monitoring and controlling process, that is not next. Identify Risks sounds like a good choice; however, identifying quality standards occurs before the Identify Risks process. You may have misread the question and assumed communication planning was complete, but notice it only says that communications requirements have been determined. Communications planning still needs to be completed, as do other aspects of planning. Identify quality standards is the best answer choice offered.

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25. **Answer** A
Explanation Design of experiments is performed in quality planning, and uses experimentation to determine statistically what variables will improve quality. It allows the project manager to focus attention on the factors that are most important. Design of experiments is also used in Manage Quality to help decrease the time and effort required to discover the optimal conditions in which to produce a quality deliverable.

26. **Answer** B
Explanation The unexpected functionality reported by the project manager is outside the scope of the project. Adding extra functionality is the definition of gold plating. Gold plating a project wastes time and probably cost. It makes the project unsuccessful.

27. **Answer** C
Explanation Measuring is part of the Control Quality process. Perform Integrated Change Control is an integration management process. It is likely that the scenario described will result in a change request submitted to Integrated Change Control.

28. **Answer** D
Explanation Changing the communications management plan may not be needed, and it does not deal with the problem at hand—the policy that is slowing things down. Confirming the department manager's opinion with someone else in the department is not the best choice, as the project manager already has heard the opinion on many other occasions. It is already confirmed. Determining whether upcoming activities should be reestimated is just being reactive. A good project manager will find the root cause and deal with that, even if it means attempting to improve the company's policies and processes. Yes, recommending improvement of the policy is the best answer. This is continuous improvement. Because there are several activities affected by the policy, it would best serve the project to get to the root cause of the problem and solve it.

29. **Answer** D
Explanation As the servant leader of an agile team, it's essential to cultivate an open environment where people feel safe to fail and make mistakes. In a scenario such as this, the first step would be to discuss the issue privately with the developer. It wouldn't be appropriate to bring this up with the entire team in the retrospective, unless you and the person who made the mistake agree beforehand that this would be a good learning opportunity for the other team members. Raising this issue without discussing it privately first would just embarrass the developer and put them on the defensive—creating the opposite of a safe and open environment. Since this person is the lead developer, the problem probably isn't due to a lack of skills or training. Although agile teams try to solve problems collectively, this appears to be a simple scenario of one individual who made a mistake. Alerting the testing department wouldn't help solve the problem and would be likely to stir up unnecessary gossip and trouble.

30. **Answer** C
Explanation All reports and diagrams are communications tools. This question asks you to pick the most appropriate quality tool to help communications. A why-why diagram, also called a cause-and-effect or Ishikawa diagram, is more appropriate than a Pareto diagram since you are trying to determine the causes. Once causes are known and you have data on occurrences, the data can be displayed in a Pareto diagram.

31. **Answer** D
Explanation Look for the proactive approach. When we plan for quality, we define the appropriate level of quality needed, which will improve quality overall and will likely be less expensive in the long run. NOTE: You may spend more initially on determining the right level of quality and doing the work to produce the required level of quality, but you will save through reduced rework, waste, and scrap.

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32. **Answer** B

Explanation Although all these choices are correct things to do, the question asks what to do first. What is the most immediate problem? Getting the instructions translated by a more experienced party could be done, but it does not address the critical concern of the footings that have already been poured according to the poorly translated instructions. Asking the team to look for other translation issues is an excellent idea. However, it does not address the immediate problem. Informing the sponsor is also not taking action to solve the problem. Isn't it most urgent to find out whether the concrete footings meet your project requirements? Are they adequate? Only the option of looking for quality impacts of the poor translation will help you determine that.

33. **Answer** A

Explanation The team is using the benchmarking technique to review methodologies used by comparable projects or organizations to establish quality metrics and acceptable variance ranges, and to measure quality.

34. **Answer** A

Explanation Interviews are used in Plan Quality Management to identify existing standards, processes, and metrics—or to create new ones. A logical data model is also used in Plan Quality Management. Its purpose is to help the team understand the requirements, and define the appropriate quality management processes. Checksheets are used in Control Quality to track data such as the type and frequency of quality problems uncovered during inspections. Cause-and-effect diagrams are used in Manage Quality to confirm that the policies, procedures, and metrics are adequate to produce the required level of quality in project deliverables. In Control Quality, cause-and-effect diagrams can be used to uncover the root cause of a variation in the quality of deliverables.

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Resources

NINE

Resource management includes both human resources and physical resources. While human resources relates to people, physical resources relates to equipment and material. For the exam, you need to understand that physical resources may also be connected to cost- and risk-related tasks within the Process domain, while human resources is connected to the People domain. In this chapter—and on the PMP exam—the term "resources" may be referred to in a variety of ways. You will see in this chapter that most of the processes of resource management include the project manager's responsibilities regarding both human and physical resources. When answering exam questions, you will need to understand the use of resources on projects from these different perspectives.

Many topics covered in this chapter may seem easy, but you need to identify any misperceptions and expand your project management knowledge. Review the following list of the most common knowledge gaps people have about resource management, and look for others that apply to you as you read the rest of this chapter:

- "Resources" refers to more than just human resources; it also includes materials, equipment, supplies, and anything else needed to complete the project.
- Creating a recognition and reward system is an important resource management function, and such systems are a required part of project management.
- The project manager is responsible for improving the competencies of team members so they are able to perform the work on the project most effectively.
- The project manager's resource management activities are formal and require documentation.
- There should be clear roles and responsibilities on the project. For example, who should be assigned to assist the project manager, who should take on specific responsibilities at meetings, and who should be completing other work not directly related to project activities?

QUICKTEST

- Resource management process
- Resource responsibilities for project managers
- Resource management plan
- Recognition and reward system
- Team building
- Conflict resolution techniques
- Coaching
- Key performance indicators
- Tracking team performance
  - Burndown chart
  - Burnup chart
- Issue log
- Responsibility assignment matrix (RAM)
- RACI chart
- Organizational breakdown structure
- Resource breakdown structure
- Resource histogram
- Team charter
- Motivation
- Training needs of team members
- Team performance assessment
- Management and leadership styles
- Powers of the project manager
- Emotional intelligence
- Influencing
- Problem-solving method
- Sources of conflict
- Conflict resolution techniques
- Preassignment
- Negotiation
- Multicriteria decision analysis
- Colocation
- Virtual teams
- Communications technology
- Tuckman ladder
- Lean
- Kaizen
- Just in time (JIT)

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- Exam topics such as motivation, conflict management, and powers of the project manager are more challenging than you might expect. It's important to know that these concepts need to be planned for and managed throughout the project.
- Projects are planned by the team and coordinated by the project manager.
- The project manager must continually confirm resource availability.
- On large projects, the project manager might have some team members help with project management activities. These people are called the project management team. So, the project team consists of the project manager, the project management team, and the other members of the team who will be doing the work of the project.
- The project manager formally plans team-building activities in advance; these activities are a required part of project management.
- The processes of resource management are repeated and updated throughout the project.
- Geographically and culturally diverse teams require additional attention and planning by the project manager.
- The project manager is responsible for controlling physical resources on the project; this is not only the responsibility of procurement or other departments that may provide physical resources.

The resource management process takes time and effort to plan. You must do things such as identify all resources needed to complete the project (including the required skills of team resources and the required quality and grade of material or equipment), define everyone's roles, create reward systems, provide training and motivation for team members, manage the use of physical resources, and track performance.

TRICKS OF THE TRADE It is best to read this chapter two or three times and make a list of the gaps in your knowledge as you read. After a couple of passes through this chapter, you will likely know the concepts well enough to be able to understand the ways in which they are applied in questions on the exam.

The following tables should help you understand how resource management fits into the overall project management process.

PMBOK® Guide: Resource Management	Done During
Plan Resource Management	Planning process group
Estimate Activity Resources	Planning process group
Acquire Resources	Executing process group
Develop Team	Executing process group
Manage Team	Executing process group
Control Resources	Monitoring and controlling process group

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ECO Domain I: People	Domain II: Process
Task 1: Manage Conflict	Task 5: Plan and Manage Budget and Resources
Task 2: Lead a Team	Task 15: Manage Project Issues
Task 3: Support Team Performance	
Task 4: Empower Team Members and Stakeholders	
Task 5: Ensure Team Members/Stakeholders Are Adequately Trained	
Task 6: Build a Team	
Task 7:Address and Remove Impediments, Obstacles, and Blockers for the Team	
Task 8: Negotiate Project Agreements	
Task 11: Engage and Support Virtual Teams	
Task 12: Define Team Ground Rules	
Task 13: Mentor Relevant Stakeholders	
Task 14: Promote Team Performance through the Application of Emotional Intelligence	

These tables illustrate that the overall resource management process from the *PMBOK® Guide* most closely maps to domain II (Process), task 5: Plan and Manage Budget and Resources (also related to Cost). It also maps to domain II (Process) task 15: Manage Project Issues (also related to Risk). Did you notice Resource Mangement as described in the *PMBOK® Guide* maps to twelve of the fourteen People domain tasks? Many of these People domain tasks are also related to stakeholder and communications management, since these three knowledge areas are closely aligned. Notice also that many of the People domain tasks have the word "team" in the name and that tasks not listed may also be related to the team. Think about the two tasks not listed as a direct mapping. Collaborate with Stakeholders (task 9) and Build Shared Understanding (task 10) are both related to human resources (the team) as a subset of stakeholders. Finally, keep in mind that communications skills and tasks are needed to carry out any resource-related tasks.

Roles and Responsibilities Roles and responsibilities go far beyond just a title. You know you are the project manager, but what does that mean as the project work is being done? Do you know what decisions you can make and enforce, and when you need the approval of someone higher in the organization? Do you know what to expect from functional managers and your project sponsor? What about the team? Do they know their responsibilities, and when they need to escalate a situation?

Project roles and responsibilities, and the authority that goes with them, are agreed upon in planning, and documented in the resource management plan. A common complaint of team members is that roles and responsibilities are not clearly defined on a project. Therefore, the definition of roles and responsibilities is a critical part of the Plan Resource Management process. Project work often includes more than just completing work packages. It may also include responsibilities such as assisting with risk, quality, and project management activities. Team members need to know what work packages and activities they are assigned to, when they are expected to report, what meetings they will be required to attend, and any other "work" they will be asked to do on the project. In a functional or matrix environment, the managers of team resources also need to understand when and for how long these resources will be needed on the project.

It's also important to understand that leadership may involve an interpersonal approach. When leading a project team, consider the motivations of the team and align project tasks and goals accordingly. This will create more productivity. Let's take a look at some key differences between management and leadership:

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Management Focus	Leadership Focus
Tasks/things	People
Control	Empowerment
Efficiency	Effectiveness
Doing things right	Doing the right things
Speed	Direction
Practices	Principles
Command	Communication

Stop and think: Is leadership independent of management? Do you practice one and not the other when managing a project? A project manager must have a solid knowledge and understanding of the practice of project management, as well as the leadership skills necessary to successfully complete a project.

The following exercise tests your knowledge of some typical roles on a project.

9.1 Exercise Do you remember the discussion on project roles in the "Framework" chapter? Your understanding of that content will impact how well you do on this exercise. You may want to review those pages before starting this exercise, or use the information in that chapter to fill your gaps.

This exercise is designed to help you answer situational questions on the exam dealing with project roles and responsibilities. If you disagree with some of the answers, make sure you are not reading something into the question, and assess whether it indicates a gap in your project management knowledge.

In your Exercise Notebook, write the initials of the key role responsible for solving each of the problems listed. Because much of the confusion of roles is between the team members (T), the project manager (PM), the sponsor (SP), and the functional manager (FM), this exercise is limited to those roles. Consider what you have learned about project roles, and remember to keep matrix organizations in mind when reading through these situations.

	Situation
1.	Two project team members are having a disagreement.
2.	There is a change to the overall project deliverable.
3.	A functional manager is trying to pull a team member off the project to do other work.
4.	The project manager does not have the authority to get things done.
5.	There are not enough resources to complete the project.
6.	The team is unsure of what needs to happen when.
7.	An activity needs more time and will cause the project to be delayed.
8.	An activity needs more time without causing the project to be delayed.
9.	A team member is not performing.
10.	The team is not sure who is in charge of the project.
11.	There is talk that the project may no longer be needed.
12.	The sponsor provides an unrealistic schedule objective.
13.	The team is in conflict over priorities between activities.
14.	The project is behind schedule.
15.	A team member determines that another method should be used to complete an activity.

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	Situation
16.	The project is running out of funds.
17.	Additional work that will increase cost and that was not identified during the risk management process is added to the project.

Answer

	Key Role	Explanation
1.	T	The people involved in the conflict should attempt to solve it themselves.
2.	SP	A change to the project deliverable is a change to the project charter. Only the sponsor can approve changes to the project charter.
3.	T	The project manager must give team members enough information (such as the schedule, network diagram, project management plan, and identified risks) so they can manage their own workloads. Because the word "trying" is used, we know this situation is occurring at the present time. If the question used the words "has pulled," the answer would be the project manager. Read situational questions carefully.
4.	SP	It is the sponsor's role to give the project manager authority via the project charter.
5.	SP/FM	The sponsor and functional manager control resources.
6.	PM	It is the project manager's role to take the individual estimates, combine them into the project schedule, and communicate that schedule to team members.
7.	SP	Notice the word "will." This means the evaluation by the team is completed and there is no available reserve, since the project completion date is most likely included in the project charter. Any such changes are changes to the project charter and require sponsor involvement.
8.	PM	Think about integrated change control here. It is the project manager's role to look for impacts to the other project constraints.
9.	PM/FM	In a matrix environment, the project manager and the functional manager share responsibility for directing resources.
10.	SP	The sponsor designates the project manager in the project charter.
11.	SP	It is the sponsor's role to protect the project from changes, including such a large change as termination (unless it becomes clear that the project is no longer meeting the objectives of the organization).
12.	SP	Only the sponsor can make a change to the project charter (including schedule objectives or constraints). The project manager must provide evidence that the schedule is unrealistic and work with the sponsor to resolve it.
13.	PM	It is the project manager's role to settle any such conflicts and to provide a network diagram and critical path. It is the sponsor's or program/portfolio manager's role to set priorities between projects.

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	Key Role	Explanation
14.	PM	Only the project manager can control the overall project schedule.
15.	T	The team member has control over their activities as long as the team member meets the time, quality, cost, and scope objectives in the project management plan. The team member must keep the project manager informed of these changes, however, so the project manager can integrate them into the rest of the project and look for any impacts.
16.	SP	It is the sponsor's role to provide funding for the project.
17.	SP	The fact that the change was not identified in the risk management process and is additional work means it was not included in the original project budget (or the contingency reserve). Therefore, the sponsor must be involved in providing additional funds.

If you got many of the answers wrong, reread the discussions of roles and responsibilities in the "Framework" chapter, and review the exact wording of the situations presented here. With such a brief description, it can be easy to misinterpret a question. Although this exercise asked you to identify the key role responsible for solving the problems, you may have preferred the word "decide" or the words "make the final decision" to describe what should happen in some of the situations. This exercise should help prepare you to interpret questions on the exam. It is meant to make you think!

Resource Responsibilities for Project Managers Make sure you connect this concept and have a clear understanding of how stakeholder, communications, and human resource management relate to each other; this will help you answer questions correctly when taking the exam.

TRICKS OF THE TRADE A trick to correctly answering exam questions on this topic is to realize that as a project manager, you have some responsibilities for resources that are ethical, relating to professional and social responsibilities, while others are administrative. The best way to approach your responsibilities is to think of your leadership position as an integral part of the team. It is your responsibility, both as a team member and project manager, to be of service to others as they complete project work. Administratively, you will have some responsibilities similar to those of a manager.

The following is a list of project manager responsibilities to keep in mind when taking the exam:

- Determine what human and physical resources you will need.
- Negotiate with resource managers for the optimal available resources.
- Work with the procurement department if necessary.
- Confirm availability of assigned resources.
- Create a project team directory.
- Create project job descriptions for team members and other stakeholders.
- Make sure all roles and responsibilities on the project are clearly assigned.
- Understand the team members' training needs related to their work on the project, and make sure team members get any necessary training.
- Create a formal plan—the resource management plan—covering topics such as how the team will be involved in the project and what roles they will perform.
- Send out letters of commendation to team members and their managers to recognize exceptional performance of project work.

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- Make sure the needs of all team members are acknowledged and considered.
- Create recognition and reward systems.
- Use emotional intelligence (EI).
- In a change-driven environment, encourage self-organizing teams and provide support as needed.
- Plan for and manage communications challenges specific to virtual teams.
- Tailor the resource management plan as appropriate to the needs of the project.
- Encourage collaboration among team members.
- Determine what physical resources will be needed on the project, and when they will be needed.
- Determine the quality, grade, and amount of physical resources needed on the project.
- Plan ahead to ensure physical resources are available and accessible when needed.
- Use resources efficiently.
- Look for ways to improve resource utilization.
- Evaluate and select appropriate methods of managing physical resources.

Plan Resources PAGE 312

The resource management plan encompasses the management of people as well as physical resources. For both types of resources, the plan must answer questions such as the following:

- What resources are required?
- What quantity of each type of resource is needed to complete the work of the project?
- When and for how long will each resource be needed?
- How will the resources be acquired?
- Are these resources available internally, or will the procurement department need to be involved?
- What will be the cost of these resources?
- Is there a limited time during which the resources will be available for the project?
- How will resources be managed throughout the project?

PMBOK® Guide
PG: Planning
Process: Plan Resource Management

ECO
Domain: I
Task: 2, 5, 6, 8, 11, 12
Domain: II
Task: 5

In terms of physical resources, the project manager needs to determine what is needed and where the resources will come from. If the resources are available from departments within the organization, the project manager must work with the managers of those departments to reach an agreement on delivery dates as well as on quantity and quality of resources. If the resources will be obtained from external sources, the project manager must work with the procurement department, creating a purchase order or bid documents to facilitate the purchase. The project manager will likely be involved in the procurement process.

Teams on agile projects plan resource involvement using an adaptive approach. Note that it's more common on agile projects for teams to remain stable throughout the project, and that agile projects typically operate in complex environments in which understanding all the environmental factors and technical components that impact the project takes additional time. Likewise, because agile projects tackle development iteratively and incrementally, learning and adjusting as they go, roles are required throughout the project as features are built incrementally.

Early in the project, the project manager will have to determine the approach they will take to manage the project. As discussed earlier in the "Processes and Domains" chapter, two common approaches to projects are plan-driven and change-driven. On a project following a plan-driven approach, as much resource management planning as possible should be completed early in the project. On a project following a change-driven approach, planning and securing resources will likely occur as a part of each iteration or

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release. Lean, Kaizen, and just in time (JIT), discussed next, are often associated with change-driven projects.

Lean The term "lean" comes from the concept of lean manufacturing, a practice that is more than 100 years old. The principle behind lean is to remove waste from a process. Agile is a derivative of this approach, which has evolved to encompass the efficient use of human as well as physical resources. The goal of lean management is to eliminate waste of time, effort, and resources, as shown in figure 9.1.

Kaizen The Japanese term *kaizen* is synonymous with continuous improvement. It means to alter (*kai*) and improve or make better (*zen*). This term is used in quality management, but it also applies to other aspects of a project, including resource management.

Just in Time (JIT) If a project is using a just in time (JIT) system for physical resources, the strategy to manage those resources will be different than if all the inventory, materials, and supplies are purchased and delivered at the beginning of the project.

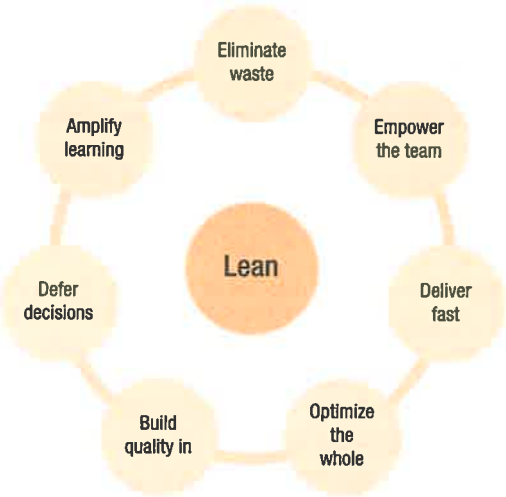

FIGURE 9.1 *Lean core concepts*

In the Plan Resource Management process, a project manager uses a variety of items, which are discussed in the following sections.

Project Management Plan The existing components of the project management plan are going to help you plan the management of people. Before you can define roles, responsibilities, reporting structure, and so forth, you'll need to consider information about the life cycle and processes already determined for the project, how work will be done, the communication needs of stakeholders, and other factors from the project management plan.

The scope baseline includes descriptions of the project deliverables, which will help you determine the resources needed to create those deliverables.

The quality management plan includes the agreed-upon level of quality and grade of physical resources needed to satisfy the requirements of the project. These decisions will impact the team's options in terms of how and where they will obtain those resources.

The stakeholder engagement plan includes the approach to involving stakeholders—including the team. It provides direction for engaging stakeholders in the planning, decision-making, and work on the project. The stakeholder register lists the individuals and groups who are project stakeholders, and it includes analysis of factors such as each stakeholder's power and interest related to the project.

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The procurement management plan describes how the project manager should interact with that department to facilitate the procurement of needed human or physical resources for the project.

Project Documents Documents that can be used in planning resource management include requirements documentation, the project schedule, and the risk and stakeholder registers. These documents provide key information, such as the timeline for needed resources, what type of resources will be needed to complete project work, and how many resources will be required to get the work done.

Enterprise Environmental Factors Before you develop a resource management plan, you need to understand what enterprise environmental factors may come into play. Remember that the term "enterprise environmental factors" refers to the company culture and existing systems the project will have to deal with or can make use of. For this process, you should take into account factors such as the following:

- What organizations will be involved in the project?
- Are there hidden agendas?
- Is there anyone who does not want the project?
- Are assigned and potential team members colocated or based in different offices and/or countries?
- What is the availability of contract help?
- What is the availability of training for project team members?

Organizational Process Assets When developing the resource management plan, you may use organizational process assets such as a resource management plan template that describes the standard responsibilities on projects, and existing policies and procedures for resource management. These assets, along with historical information, such as lessons learned from similar projects, can help increase the efficiency of the Plan Resource Management process, as well as the effectiveness of the resulting plan.

Plan Resource Management Tools and Techniques

A comprehensive resource management plan includes documentation of all project responsibilities and assignments on the project. There are a lot of methods that can be used to document and communicate roles and responsibilities of management, team members, and other stakeholders. Examples include a responsibility assignment matrix (RAM), a RACI chart, an organizational breakdown structure, a resource breakdown structure (RBS), and the WBS. Additional tools and techniques used in the plan resource management process include physical resource documentation and organizational theory.

For the exam, know the tools presented in the following sections, including the information each tool displays so that you can answer questions such as the following:

Question A responsibility assignment matrix does not show _____.

Answer When people will do their jobs (time).

Responsibility Assignment Matrix (RAM)[1] This chart cross-references team members with the activities or work packages they are to accomplish. Figure 9.2 is an example of a RAM.

	Team Member			
Activity	*Karla*	*Patrick*	*Muhammad*	*Trisha*
A	P		S	
B		S		P

Key: P = Primary responsibility; S = Secondary responsibility

FIGURE 9.2 *Responsibility assignment matrix*

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RACI Chart[2] (Responsible, Accountable, Consult, and Inform) This chart is a type of responsibility assignment matrix that defines role assignments more clearly than the example shown in figure 9.2. Instead of the P and S shown in the figure, the letters R for Responsible, A for Accountable, C for Consult, and I for Inform are used. Note that multiple resources may be responsible, informed, or consulted, but only one person is held accountable.

Organizational Breakdown Structure[3] An organizational breakdown structure can be used to assign project responsibilities to divisions or departments within the organization, such as marketing, product development, or IT. In a matrix organization, the project manager will have to interface with the managers of each department involved in the project to coordinate availability and scheduling of human and physical resources that will be used on the project. Figure 9.3 is an example of an organizational breakdown structure.

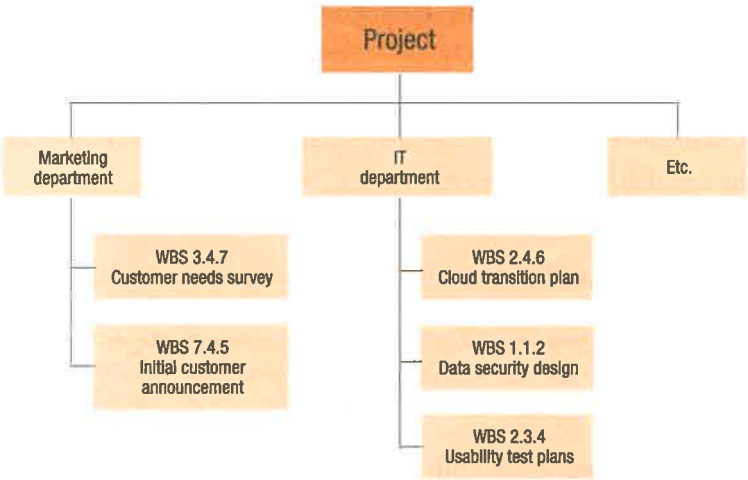

FIGURE 9.3 *Organizational breakdown structure*

Resource Breakdown Structure[4] Similar in format to a WBS and utilizing its content, the resource breakdown structure breaks the work down by type of resource (see figure 9.4).

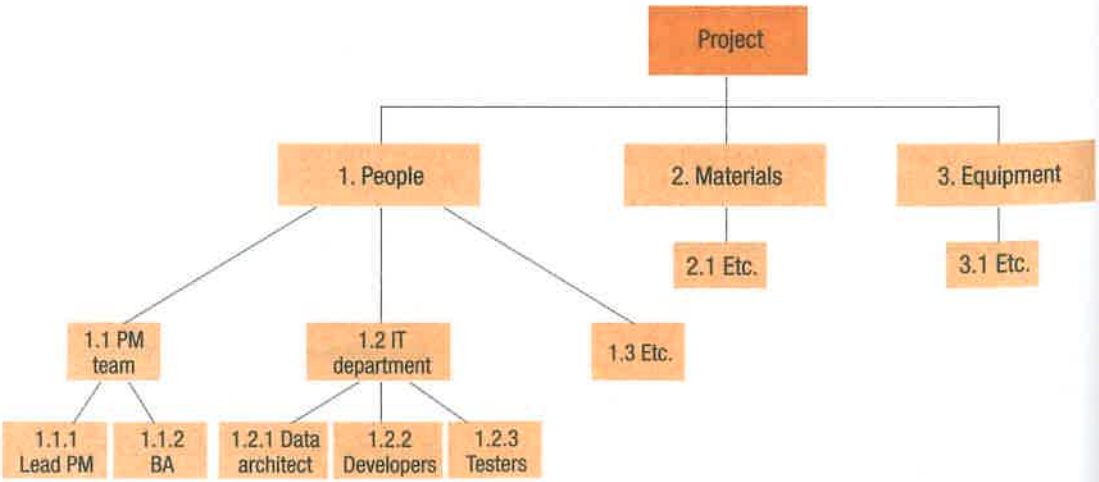

FIGURE 9.4 *Resource breakdown structure*

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Work Breakdown Structure Are you surprised to see the WBS here? Can you think of how the WBS could be a valuable tool in creating the resource management plan? In the "Scope" chapter, we said that all project work must be represented in the WBS. It follows, then, that the WBS is a great tool to ensure that each work package has an "owner"—a team member responsible to complete that work.

Physical Resource Documentation In addition to mapping out the roles and responsibilities of people on the project, the project manager must plan ahead for usage of physical resources. This aspect of planning is as important as planning for the management of people!

The project manager must document the physical resource needs, which may involve adapting tools and techniques often used for other purposes. For example, since the WBS shows the project deliverables broken down into work packages, it could be used to plan resource requirements for each of those work packages. The WBS could also be used as a reference to ensure that all necessary physical resources for each work package have been secured.

Organizational Theory Organizational theory studies organizations to identify how they solve problems and how they maximize efficiency and productivity and meet the expectations of stakeholders. Such analysis helps the organization develop effective resource management policies and procedures for the acquisition, management, and evaluation of human and physical resources. Adopting practices such as JIT, Lean, Kaizen, or Six Sigma influences how projects will handle the management of physical resources.

The outputs of the plan resource management process are discussed in the following sections.

Resource Management Plan The primary result (output) of planning resource management is, of course, a resource management plan. If you manage small projects, think for a moment about what the resource management effort would involve on a large project that has hundreds of assigned resources. Would it take more work than you are doing now to manage all the resources on your project? Large projects require a plan for when and how resources will be added, managed, and released from the project. This is what the resource management plan provides.

Components of the resource management plan include the following:

- Human Resources
  - Identification of human resource requirements (who, when, how many, what skills, what level of expertise, duration)
  - Roles and responsibilities (described earlier in this chapter)
  - Project organizational charts (described earlier in this chapter)
  - Process for acquiring human resources (internal or procurement)
  - Training, team development, and recognition (goals, what, when)
  - Project team management (team charter, ground rules, engagement, communications)
  - Compliance (How will the project comply with any rules related to human resources?)
  - Safety (policies to protect the resources)
  - Release of human resources
- Physical Resources
  - Identification of physical resource requirements (what, when, how many, what type, quality, grade, duration)
  - Process for acquiring physical resources (internal or procurement)
  - Inventory management
  - Release of resources

A project manager must motivate their team, especially when working on a project in a matrix organization. Have you ever wondered, "How do I get improved performance from people who do not report directly to me in the organization?" If your team members are not motivated, it is nearly impossible to be effective as a project manager. This is not to say that great project managers do not have issues with motivating people, but they have the tools and knowledge to prevent and to deal with such problems.

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Recognizing individual and team accomplishments is one of the most effective ways to motivate and gain cooperation from your team, regardless of the reporting relationship. Excellent project managers include a plan to do so as part of their resource management plan. Developing such a plan can be a significant effort, as it should include when and how resources will be recognized, and what actions or achievements will be rewarded.

Everyone likes to feel appreciated. A good start to planning how to use recognition and rewards[5] is to make a conscious effort to personally acknowledge the efforts of team members. A smile and a "thank you" are often more meaningful than a so-called reward. But you need to go beyond that in your planning. To make the rewards more personal, consider asking what your team members and stakeholders want to get out of the project, on a professional and personal level. They might respond with such things as, "I want to learn more about XYZ," "I want to decrease the time I am allocated to this project," "I want to make sure I leave work on time on Tuesday nights because I have a family obligation," or "I want to be assigned a certain piece of the project work."

After gathering such information, a project manager creates a plan that includes what recognition and rewards will be given, to whom, and when. As the project progresses, the plan may be iterated as new team members are added, and as the project manager becomes more familiar with the team and what motivates them.

Recognizing and rewarding the team might include performing the following actions on an ongoing basis, while project work is being done:

- Saying "thank you" more often
- Awarding prizes for performance
- Recommending team members for raises or choice of work assignments, even though such actions by the project manager may not officially be part of the team members' performance reviews
- Sending notes about great performance to team members' managers
- Planning milestone parties or other celebrations
- Adjusting the project to assign people to activities they want to work on
- Assigning a team member to a non-critical-path activity so that they can gain more knowledge in that area

The list could go on and on, but ask yourself, "Do I do any of these things? Do I do them systematically?" Creating a recognition plan requires planning in advance of any project work, and then iterating that plan as the project progresses.

Team Charter This document is a working agreement developed by the members of the project team. It describes the approach the team will take regarding communications, decision-making, and conflict resolution, as well as ground rules for team meetings. The team charter is a project document and can be referenced at any time during the project.

Team charters on predictive projects differ from those on agile projects. On predictive projects with unchanging requirements or technology, it is appropriate to plan, plan some more, and then execute. But on an agile, dynamic project with a moving target, a high degree of planning may be inappropriate because key elements of the project are likely to change. For agile and hybrid projects like this, teams need to allow for mid-flight adjustments and make sure they have the processes (such as prioritization, demos, retrospectives, etc.) in place to allow for effective and efficient adjustments.

Setting ground rules can help eliminate conflicts or problems with the team during the project because everyone knows what is expected of them. And if team members have input on the creation of the ground rules, they're more likely to follow them. Ground rules can be especially important when the team is managed virtually.

The ground rules may include items such as the following:

- How a team member should resolve a conflict with another team member

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- When a team member should notify the project manager that they are having difficulty with an activity
- Rules for meetings
- Who is authorized to give direction to contractors
- How the team will decide work assignments
- When and how to provide status updates to the project manager
- Methods for coordinating and approving changes to team members' calendars, both in normal and emergency situations

Project Document Updates The assumption log is updated to reflect assumptions made in planning regarding resources. These may include assumptions made about the availability, quantity, quality, or type of human and/or physical resources. Other assumptions made might relate to what type of rewards and recognition will be effective, and how the releasing of resources should be managed. Assumptions can change as the project progresses, and should be regularly assessed for validity. Incorrect assumptions may create risks on the project.

Another document that may need to be updated is the risk register. Risks related to resources should be added to the risk register, and then analyzed and prioritized along with other documented risks in the risk management process.

Estimate Resource Requirements PAGE 320

PMBOK® Guide
PG: Planning
Process: Estimate Activity Resources

ECO
Domain: I
Task: 5, 6, 8
Domain: II
Task: 5

When estimating activity resources, the project manager and team determine the type and quantity of all resources needed to complete project work. This includes people to perform the project work, and any equipment or materials needed to fulfill the requirements of the project.

It's important to note that the resource management plan provides documentation on estimating methods that may be used when determining estimates. Other inputs include the scope baseline and the activity list from Schedule Management. These inputs help to estimate the needed resources at the work package level and activity level, respectively, and are important elements to create accurate estimates. Another input from schedule management is activity attributes. Attributes provide specific information about each activity, such as the type and amount of human and physical resources expected to be required to complete them.

Cost estimates provide constraints in terms of resource estimating, as the resource costs must fall within the cost baseline. Resource calendars identify organizational work hours and company holidays, and show the availability of potential resources—both human and physical. Organizational process assets include policies the project must follow when arranging for staff and needed equipment.

In the "Schedule" and "Cost" chapters, we discussed estimating techniques used to develop the schedule and budget. Several of those techniques, such as analogous estimating, may also be used to estimate activity resources (see the "Schedule" and "Cost" chapters for a complete list).

Another tool you can use to estimate resources is a resource histogram. A resource histogram is a way to visualize resource requirements, and compare needed resources and their availability, to better enable estimating. As depicted in figure 9.5, a resource histogram is a bar chart that shows the number of resources needed per time period; it also illustrates where there is a spike in the need for resources. If the materials, equipment, or people are not available when they are needed, the project manager must evaluate available options, which may include negotiating with another department to provide the resources, procuring the resources from an external source, or adjusting the project schedule to do the work when the resources are available.

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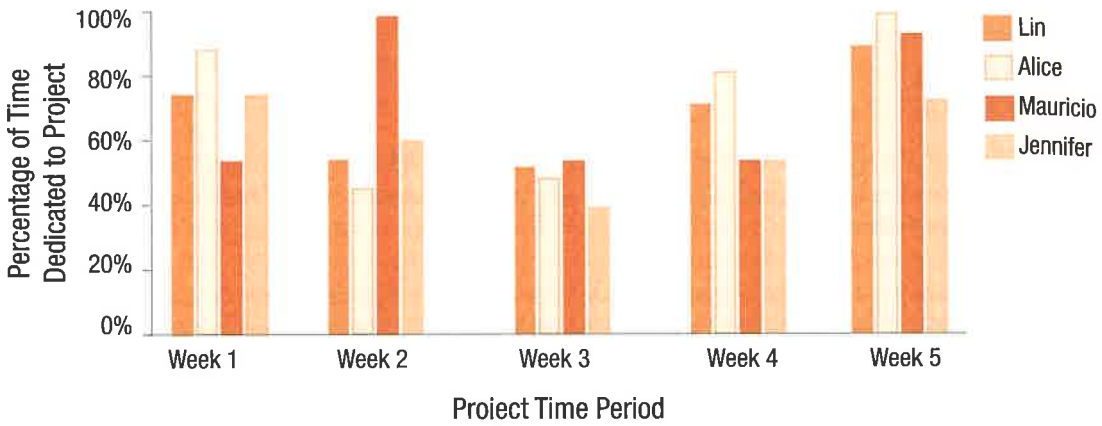

FIGURE 9.5 *Resource histogram*

Resource leveling is a technique that may be used to change a project to minimize the peaks and valleys of resource usage (level the resources). The project manager could use a histogram to help in performing that activity if resources are limited.

At the end of this process, the team will have determined resource requirements for project activities, including the cost, quantity, and availability of human and physical resources. They may choose to document the requirements in a resource breakdown structure. The RBS in this process is an iteration of the document that was originally created in the Plan Resource Management process.

9.2 Exercise In the following table, identify which activities are involved in the Estimate Activity Resources process. In your Exercise Notebook write "yes" if the described action is part of the Estimate Activity Resources process; if it's not, write "no." Check your answers against the table.

Action
1. Review project management plan.
2. Review scope baseline.
3. Review resource availability.
4. Review cost estimates.
5. Get one time estimate per activity.
6. Complete an analysis of the reserves needed on the project.
7. Create a company calendar identifying working and nonworking days.
8. Create milestones.
9. Review the WBS, activity list, and activity attributes.
10. Review the risk register and assumption log.
11. Identify potentially available resources and their skill levels.
12. Review historical information about the use of resources on similar projects.
13. Review organizational policies on resource use.
14. See how leads and lags affect the time estimate.
15. Solicit expert judgment on what resources are needed and available.
16. Create bottom-up, analogous, or parametric estimates.

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	Action
17.	Analyze alternative equipment or methods to use in completing the work and approaches to better utilize resources.
18.	Show network dependencies per activity.
19.	Identify areas of the project that cannot be completed internally or would otherwise be more efficiently achieved through outsourcing. This information will be shared with the procurement department.
20.	Crash the project.
21.	Break the activity down further if the activity is too complex to estimate resources (bottom-up estimating).
22.	Quantify resource requirements by activity.
23.	Create a hierarchical image that organizes the planned resources by their category and type (a resource breakdown structure).
24.	Fast track the project.
25.	Develop the schedule.
26.	Develop a plan as to what types of resources will be used.
27.	Update project documents.

Answer

Is It Part of Estimate Activity Resources?				
1. Yes	7. No	13. Yes	19. Yes	25. No
2. Yes	8. No	14. No	20. No	26. Yes
3. Yes	9. Yes	15. Yes	21. Yes	27. Yes
4. Yes	10. Yes	16. Yes	22. Yes	
5. No	11. Yes	17. Yes	23. Yes	
6. No	12. Yes	18. No	24. No	

Acquire and Release Resources

This process involves following the resource management plan to secure all resources needed for the project. The resource management plan describes how resources will be acquired and released, and the resource requirements documentation tells the project manager what types of resources are needed. The project schedule and cost baseline provide essential information regarding when resources will be required and the amount of funds budgeted to pay for them.

PMBOK® Guide
PG: Executing
Process: Acquire Resources

To understand why this is an executing process, think of a large project that may last several years and require hundreds of people and lots of physical resources. A planning team is acquired early in planning to help the project manager. However, many of the people and other resources needed to do the work may not be needed until long after planning starts. The final list of resources might include contractors, sellers, and people who will work on the project years into the future and may not even be employed by the company until needed. Likewise, the physical resources may be purchased closer to the time they are needed, to avoid the need to warehouse inventory. Acquiring the planned resources as they are needed is an example of rolling wave planning.

ECO
Domain: I
Task: 6,8, 11
Domain: II
Task: 5

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TRICKS OF THE TRADE In a predictive-based approach, the project manager is acquiring and releasing human resources as their work is needed and completed. Agile environments typically call for keeping a team stable and bringing projects to the team to maintain high performance. Variations on these approaches depend on the project and business environment.

Acquiring resources begins by using the planning and estimating work, which identified the type and quantity of resources needed. Let's look first at the process of acquiring the team, and then at acquiring physical resources.

When it's time to finalize the people who will perform the work of the project, the project manager may be required to negotiate with functional (resource) managers, other project managers, and the resources themselves in order to arrange their participation on the project. If the resources must be hired or contracted, work with the human resource or procurement departments may be necessary.

The project manager will also use the resource requirements documentation as a reference in acquiring physical resources. Often this involves working with the procurement or inventory management department.

A project manager has to work with the resources they are given, or acquire those that are needed. Resource availability (as indicated by resource calendars) and the project schedule must be coordinated to ensure that the right resources will be available when they are required.

To review, acquiring project resources includes all the following:

- Knowing which resources are preassigned to the project and confirming their availability
- Negotiating for the best possible resources
- Hiring new employees
- Hiring resources through the contracting process from outside the performing organization—outsourcing
- Using JIT, Lean, or other methods as required by the organization
- Managing the risk of resources becoming unavailable

Types of Teams The makeup of the final project team can take one or a combination of forms, such as the following:

- **Dedicated** Most of the team members work full-time and exclusively on the project. From the perspective of the project manager, this is the easiest form of team to work with, as team members can dedicate most of their energy to the project and often report directly to the project manager. Dedicated teams are most common in projectized organizations, but can also be found in matrix organizations; they're least likely to exist in functional organizations. Dedicated teams are important on rapidly changing agile projects. In these environments, more information is communicated face-to-face and tacit knowledge is more valuable.
- **Part-time** Team members and the project manager spend a portion of their time working on the project while also working on other projects and/or their usual (non-project-related) work responsibilities. Part-time teams are most often seen in functional and matrix organizations.
- **Partnership** In cases where several organizations undertake a project, the teams are likely to consist of people from each of the participating organizations, plus the project manager from the organization taking the lead on the project. Such teams may offer advantages, such as cost savings, but they can be difficult to manage.
- **Virtual** When multiple organizations, offices, groups, or individuals are involved on a project, the geographic distance of these organizations can necessitate the creation of virtual teams (see the "Virtual Teams" section of this chapter). Agile organizations usually try to avoid virtual teams where possible. Technology helps agile teams work virtually, but face-to-face communication is always preferred.

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TRICKS OF THE TRADE For the exam, be aware of how the type of team described in a situational question could impact the project manager's work. For example, with a dedicated team, the project manager will have more control over the team members. With a part-time team, the project manager will likely have to negotiate with functional managers and leadership to acquire and retain team members. With a partnership or virtual team, coordination among the various organizations or locations might require increased risk management work, more effort to coordinate communication, and so on.

Let's review several of the ways a project manager may obtain resources.

Preassignment As noted earlier, sometimes resources are assigned before the project begins. Preassigned resources are documented in the project charter. This relates to both physical and team resources.

Negotiation When resources are not preassigned, they may be acquired through negotiation. You will see negotiation referenced frequently on the exam as it relates to gaining resources from within your organization and in procurement situations. To negotiate for human or physical resources from within the organization, the project manager should do the following:

- Know the needs of the project and its priority within the organization.
- Be able to express how the resource's manager will benefit from assisting the project manager.
- Understand that the resource's manager has their own work to do and may not gain benefits from supporting the project.
- Do not ask for the best resources if the project does not need them.
- Be able to prove, using project management tools such as the network diagram and project schedule, why the project requires the stated quantity and quality of resources.
- Use negotiation as an opportunity to discover what the resource's manager will need from the project manager in order to manage their own resources.
- Build a relationship so the project manager can call on the expertise of the resource's manager later in the project if necessary.
- Work with the resource's manager to deal with situations as they arise.

Notice the previous list goes beyond traditional negotiation strategy and includes elements of professional responsibility. Negotiations are most effective when the interactions between participants are positive and there is some room for give and take on each side. Professional and social responsibility is discussed throughout this book and is relevant in every part of a project manager's job.

Virtual Teams Not all teams meet face-to-face. Virtual teams have to rely on other forms of communication to work together. Although virtual teams can be more challenging to manage because of communication issues and differences in schedules, languages, and/or culture, they offer the opportunity to benefit from the expertise of team members who are in distant locations or who are otherwise unavailable to participate with the team onsite.

The big challenge for virtual teams is finding ways to create "virtual colocation"—in other words, trying to replicate the benefits of face-to-face collaboration, osmotic communication, tacit knowledge, and improved relationships that come from working near each other. Fortunately, the same tools making virtual teams more common also provide ways to simulate the benefits of face-to-face collaboration. Let's look at some examples.

- **Videoconferencing and live chat** These tools can be used to simulate a shared team environment and allow virtual stakeholders to chat and interact as if their colleagues were within earshot.
- **Interactive whiteboards** These tools allow team members to share content with multiple locations and collaborate in a visual whiteboard-type environment.

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- **Instant messaging (IM)** Instant messaging allows people halfway around the world to communicate instantaneously with ease.
- **Presence-based applications** These applications extend IM capabilities by managing the status of participants to create a virtual office environment for sharing information.

There may be questions on the exam that ask why virtual teams might be necessary as well as some that describe situations that involve acquiring and managing virtual teams. You may also encounter situational questions for which choosing the correct answer depends on your understanding that a virtual team might require a different approach than a colocated team.

Multicriteria Decision Analysis When acquiring resources, the project manager may establish a set of criteria to help choose potential team members or physical resources. Factors that address the needs of the project, such as availability, cost, experience, location, and/or a required skill set, are weighted by importance, and potential resources are evaluated based on the selected criteria.

A potential issue to be aware of when dealing with team members is something called the "halo effect,"[6] which refers to a tendency to rate team members high or low on all factors due to the impression of a high or low rating on one specific factor. Because of the halo effect, a project manager might say to a team member, "You are a great programmer. Therefore, we will make you a leader of a team within the project and expect you to be great at that as well." Since a person who is a great programmer may not, in fact, be qualified to be a team leader, such assumptions can have a negative impact on the project schedule, cost, and quality, and should be avoided.

Outputs of Acquire Resources The outputs of the Acquire Resources process include physical resource assignments, project or work assignments, and resource calendars that show the planned utilization and availability of project resources. Here are some things to remember about the outputs of this process:

- If decisions made in this process require changes to approved management plans or project documents, change requests are submitted to integrated change control. Affected documents and plans may include any of the plans or baselines within the project management plan.
- The resource management plan may be changed based on the project experience to date. For example, the plan for acquiring future resources may need to be adjusted if it doesn't work as expected.
- The project schedule may need to be adjusted to accommodate the availability of resources with specific expertise needed by the project. The cost baseline may be impacted if hourly rates or material prices will need adjustment from what was estimated.
- Project documents will need to be updated or changed, with new team members added or information changed in the stakeholder register. The resource breakdown structure is iterated to include specific information about human or physical resources that have been committed to the project.
- Newly identified risks related to human and physical resources are added to the risk register, reviewed, and analyzed. For example, a resource with unique qualifications could be called away during the project, or the equipment purchased or rented may have a higher failure rate than anticipated. Resource requirements, including the type, quantity, skill level, or quality and grade may change.
- There are usually lessons learned to be captured, integrated into the project for future acquisitions, and shared with the organization.

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Develop Team PAGE 336

Similar to many project management processes, the Develop Team process is ongoing throughout project work. This process should result in decreased turnover, enhanced individual knowledge and skills, and improved teamwork. The project manager works to lead, empower, and motivate the team to achieve high performance and to meet project objectives. This is accomplished through efforts to create an environment conducive to building trust and cooperation, and by providing training and support to the team. Team members are recognized for their efforts.

A plan for making all of this happen should be included in the resource management plan. The project manager can also make use of lessons learned earlier in the project and on other, similar projects to enhance their ability to effectively develop the team.

PMBOK® Guide
PG: Executing
Process: Develop Team

ECO
Domain: I
Task: 1, 3, 4, 5, 6, 13

9.3 Exercise In your Exercise Notebook, write down the answer to this question: What do you think a project manager needs to do to develop a team?

Answer An exercise like this can be tempting to skip. But remember that the only effective way to find gaps is to test your knowledge and understanding of the goals, actions, and benefits of the process before you look at the answers.

You may do some of the activities listed below on your projects, but you might not plan them in or do them consistently or consciously. These activities are part of proper project management. Keep them in mind for the exam to help you understand the situations described and select the best answer choices.

When managing a project, the project manager must ensure that the project team is working together as effectively and efficiently as possible. This may include any of the following:

- Using soft skills, such as mentoring, leadership, negotiation, empathy, and communication
- Encouraging teamwork
- Communicating honestly, effectively, and in a timely manner with the people assigned to your team
- Assessing team members' strengths and weaknesses, preferences, and learning styles to help the team work together
- Establishing and maintaining trust between the project manager and each team member, and among all stakeholders
- Collaborating with the team to create a shared vision, make good, bought-into decisions, and to find mutually beneficial solutions to problems
- Capitalizing on cultural differences
- Holding team-building activities
- Building a sense of team identity
- Setting realistic goals
- Providing training for team members as needed
- Encouraging team members to uphold the agreements documented in the team charter
- Assisting the team with conflict resolution when needed
- Giving recognition and rewards
- Placing team members in the same location, if possible (colocation)
- Facilitating communication between team members
- Evaluating and working to improve team performance

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- Motivating team members
- Improving team members' knowledge
- Encouraging a positive team culture

Remember that on a properly managed project, team members are empowered to do the project work. They need to have input into the project, including what work needs to be done, when, at what cost, what the risks may be, and so on. Project managers may also invite new team members to review their part of the project for changes before they start work.

Project team members of empowered teams are free from command-and-control management and can use their own knowledge to determine how to best do their job. In addition, project managers typically do not have the same expert insight into how tasks should be completed as do the people who are performing the activities. Project managers are better served by allowing team members to direct their own work, and should only describe iteration goals at a high level, allowing the team to determine how to best accomplish the work.

Interpersonal and Team Skills

Motivation Theory[7] In the matrix environment, team members often don't report directly to the project manager. To gain the cooperation of team members, the project manager must understand how to motivate them.

As you have read in this chapter, one of the best ways to gain cooperation is to give rewards. How can we reward people if we do not understand what motivates them? Questions on the exam related to this topic do not directly quote motivation theorists. The questions may simply describe situations and ask you what to do. The answer might depend on understanding that the person in the situation is a Theory X manager, or that the project manager was using an ineffective motivation technique.

Following are explanations of four motivation theories that can help you understand situations for the exam.

McGregor's Theory of X and Y[8] McGregor believed that all workers fit into one of two groups: X and Y. The exam may describe this concept in many different ways. It can be confusing to determine which answer is correct or even what the choices are saying. For those of you with strong visual memories, here is a trick to answering questions on these theories.

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Theory X Based on the picture, take a guess as to what Theory X is.

Answer Managers who accept this theory believe that people need to be watched every minute. They believe employees are incapable, avoid responsibility, and avoid work whenever possible.

Theory Y Based on the picture, take a guess as to what Theory Y is.

Answer Managers who accept this theory believe that people are willing to work without supervision, and want to achieve. They believe employees can direct their own efforts. It's a PMI-ism that this is indeed how team members behave, so unless directed otherwise, assume this perspective when responding to exam questions.

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Maslow's Hierarchy of Needs[9] Maslow's message is that the highest motivation for most people is to contribute and to use their skills. Maslow called this "self-actualization." He created a hierarchy of needs to explain how people are motivated and stated that a person cannot ascend to the next level until the levels below are fulfilled. See figure 9.6.

FIGURE 9.6 *A representation of Maslow's hierarchy of needs*

McClelland's Theory of Needs[10] **(or Acquired Needs Theory)** This theory states that people are most motivated by one of three needs. A person falling into one need category would be managed differently than a person falling into another category. The following table explains the three need categories.

Primary Need	Behavioral Style
Achievement	These people should be given projects that are challenging but are reachable. They like recognition.
Affiliation	These people work best when cooperating with others. They seek approval rather than recognition.
Power	People whose need for power is socially oriented, rather than personally oriented, are effective leaders and should be allowed to manage others. These people like to organize and influence others.

Herzberg's Two-Factor Theory of Motivation[11] Herzberg's theory deals with hygiene factors and motivating agents.

Hygiene Factors: Poor hygiene factors may destroy motivation, but improving them, under most circumstances, will not improve motivation. Hygiene factors are not sufficient to motivate people.

Examples of hygiene factors include the following:

- Working conditions
- Salary
- Personal life
- Relationships at work
- Security
- Status

Motivating Agents: People are motivated, energized, and engaged by the work itself, including factors such as the following:

- Responsibility
- Self-actualization
- Professional growth
- Recognition

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So, the lesson here is that motivating people is best done by rewarding them and letting them grow. Giving raises is not the most effective motivator. This is generally good news for project managers, as they often do not have any influence over the pay raises of their team members. Solving an individual or team issue may mean that you have to make certain that basic needs are met within the project.

Team Building Team building can play a major role in team development—helping to form the project team into a cohesive group working for the best interests of the project and enhancing project performance. Make sure you know the following key points about team building:

- It is the project manager's job to guide, manage, and improve the interactions of team members.
- The project manager should work to improve trust and cohesiveness among the team members.
- The project manager should incorporate team-building activities into project activities.
- Team building requires a concerted effort and continued attention throughout the life of the project.
- WBS creation is a team-building activity because it allows team members to actively engage in the planning and ownership of the project; similar benefits occur when the team is involved in other planning efforts, as well.
- Team building should start early in the life of the project.

Let's spend a little more time on the concept of trust. First, think of project problems you have recently experienced. Now ask yourself the following questions: "Could these problems be caused by a lack of trust? Do team members trust each other? Do they trust me?" Your team needs to feel that you are working in the best interests of the project, the company, and them—rather than in your own best interests. Trust is gained or lost from the minute you meet each team member for the first time. If the team does not trust you, you cannot easily be successful. The team will not take your direction or follow your instructions, and the project will suffer.

An important role of a project manager is to create a psychologically safe work environment where people can ask questions and show incomplete versions of their work without being criticized. Providing a team with this level of trust increases collaboration and helps improve the project. Another common method for increasing trust on agile projects is to engage the team in the development of estimates. Remember when we discussed Planning Poker in the "Schedule" chapter? Activities like Planning Poker build trust amongst the team members, the estimate, and the solution.

Once you have trust, it can be lost if you are not honest and consistent. Assuming you work in a matrix organization, how do you get people to cooperate if you do not have the ability to give them a raise or a promotion? Trust, as well as a recognition and reward system, are the answers.

Trust also affects, and is affected by, your reputation. Do you know what your reputation is? Many of the people you meet know. Why not ask them about it so you can deal with any changes you need to make?

Team building helps build trust, and it is a concept that appears throughout the exam. It is an attitude, as well as an action. Do you have the attitude of helping to build the team, or do you think the team members should just follow instructions and accept what they are told? Some project managers think team building is a minor activity; they bring in lunch for the team a couple times during their three-year project and believe they have done team building.

Team building, like many parts of project management, is, in part, a science. The Tuckman ladder model formally identifies the following stages of team formation and development:[12]

- **Forming** People are brought together as a team.
- **Storming** There are disagreements as people learn to work together.
- **Norming** Team members begin to build good working relationships and learn to trust the project manager and each other.
- **Performing** The team becomes efficient and works effectively together. This is the point when the project manager can give the most attention to develop individual team members.
- **Adjourning** The project ends, and the team is disbanded.

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New teams may go through each step, while teams that have worked together before may experience a shortened version, possibly even skipping some of the early steps.

Team building is about more than just bringing resources together to make a project successful. A project manager should look to assess the skills of the team and help team members grow, which will be mutually beneficial for the team members and the project. Team building also includes creating the best possible atmosphere for the team to succeed, continuously assessing the performance and processes of the team, and maintaining and encouraging the working order of the team.

Let's look at a few other team-building models, Cockburn's Shu-Ha-Ri model and Dreyfus's model of skill acquisition.

Shu-Ha-Ri Model of Skill Mastery[13] The Shu-Ha-Ri model describes a three-step process of increasing mastery :

Shu: Obeying the rules—*shu* means "to keep, protect, or maintain."

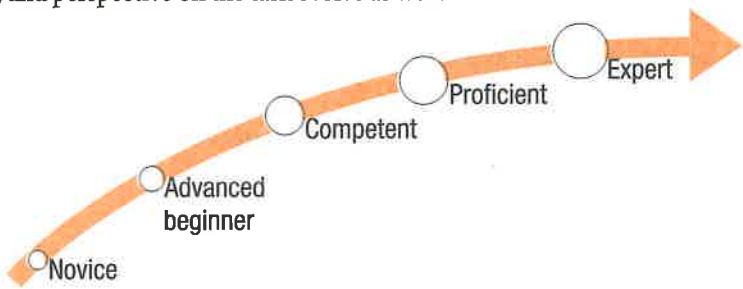
Ha: Consciously moving away from the rules—*ha* means "to detach or break free."

Ri: Unconsciously finding an individual path—*ri* means "to go beyond or transcend."

Cockburn's model states when mastering a new skill or process, you move through three levels, or stages. Beginners at the *shu* level start by following the rules absorbed from their teachers, mentors, or learning experiences. Once they've mastered those guidelines through practice, they reach the *ha* level where they can let go of the rules and work intuitively. The final stage, *ri*, is full mastery; at this point they have integrated so thoroughly that they transcend the rules and strike out onto new paths for others to follow.

One application of the Shu-Ha-Ri model addresses the appropriate time and place for agile process tailoring. When a team is new to agile, it's best to start by following a method that has already been tested, proven, and refined by others. The team needs to practice that system and develop some mastery over it before they can understand how and why all the pieces work together.

Dreyfus Model of Adult Skill Acquisition[14] This model by Stuart E. Dreyfus suggests that adults learn new skills over five stages—novice, advanced beginner, competent, proficient, and expert. In addition to improving your skills as you move through each of these stages your level of commitment, approach to decision making, and perspective on the task evolve as well.



Commitment: Detached	Commitment: Detached	Commitment: Detached understanding and deciding; involved outcome	Commitment: Involved understanding; detached deciding	Commitment: Involved
Decisions: Analytic	Decisions: Analytic	Decisions: Analytic	Decisions: Analytic	Decisions: Intuitive
Perspective: None	Perspective: None	Perspective: Chosen	Perspective: Experienced	Perspective: Experienced

FIGURE 9.7 *Dreyfus Model of Skill Mastery*

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Let's examine each of the five stages of this model.

- **Novice:** Novices follow the rules they have been given and make analytical decisions with limited knowledge. For example, if you are learning to drive a manual transmission, you might be told to change gears as the engine approaches 2,500 rpm. Although this rule is a good start, it could lead to problems if you drive on a hill, which will influence when you should switch gears.
- **Advanced beginner:** At this stage, you are still following rules and making analytical decisions, but now you have gained enough experience with real-world situations to begin to understand the context of the rules. Continuing our example to decide when to change gears, you might use a guideline such as "gear up when you hear the engine racing."
- **Competent:** As you gain competence, the number of rules and guidelines for different contexts becomes overwhelming. Since you can't apply them all, you begin to decide which rules are the best for each situation; this makes you feel more personally responsible for the choices you are making.
- **Proficient:** At this level, your decision making is still analytical, but you are actively choosing the best strategy rather than relying on the rules. In the process, you become more emotionally involved in the task. For example, as a proficient driver, you will have a gut feeling if you are approaching a corner too fast on a rainy day.
- **Expert:** As you develop expertise, your decision making becomes intuitive—you can spontaneously assess the alternatives and select the best approach without having to first analytically examine all the possible strategies.

As you progress through the mastery of new skills, your perspective changes from neutral (no opinion) to choosing a perspective based on the circumstances, to an expert perspective rooted in your own experiences. Meanwhile, your decision-making approach moves from analytical to intuitive, and your commitment moves from detached to involved.

Project managers who feel they do not have time for team building typically are not using project management best practices on their projects. Practices such as properly planning a project and managing risks and quality save significant amounts of time on a project, freeing up the project manager to do other important things, like team-building activities. When you take the exam, assume the project manager featured in the questions has a team-building plan appropriate to the size and characteristics of the team.

Team-building activities can include the following:

- Involving team members in planning the project, including creating the WBS or backlog as a group
- Taking classes together
- Retrospectives by the team to evaluate and improve their processes and interactions
- Collaborative problem-solving
- Milestone parties
- Holiday and birthday celebrations
- Skills assessments and development

Conflict Management On any project, there may be conflicts among team members or between team members and the project manager. This is especially true as a team is moving through the forming and storming stages of development on the Tuckman ladder, discussed previously. It is a responsibility of the project manager to address such conflicts, and facilitate resolution in a way that satisfies everyone involved. We will further discuss conflict management in the "Manage Team" section.

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Influencing "Influencing" is a rather ambiguous term, but it is an important aspect of a project manager's role and it begins with the project manager actively listening to differing viewpoints expressed by team members. Acknowledging those different perspectives and using communication and persuasive skills helps the project manager develop mutual trust and, eventually, agreement within the team.

Individual and Team Assessments

Individual Assessments The more you know about each person on the project team, the easier it is to build trust, improve team communication, and encourage cooperation among team members. Personnel assessment tools can help you learn more about team members by revealing how they make decisions, interact with others, and process information. This information can give you insight into how to lead and guide the team. Formal and informal assessment of team members by the project manager should continue throughout the project.

Team Assessments The project manager completes formal and informal team performance assessments as part of developing the project team. These assessments are meant to evaluate and enhance the effectiveness of the team as a whole. They may include an analysis of how much team members' skills have improved over the course of the project; how well the team is performing, interacting, and dealing with conflict; and how they are progressing through the stages of team development. The assessments also help identify needed support or intervention by the project manager. Such assessments should be ongoing while project work is being done. The results of team assessments can be used to recognize the team's progress or to motivate them to improve. Think of team performance assessment as looking at team effectiveness. The results of these assessments are also inputs to the Manage Team process, in which the project manager uses them to address issues identified.

Hybrid Assessments One way to assess individual team members is to designate them as I-shaped or T-shaped. I-shaped team members specialize in one area, while T-shaped team members have a broad range of skills. On hybrid and agile projects where the work is done iteratively and incrementally, teams prefer T-shaped people who can help share the workload or adapt to the changing needs of the project. T-shaped people help optimize value to the project by reducing bottlenecks.

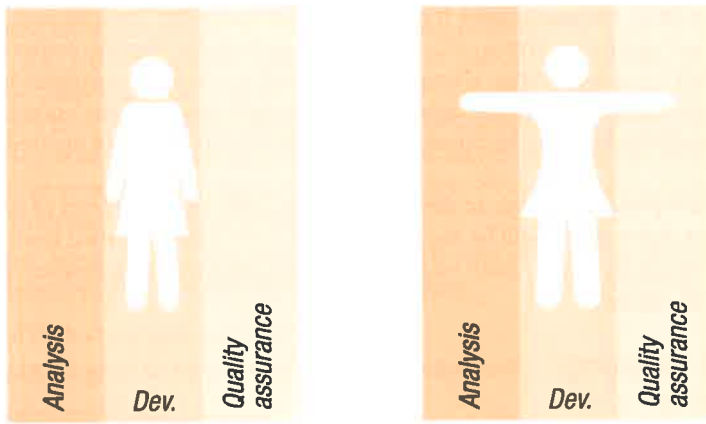

FIGURE 9.8 *I- and T-shaped team members*

Training Team members may require training to perform on the project or to enhance their performance. Such training can help team members, while also decreasing the overall project cost and schedule through increased efficiency. If the training will benefit the organization in the long run and/or can be used on future projects, it may be covered as an organizational cost. Otherwise, it is paid for by the project and documented in the resource management plan and included in the project budget.

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Project Performance Appraisals Project performance appraisals are evaluations of individual team member performance. In this effort, the project manager collects information from team members' supervisors and adjusts the project accordingly. It's also important to understand that an appraisal might bring to the project manager's attention the need to provide additional training or encouragement to a team member. Note that the focus of this appraisal is on the individual's performance of their assigned responsibilities, rather than on team performance.

Because the Develop Team and Manage Team processes are performed at the same time, it is sometimes difficult to determine what happens in which process. For example, did you know project performance appraisals are performed as part of Manage Team, while the rewards and additional training indicated by the results of those appraisals are given as part of Develop Team?

Coaching The goal of coaching is to help team members stay on track, overcome issues, continually improve their skills, and achieve their goals. Coaching is done at two levels—the team and the individual team members. Individual coaching sessions should be confidential meetings in a safe environment. During the conversation, it's important to be frank, yet remain positive and respectful. After the meeting, the coach should follow up to make sure there is improvement.

Key Performance Indicators Key Performance Indicators (KPIs) are measures used to review project performance. Project managers use KPIs to assess their team's performance and help plan the project as it is ongoing. On agile projects, where there is a fixed time and cost, KPIs are used to estimate the cost of the project. Here are some commonly used KPIs as they relate to agile:

- **Rate of progress** How many features or user stories are getting completed and accepted by the product owner per week or month?
- **Remaining work** How much work is left in the backlog?
- **Likely completion date** Take the amount of work left to do and divide it by your current rate of progress.
- **Likely costs remaining** For simple projects, this is the salary burn rate for the team multiplied by the remaining weeks left.

Colocation[15] A project manager might try to arrange for the entire team in each city to have offices together in one place or one room. This is called colocation, and it helps improve communication, decreases the impact of conflict (since all parties are right there), and, in a matrix organization, improves project identity for the project team and for management. The project charter, team norms, task boards, WBS, network diagram, and schedule may be posted on the walls to keep everyone focused on the work of the project.

The efforts of the project manager to develop the team have an added level of complexity when the team is not colocated. Extra efforts will be required to keep everyone on a virtual team informed, engaged, and committed to the project work. Such efforts include an emphasis on communication. Tools such as electronic task boards can help.

Communications Technology Technology provides many ways to keep in touch during a project, including the following:

- A shared portal, such as a website, enables access to current project documents at any time and from any location.
- Video or audio conferencing can be used to conduct virtual meetings when team members are working from remote locations.
- Email, text, and online chat are familiar ways for the project manager and team to communicate.

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Communications technology is a valuable asset on any project, but particularly on virtual projects. The project manager can use technology to build and support team efforts, even among team members who may not ever have the opportunity to work in the same physical location. Of course, communications technology also helps colocated team members stay in contact with each other and provide timely updates to other team members as needed. The resource management plan includes specifics of how the project manager will use available communications technology to meet the development needs of the team.

Recognition and Rewards In the Develop Team process, the project manager appraises performance and provides recognition and rewards in response to the work of the team or individual team members. To be effective, such rewards should be determined based on the project manager's understanding of what is valuable to the team member or group being recognized. In addition to recognizing past accomplishments, rewards provide incentive for ongoing achievement and efforts.

Outputs of Develop Team The results of team performance assessments are an output of this process. As you will read in the next section, these results are an input to the Manage Team process, and they provide insight for the project manager regarding continuous improvement of the team's performance. If the project manager determines that changes to any of the project plans are necessary, change requests are processed through integrated change control. Project documents, including the project schedule, team assignments, and resource calendars may require such formal changes.

Organizational process assets updates may include changes to training requirements, newly adopted team-building exercises, and revisions to existing templates for individual and team assessments. This process may also result in updates to documents such as the team charter and lessons learned register.

Manage Team

Manage Team involves all the day-to-day management activities that you're likely already doing on your projects. But there may be more to managing a team than you realize. Not knowing the responsibilities of a project manager as described in this chapter could cause you to get questions wrong on the exam.

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PG: Executing
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Team

Details related to team-management activities are included in the resource management plan. Other inputs to this process include the issue log (specifically issues related to the team), project team assignments (documented in a RACI chart), and the team charter. Work performance reports provide an indication of project progress as compared to the project management plan. The project manager uses this information to identify necessary corrective actions. Results of team performance assessments from the Develop Team process are analyzed to identify successes that need to be recognized, areas in which the team may need additional support or assistance, and issues or conflicts that need to be resolved in this process. Ultimately, team members are released as their work is completed.

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In the Manage Team process, the project manager should perform the following activities to help challenge team members to be part of a high performing team:

- Tracking and evaluating team performance
- Providing leadership
- Mentoring team members
- Planning and facilitating career development
- Dealing with team issues
- Facilitating conflict resolution
- Negotiating and influencing
- Adjusting plans based on performance data
- Managing risks to team success

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- Observing what is happening
- Using an issue log to track resolution
- Actively looking for and helping to resolve conflicts that team members cannot resolve on their own

Team Progress Part of supporting a high-performing team is assessing how each team member is fulfilling their responsibilities. Project performance appraisals and progress tracking provide this information on individual team members.

Burndown Charts Burndown charts track work to be done on a project. As work is completed, the progress line on the chart will move downward, reflecting the amount of work that still needs to be done. They are commonly used to measure the team's progress in completing the project work. A sample burndown chart is shown in figure 9.9.

Burnup Charts Burnup charts track the work that has been completed. Therefore, over the course of the project, the progress line on a burnup chart will move upward, showing the increasing amount of work that has been completed. The big advantage of using a burnup chart is that it can show changes in scope, making the impact of those changes visible. A sample burnup chart is shown in figure 9.9.

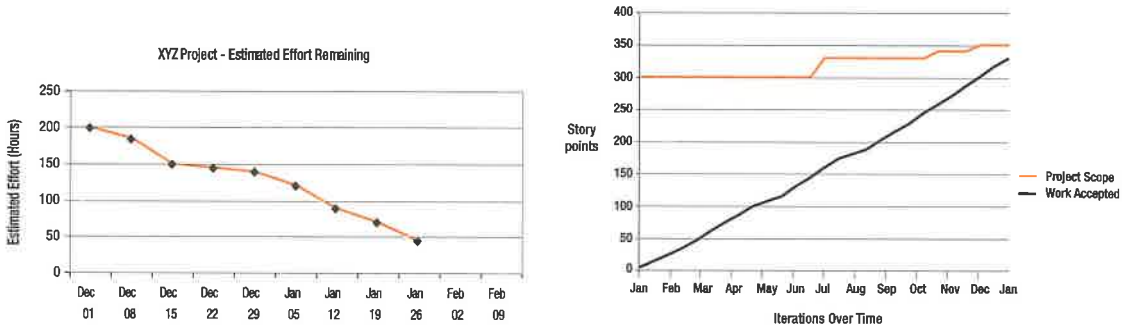

FIGURE 9.9 *Burndown chart (left); burnup chart (right)*

Every project is different and presents unique challenges to the project manager. Factors such as the size and makeup of the team, the experience level of the team, and the complexity of the actual project work must be considered by the project manager in their efforts to get the best from the team.

Consider the following questions:

Question You were just assigned to take over a project from another project manager who is leaving the company. The previous project manager tells you that the project is on schedule, but only because he has constantly pushed the team to perform. What is the first thing you should do as the new project manager?

A. Check risk status

B. Check cost performance

C. Determine a management strategy

D. Tell the team your objectives

Answer C

Explanation Before you can do anything else, you need to find a more effective management strategy. A management strategy that encourages performance will provide a sustainable framework for a motivated team to accomplish the required work. This may require requesting a change to the resource management plan that

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includes adding team-building activities as well as a recognition and reward system as part of developing and managing a team.

Question Another project manager in your organization comes to you for advice. She's having trouble getting her team to take ownership of the project and be comfortable selecting the work to be done. She keeps finding herself making the decisions and directing their work. What do you advise her to do?

A. At the stand-up meetings, assign a different person each day as the decision maker to get them all comfortable in the role.

B. Meet them halfway and work with their functional managers to align each team member's goals with the project goals.

C. Implement an incentive plan and officially report any lack of participation to team members' functional managers.

D. Explain to them that agile teams self-select their work and tell them to get on with it.

Answer B

Explanation In this situation, the project manager should assume a coaching role to help the team members get to the point where they are comfortable selecting their own work. This will include helping team members move project work forward, maintaining a safe work environment, partnering with their managers, and modeling positive relationships. Assigning someone as a decision maker at stand-up meetings is incorrect as agile teams are consensus-driven and decisions aren't made in stand-up meetings. Incentive plans can be useful, but what this team really needs is guidance. Simply explaining that agile teams self-select their work isn't enough to get team members comfortable assuming more ownership of the project.

Because a goal of coaching and managing the team is to engage team members and encourage them to do their best work on the project, involving them in decisions about the work is an excellent strategy. Because the team was involved in developing the plan, team members will be more likely to take on the attitude of, "I helped create this plan, so I do not mind being held to what is included in it." This collaboration between the project manager and team should continue in the Manage Team process.

Coaching, managing, and being of service to the team takes planning and a focused effort throughout the project that includes addressing issues before they become problems, listening, communicating, and maintaining relationships.

If you were an observer of your project management work, what would you see? Do you have a tendency to busy yourself issuing reports, rather than really seeing what the team is doing, how team members are interacting, what they feel is missing or doesn't work, and what is generating problems? Whether your team is colocated or virtual, paying attention to the tone of interactions, including emails and phone conversations will tell you more about what is going on than simply analyzing data. A project manager should observe what is happening and talk to people to understand how things are going.

Issue Log Many project managers use issue logs, also known as issue registers or action item logs, to record problems and their resolutions. You have seen the issue log used in integration and quality processes, and you will also see it in other knowledge areas within this book. Because it is updated to reflect new issues as well as the resolution of issues, it is frequently an input and an output of the same processes.

As part of managing team members and stakeholders, the issue log can be used to communicate about issues on the project. It facilitates the assessment of the causes of issues, the impact of issues on scope, schedule, cost, risk, and other aspects of the project, and the recommendation of corrective actions that could be taken. Such a log indicates to people that their needs will be considered, even if they are not

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addressed at the time the issue arises. Effective project managers control issues so they do not impact the project. The issue log is updated as part of project documents updates throughout the project.

An issue log might look like the one shown in figure 9.10.

Issue #	Issue	Date Added	Raised By	Person Assigned	Resolution Due Date	Status	Date Resolved	Resolution

FIGURE 9.10 *Issue log*

An issue log should be customized to meet the needs of the people who will be using it. For example, an issue log could include more detail—such as a description or the category of the issue (such as team, schedule, or technical)—as preferred by the team.

Many concepts related to managing people can appear on the exam. The next several pages include information and exercises related to some important topics.

Management and Leadership Styles The exam refers to management and leadership styles using the terms and concepts discussed in this section. However, there is no one right way to lead or manage that fits all situations or all project managers. Project managers should know the science of project management and make educated decisions about what they are doing, even when it comes to interacting with and managing people. To choose the most effective approach when answering exam questions, you must consider the information in the scenario, including whether the management and leadership of the project manager have been effective up to this point, what the skill levels, experience, and needs of your team members are, and how complex the project work is.

TRICKS OF THE TRADE You will likely need to use many leadership approaches throughout the life of a project. The term "situational leadership" refers to a manager using different leadership styles based on the people and project work they are dealing with. For example, there is a general consensus that a project manager needs to provide more direction (directing leadership style) at the beginning of the project because the project manager knows the project management work that must be done to plan the project. During project executing, the project manager needs to do more coaching, facilitating, supporting, influencing, and delegating.

You should be aware of some key terms related to management and leadership styles in the context of managing a project. On the exam, expect questions that describe a situation and then ask what you should do. The options might include solutions that involve using various forms of leadership styles; you will need to select the best answer based on the situation presented. The three bulleted lists that follow include important terms and definitions. Read the definitions two or three times so you are familiar with the terms before you see them used on the exam.

Some of the primary styles that you may see described in situational questions include the following:

- **Directing** The project manager uses their expertise to guide team members in what to do.
- **Facilitating** The project manager enables communication and helps remove roadblocks.
- **Coaching** The project manager advises and makes recommendations, helping the team and other stakeholders achieve their goals.
- **Supporting** The project manager encourages and provides assistance to team members and stakeholders in working through the situations they encounter.
- **Influencing** The project manager emphasizes teamwork, team building, and team decision-making, and works with their team to influence collaborative, successful project implementation.

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- **Delegating** The project manager establishes goals and then gives the project team sufficient authority to complete the work. For basic project management, the manager involves the team in the planning process and assigns or delegates planning and executing work to team members. Delegating can be hard for some people because they feel they can do the work better themselves. Using proper project management practices should help a project manager feel comfortable that others know what needs to be done and that the project can be successful.
- **Servant** The project manager shares power, puts the needs of the team first and helps people develop and perform to their best potential.

The following management and leadership styles may be particularly effective when the team is dealing with issues such as resolving conflicts, negotiating, prioritizing, or other decision-making activities:

- **Consultative** This bottom-up approach uses influence to achieve results. The project manager considers others' opinions and acts as the servant-leader for the team.
- **Consensus** The project manager encourages problem-solving in a group and makes decisions based on group agreement.
- **Democratic or participative** This style involves encouraging team participation in the decision-making process. Team members "own" the decisions made by the group, resulting in improved teamwork and cooperation.
- **Bureaucratic** This style focuses on following procedures exactly. The bureaucratic style may be appropriate for work in which details are critical or when specific safety or other regulations must be strictly adhered to.
- **Analytical** This style depends on the manager's own technical knowledge and ability. Analytical managers often make the technical decisions for the project and then communicate those decisions to their teams. Interview-style communication, in which the project manager asks questions to get the facts, is common with this management style.

Some management and leadership styles that may be described in situational questions or answer choices are not inherently bad, but they may create challenges for the project manager, team, and other stakeholders. For example, if the success of a project team is based on the charisma of its project manager, rather than on a strong management plan, and that project manager leaves the organization mid-project, the team may falter. Or, if a project manager takes a laissez-faire approach, and the team is not sufficiently skilled or motivated, it may be difficult to get the work done as planned. The following management and leadership styles are ones that have the potential to create such challenges:

- **Charismatic** Charismatic managers energize and encourage their teams in performing project work. With this style, project success may become dependent on the presence of the charismatic leader, with the team relying on the leader for motivation.
- **Autocratic** This is a top-down approach. The manager may coach or delegate, but everyone does what the manager tells them to do.
- **Consultative-autocratic** In this style, the project manager solicits input from team members, but retains decision-making authority.
- **Laissez-faire** The French term "laissez-faire" has been translated as meaning "allow to act," "allow to do," or "leave alone." A laissez-faire manager is not directly involved in the work of the team, but manages and consults as necessary. This style can be appropriate with a highly skilled team.
- **Driver** A manager with a driver style is constantly giving directions. Their competitive attitude drives the team to win.

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Powers of the Project Manager This section could be titled, "How to Get Cooperation from the Team and Stakeholders." Project managers can have difficulty getting people to cooperate and perform, especially if they are working in a matrix organization. Understanding the following types of power can help:

- **Formal (legitimate)** This power is based on your position. Example: "I understand you disagree. However, after careful evaluation, I believe my decision is in the best interest of the team, and this is what we are going to do."
- **Reward** This power stems from the ability to give rewards. Example: "I understand that you want to participate in the acceptance testing of this project. Because of your performance, I will assign you as part of that team."
- **Penalty (coercive)** This power comes from the ability to penalize team members. Example: "If this does not get done on time, I will remove you from the group traveling to the customer meeting."
- **Expert** This power comes from being the technical or project management expert. Example: "This project manager has been successful on other projects. Let's give her a chance!"
- **Referent** This power comes from another person liking you, respecting you, or wanting to be like you. It is the power of charisma and fame. Example: The most-liked and respected project manager in the organization says, "I think we should change the content of our standard project charter."

NOTE: The best forms of power are expert and reward. Penalty power is generally the least effective. Formal, reward, and penalty are powers derived from your position in the company. Expert power is earned on your own.

On the exam, expect questions that describe a situation and then ask what you should do. The options might include solutions using various forms of power. You'll then need to select the best answer based on the situation presented. To answer these questions, know that penalty is generally an incorrect choice, but make sure it isn't the most appropriate choice for the particular situation described.

Conflict Management Many situational questions on the exam describe conflicts. Therefore, to be able to pick the best choice from many "right" answers, you should understand different conflict resolution techniques and be able to determine which one is best for the situation described.

First, let's think about conflict. Is it bad? Should we spend time preventing the root causes of conflict? Who should resolve the conflict?

Try to answer the questions just posed. Get them right, and you are likely to do well on this part of the exam. The answers are:

- No, conflict is not inherently bad.
- Yes, it is important to identify and deal with the root causes of conflict.
- Conflict should be resolved by those who are involved, possibly assisted by the project manager.

Although we often think conflict is bad, it actually presents opportunities for improvement. This is another topic many people have a different understanding about than what is supported by currently accepted research. Make sure your basic thinking about conflict is on the new side and not the old, as shown in the following table.

Changing Views of Conflict

Old	New
Conflict is dysfunctional and caused by personality differences or a failure of leadership.	Conflict is an inevitable consequence of organizational interactions.
Conflict is to be avoided.	Conflict can be beneficial.

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Changing Views of Conflict	
Conflict is resolved by physical separation or the intervention of upper management.	Conflict is resolved through openness, identifying the causes, and problem-solving by the people involved and their immediate managers.

Conflict is inevitable, in part, because of the following factors:

- The nature of projects, which attempt to address the needs and requirements of many stakeholders
- Organizational limitations on the power of the project manager
- The necessity of obtaining resources from functional (resource) managers

The project manager has a professional responsibility as part of basic project management to attempt to avoid unnecessary conflicts through the following actions:

- Keeping the team informed about the following:
  - Exactly where the project is headed
  - Project constraints and objectives
  - The contents of the project charter
  - All key decisions
  - Changes
- Clearly assigning work without ambiguity or overlapping responsibilities
- Making work assignments interesting and challenging
- Following good project management and project planning practices

Note what we just stated: Many conflicts can be avoided. Do you do the things on the previous list? Did you realize the project manager has a professional responsibility to do such things? They are not optional; they are good project management.

TRICKS OF THE TRADE® Many people think the main source of conflict on a project is personality differences. They may be surprised to learn this is rarely the case. It only becomes personal if the root cause of the problem is not resolved. The following describes seven common sources of conflict in order of frequency (note that personality is last):

1. Schedules (unrealistic, resources not available)
2. Project priorities
3. Resources
4. Technical opinions
5. Administrative procedures
6. Cost
7. Personality

Conflict is best resolved by those involved in the conflict. The project manager should generally try to facilitate the resolution of problems and conflict as long as they have authority over those in conflict or over the issues in conflict. If not, the sponsor or functional managers may be called in to assist. There is one exception: In instances related to professional and social responsibility (someone breaking laws, not following policies, or acting unethically), the project manager must take the issue to someone higher in the organization.

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TRICKS OF THE TRADE When you have questions on the exam relating to conflict management, make sure you think: "Who generally has responsibility for (and authority over) the situation described in this question?"; "What resolution of this problem would best serve the customer's interests?"; and "What is the urgency with which I need to solve the conflict?" Would it be best to let everyone cool down or is this something that must be resolved immediately? What would happen if you didn't get involved versus involving yourself?

Know the following conflict resolution techniques for the exam. Notice that some have more than one title; you should know both.

- **Collaborating (problem-solving)** With this technique, the parties openly discuss differences and try to incorporate multiple viewpoints to arrive at a consensus. Collaboration leads to a win-win situation.
- **Compromising (reconciling)** This technique involves finding solutions that bring some degree of satisfaction to both parties. This is a lose-lose situation, since no party gets everything. Did you know that compromise is not the best choice, but rather second to collaborating?
- **Withdrawal (avoidance)** With this technique, the parties retreat or postpone a decision on a problem. Dealing with problems is a PMI-ism; therefore, withdrawal is not usually the best choice for resolving conflict, though there may be situations where it is necessary.
- **Smoothing (accommodating)** This technique includes making some concessions, and it emphasizes agreement rather than differences of opinion. It does not result in a permanent or complete resolution of the conflict.
- **Forcing (directing)** This technique involves pushing one viewpoint at the expense of another. It is a win-lose situation.

9.4 Exercise Read the description of a conflict resolution in the table below, and write in your Exercise Notebook which of the conflict resolution techniques (collaborating, compromising, withdrawal, smoothing, or forcing) is being used.

	Description
1.	"Do it my way!"
2.	"Let's calm down and get the job done!"
3.	"Let us do a little of what both of you suggest."
4.	"Let's deal with this issue next week."
5.	"Miguel and Kathleen, both of you want this project to cause as little distraction to your departments as possible. With that in mind, I am sure we can come to an agreement on the purchase of equipment and what is best for the project."
6.	"We have talked about new computers enough. I do not want to get the computers, and that is it!"
7.	"Miguel, you say the project should include the purchase of new computers, and Kathleen, you say the project can use existing equipment. I suggest we perform the following test on the existing equipment to determine if it needs to be replaced."
8.	"Let's see what everyone thinks, and try to reach a consensus."
9.	"Since we cannot decide on the purchase of new computers, we will have to wait until our meeting next month."
10.	"Miguel, what if we get new computers for the design activity on the project and use the existing computers for the monitoring functions?"

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Answer

Conflict Resolution Technique Described		
1. Forcing	5. Smoothing	9. Withdrawal
2. Smoothing	6. Forcing	10. Compromising
3. Compromising	7. Collaborating	
4. Withdrawal	8. Collaborating	

TRICKS OF THE TRADE On the exam, remember to look for collaborating or problem-solving choices as generally the best answers. Forcing is usually the worst, but remember that the answer depends on the situation described. There could be situations in which withdrawal is the best option.

Conflict resolution expert Speed B. Leas created the following framework[16] for project managers to judge the seriousness of a conflict and better understand how conflicts may escalate.

Level	Name	Characteristic	Language	Atmosphere/Environment
Level 1	Problem to Solve	Information sharing and collaboration	Open and fact-based	People have different opinions or misunderstandings, or there are conflicting goals or values. The atmosphere isn't comfortable, but it isn't emotionally charged either.
Level 2	Disagreement	Personal protection trumps resolving the conflict	Guarded and open to interpretation	Self-protection becomes important. Team members distance themselves from the debate. Discussions happen off-line (outside of the team environment). Good-natured joking moves to half-joking barbs.
Level 3	Contest	Winning trumps resolving the conflict	Includes personal attacks	The aim is to win. People take sides. Blaming flourishes.
Level 4	Crusade	Protecting one's own group becomes the focus	Ideological	Resolving the situation is not good enough. Team members believe that people "on the other side" will not change and need to be removed.
Level 5	World War	Destroy the other!	Little or nonexistent	"Destroy!" is the battle cry. The combatants must be separated. No constructive outcome can be had.

Understanding this framework of the stages of conflict can help you look at a situation more objectively, moving past your own judgments to see what is really happening. Identifying the stage of a conflict can also help you determine what tools and techniques may work in a given situation.

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Based on Leas' model, when a team is in conflict, you should first take some time to observe the situation and make sure you are seeing both sides of the dispute. This means, at first, you simply listen to the complaints without immediately trying to solve them. Feel the energy of the group and assess the level of conflict. Look for glances, eye rolling, and words that halt conversations to ascertain if the conflict is out in the open or if it is playing out below the surface.

One way to determine the level of conflict is to focus on the language the team is using and compare it to Leas' description of the five levels. Take a look at the table again. What sort of language would you expect to hear in a Level 2 conflict? How about a Level 5 conflict?

Level 2 might sound something like this:

I know you think my idea won't work as well, but we tried your approach last time, and there were a lot of problems.

Level 5 would be much more combative:

It's us or them. We have to beat them!

After observing and diagnosing the level of conflict, you can decide what to do about it. If the conflict is at Levels 1 through 3, do not take any immediate action to resolve it. Instead, first give the team a chance to fix it themselves. If the team can overcome the conflict on their own, they will have developed and exercised their own skills for resolving conflicts. It is okay for them to have some discomfort during this process, because that will better equip them to manage similar conflicts in the future. However, if the situation doesn't improve and instead seems to be escalating, the following guidelines can be useful in resolving the conflict:

Level 1 (Problem to Solve): Try constructing a collaborative scenario to illustrate the competing issues and use that scenario to help build consensus around a decision that everyone can support.

Level 2 (Disagreement): Conflict resolution typically involves empowering the relevant team members to solve the problem. This approach builds the team members' support for the decision and restores a sense of safety to the group.

Level 3 (Contest): The conflict has become accusatory. To help fix the issue, we need to accommodate people's differing views. Although this may involve compromising on the work to be done, we should not compromise the team's values.

Level 4 (Crusade): Resolving this level of conflict requires diplomacy. Since the communications between opposing sides have largely broken down, the team may need a facilitator to convey messages between the different parties. Our focus should be on de-escalating the conflict to take it down a level or two.

Level 5 (World War): Conflict at this level may be unresolvable. Instead of trying to fix it, we may need to figure out how we can give people ways to live with it. At this level we might separate the opposing individuals to prevent further harm to each other.

Remember, conflict is normal and inevitable when people work closely together. Project managers often feel obliged to help resolve a conflict. However, before rushing in, it is best to observe the situation to get a better view of the issues. Leas' model can help us objectively assess the severity of a conflict. Pay attention to the language being used and give the team an opportunity to resolve the conflict themselves. If you do need to intervene, focus on de-escalating the problem by separating facts from emotions and look for ways to help people move forward despite their differences.

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9.5 Exercise Review the following snippets of conversation, then write in your Exercise Notebook the conflict level illustrated in each.

Snippet
1. "They have no idea, yet again. We would be better off without them!"
2. "Okay, I get that you will have extra work if we choose this option. But so will I if we go with your method. And I'll have to redo this piece each time we set up a new page."
3. "That's it! I warned you before. You and me—outside, right now!"
4. "I know you have told me before, but I must be losing it. How do I request a ticket again?"
5. "You're just pushing for this option because it makes your job easier. You never care about how it impacts anyone else! I'm tired of it. I think we should try something else for once."

Answer

Conflict Level
1. Level 4
2. Level 2
3. Level 5
4. Level 1
5. Level 3

Emotional Intelligence Emotional intelligence is the ability to recognize and express one's emotions appropriately, and to perceive and manage the emotions being expressed by others using observation, communication, and interpersonal skills. An emotionally intelligent project manager is able to establish and maintain positive relationships by adjusting communications and anticipating the needs of others. They understand how emotion can drive the behavior of others and are able to use this understanding when dealing with issues and concerns of the team. Emotionally intelligent project managers are able to effectively use conflict resolution techniques—such as collaborating or smoothing, rather than forcing—because they are perceived as being trustworthy and fair.

Emotional intelligence enables a project manager to bring out the best in coworkers and team members by making them feel valued and important. Clearly, this trait is an asset for a project manager. Emotional intelligence can be developed and increased with study and practice.

The model shown in figure 9.11 organizes the different aspects of emotional intelligence into four quadrants. It represents the emotional skills related to "Self" on the left side and those related to "Others" on the right. Each of those columns is also split into two skill areas, "Regulate" and "Recognize," to make four cells.

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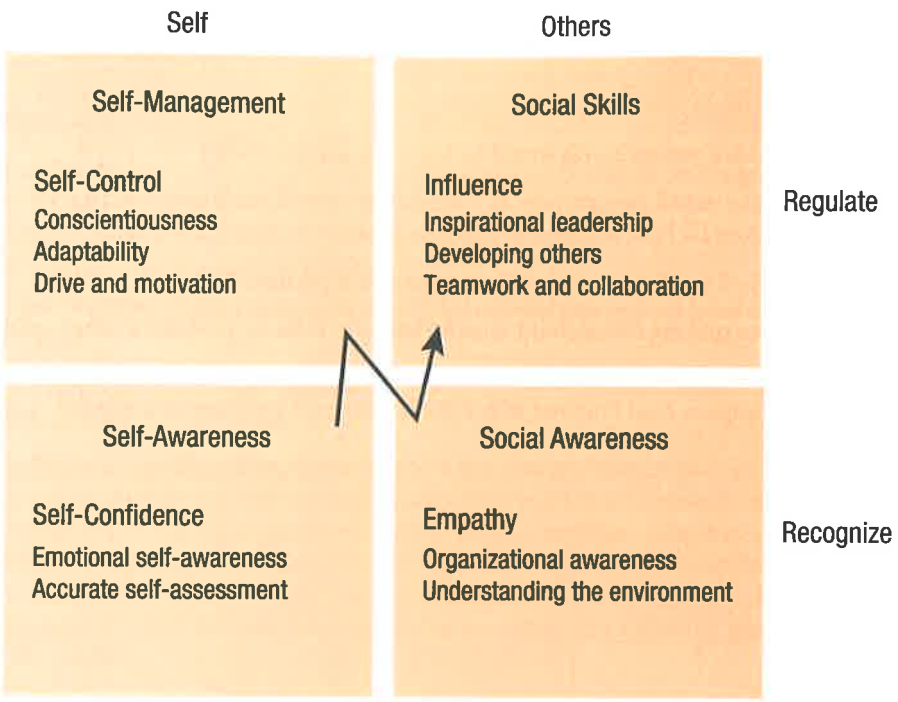

FIGURE 9.11 *Quadrants of emotional intelligence*

While everyone has some level of skill in all quadrants, it is usually easiest to start improving your emotional intelligence by recognizing your patterns in the "Self-Awareness" quadrant (bottom left). After that, you can learn to regulate yourself through "Self-Management" (top left), then build your "Social Awareness" (bottom right), and finally, hone your "Social Skills" (top right).

In other words, you must first recognize your own feelings. Once you understand your emotions, you can begin to control them. To start, you need to recognize what makes you angry, frustrated, happy, or thankful. Then you can realize you have the power to choose how to respond to those feelings. Recognizing you have a choice is a key part of becoming self-aware.

Keep in mind that how well you manage yourself and your attitude has an impact on those around you, particularly if you are in a position of leadership. Don't be the toxic, negative leader. Be the passionate, uplifting leader and create an atmosphere of cooperation and performance.

Once you've sorted yourself out in the areas of self-awareness and self-management, you can work on developing social awareness and empathy for others. As a project manager or team leader, you need to be able to identify when team members are stuck, frustrated, or upset. Once you're able to recognize these issues in your team, you can use your abilities to influence, inspire, lead, and develop others to help motivate your team to do their work and collaborate with each other.

TRICKS OF THE TRADE

Other Important Terms One of the things that drives people crazy about the exam is that they see terms they do not know. The following discussion of topics related to human resource management should help you get more familiar with some terms that have been on the exam but which you may not have run across previously.

- **Expectancy theory**[17] Employees who believe their efforts will lead to effective performance and who expect to be rewarded for their accomplishments will remain productive as rewards meet their expectations.
- **Arbitration** In arbitration, a neutral party hears and resolves a dispute.

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- **Perquisites (perks)** Some employees receive special rewards, such as assigned parking spaces, corner offices, organizational logo apparel, and executive dining.
- **Fringe benefits**[18] These are the standard benefits formally given to all employees, such as education benefits, insurance, and profit sharing.

Note that the exam can have made-up terms and processes as answer choices. But remember, if you are well trained in project management and you see a term on the exam that you do not recognize, chances are it is not the right answer!

Outputs of Manage Team Plans for releasing team members are included in the resource management plan. Because the length and focus of assigned work varies, team members may be released at different times throughout the project, as their work is completed. Whenever it occurs, release of team members is considered a part of this process.

As an output of this process, change requests may be needed to reflect changes in resource assignments, costs, schedule, or any other part of the project management plan or project documents. Examples include changes to plans for recognition and rewards, or newly identified needs for team training.

The issue log and lessons learned may be updated based on results of team management efforts. In addition, the existing systems for human resource management appraisals and evaluations may be updated.

Control Resources

While the *PMBOK® Guide* categorizes the control and management of physical resources as a process separate from that of managing people, can you see how this process might also fit within the process described above as "acquire and release resources"? The ECO addresses this process in the Process domain together with human resources management in task 5, Plan and Manage Budget and Resources. The bottom line is the project manager and team must ensure that the physical resources assigned to the project are available when they are needed—in the right place and in the right quantity.

PMBOK® Guide
PG: Monitoring and Controlling
Process: Control Resources

In this process, the project manager also monitors the amount, costs, and quality of resources being used, and compares that to what was planned. If there are any discrepancies between the planned versus actual utilization, corrective action may be necessary.

ECO
Domain: II
Task: 5

Remember the concept of integration and how project processes are related. Imagine a team of construction workers arriving on site only to find that the building materials and construction equipment have not yet arrived. A resource issue like this could impact not only the plan for resource management, but also those for schedule and cost, and potentially scope and quality.

The resource management plan indicates how physical resources should be acquired, utilized, controlled, and released. Other inputs to assist the project manager in controlling resources include project documents, agreements and contracts, and work performance data—all of which are discussed in the following sections.

Project Documents Use the following project documents to determine how you will control resources.

- **Impediment board** Specific to adaptive teams, this visual tool allows the team to track issues and risks associated with the project.
- **Issue log** This document provides information about current issues regarding resource usage on the project. Issues might include availability (over- or under-supply), usage (more resources or less resources being used than what was planned), quality discrepancies, and cost overruns related to resource usage.
- **Lessons learned register** The project manager may be able to benefit from previous project experience with resource control efforts and from historical lessons learned from other similar projects.

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- **Resource assignments** Resource assignments show anticipated resource usage and where the resources are coming from.
- **Project schedule** The project schedule indicates what resources are planned to be used, on which activities, and when they are needed.
- **Resource breakdown structure** Resource requirements are likely documented in a resource breakdown structure, which may be referenced by the project manager when a physical resource needs to be reordered or replaced.
- **Resource requirements** Resource requirements include what materials, supplies, and equipment are needed.
- **Risk register** The risk register includes information on potential risks related to the acquisition and use of physical resources. The project manager and team must be aware of these risks, so they are able to recognize risk triggers and initiate risk responses. Newly identified risks to physical resources may be added to the risk register throughout this process.

Agreements/Contracts If any of the physical resources being used on the project were obtained from a source external to the project, a contract includes details on the procurement as well as the seller's contact information, which can be important if issues arise related to the delivery or quality of the resources, or if additional resources are needed from the same source.

Work Performance Data This documentation provides a measurement of resources used, dates they arrived, and whether they worked as intended. Analysis of work performance data, the issue log, and other inputs gives the project manager an idea of how actual resource usage compares to the plan. The tools and techniques discussed in the following sections are used to evaluate ways to address any variances from the plan.

The following tools and techniques may be used as part of the Control Resources process.

Performance Reviews The project manager may undertake a performance review to analyze actual versus planned resource usage and performance. Cost and schedule data may be included in this analysis to determine possible causes of variance from the resource management plan.

Trend Analysis The project manager may compare measurements taken throughout the project to assess resource usage and then use that information to extrapolate potential future usage. This process also compares data to determine whether resource performance is improving or worsening.

Alternatives Analysis Options for dealing with variances—such as purchasing more or different resources or adding staff to expedite the use of those resources—may be evaluated to determine the most effective way to bring physical resource utilization back to what was planned, or to accommodate improvements in usage. For each option, the project manager might consider factors such as availability, quality, cost, and speed. The options are weighed to determine the most beneficial and cost-effective solution.

Also note that the project manager may use cost-benefit analysis to determine the most cost-effective way to correct a problem or improve a situation. This may be performed as part of alternatives analysis.

Project Management Information System (PMIS) You have seen throughout this book that the PMIS is used in many areas of project management. In this process, it can be used to track, access, and analyze data on the use of resources and to problem-solve issues regarding resource management. The results of these efforts will be stored in the PMIS so they are accessible throughout the organization. The outputs of the Control Resources process include work performance information, change requests, and updates to project documents and the project management plan.

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Work Performance Information Did you notice that work performance data is an input to this process, and work performance information is an output? The difference is that the work performance data is raw data. It is analyzed in this process, and used to compare actual to planned results to create work performance information.

Project Documents The documents that were inputs to this process may be updated based on the work of monitoring and controlling resources. These documents may include the issue log, the lessons learned register, resource assignments, the project schedule and risk register, and the resource breakdown structure.

Project Management Plan Components of the project management plan, specifically the resource management plan, may be updated to reflect minor changes in the usage, availability, and quality of resources. In addition to the resource management plan, the project schedule, cost baselines, and quality management plan may be changed as a result of this process.

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Practice Exam

1. All the following are forms of power derived from the project manager's position except:
   A. Formal
   B. Reward
   C. Penalty
   D. Expert

2. The highest point of Maslow's hierarchy of needs is:
   A. Physiological satisfaction
   B. Attainment of survival
   C. Need for association
   D. Esteem

3. Senior management has been extremely impressed by a new team member on the software development project. The team member has enthusiastically and efficiently completed his assigned activities. He has also demonstrated courtesy, respect, and consideration to everyone around him. For these reasons, management is planning to promote the team member to a business analyst position that is currently open on the project. The halo effect refers to the tendency to:
   A. Promote from within.
   B. Hire the best.
   C. Move people into new roles or new technical fields because they are good in their current technical field.
   D. Move people into project management because they have had project management training.

4. The replacement of an important legacy system in the organization will be challenging because there are offices in seven countries, and the business operations cannot be interrupted. Your objective is to have the system updated before new regulations go into effect in one of the participating countries. There are many opinions on how the system should be changed. Some stakeholders are expecting that the new system will encompass more capabilities than the current system. Both internal team members and consultants will be involved in making the hardware and software changes. The sponsor is hoping to keep costs down by using organizational team members to perform the testing and installation activities. You are defining the roles and responsibilities of the stakeholders on the project. The sponsor's role on a project is best described as:
   A. Helping to plan activities
   B. Helping to prevent unnecessary changes to project objectives
   C. Identifying unnecessary project constraints
   D. Helping to develop the project management plan

5. The project is expected to take four years. The project team members will not all be coming on at the start of the project, but rather will join and leave the team as needed. Historically, projects similar to this one have been volatile, and the work intense. Therefore, conflict between team members is almost inevitable. Which of the following conflict resolution techniques will generate the most lasting solution?
   A. Forcing
   B. Smoothing
   C. Compromise
   D. Problem-solving

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6. The most common causes of conflict on a project are schedules, project priorities, and:
   A. Personalities
   B. Resources
   C. Cost
   D. Management

7. Two stakeholders are disagreeing via a series of emails as to whether a deliverable meets the acceptance criteria. One of the stakeholders wanted different criteria, but the cost-benefit analysis done in planning did not support delivering that level of performance. The stakeholders agreed that the higher level of performance was not required and was not cost effective. A team member has just informed you that a problem with her work has occurred. The deliverable she is working on must be shipped today, or there will be a project breach. One of the stakeholders having the email disagreement comes to you to complain about the other. You say, "I cannot deal with this issue right now." Which of the following techniques are you using?
   A. Problem-solving
   B. Forcing
   C. Withdrawal
   D. Compromising

8. What does a resource histogram show that a responsibility assignment matrix does not?
   A. Time
   B. Activities
   C. Interrelationships
   D. The person in charge of each activity

9. The project you are managing is following the lean approach to develop software for automated loading of vehicles. Which effort should you ask the team to prioritize for this project?
   A. Use emotional intelligence to elicit stakeholder requirements.
   B. Research innovative new features.
   C. Shorten the time it takes to deploy a new feature after it's identified.
   D. Develop prototypes of new features for technical review.

10. The PMO has asked you to follow the principles of kaizen on your next change-driven project. What will this mean in reality?
    A. The product owner will need to submit all substantive scope changes to the PMO for review.
    B. The user story backlog can be reprioritized or updated at any time.
    C. The team is empowered to initiate small, incremental improvements to their development process.
    D. It won't mean much in reality since kaizen is just a principle, not a process or technique.

11. You have just been assigned as project manager for a large telecommunications project. This one-year project is about halfway done. The project team consists of 5 sellers and 20 of your company's employees. You want to understand who is responsible for doing what on the project. Where would you find this information?
    A. Responsibility assignment matrix
    B. Resource histogram
    C. Bar chart
    D. Project organizational chart

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12. During project planning in a matrix organization, the project manager determines that additional human resources are needed. From whom would she request these resources?
    A. The PMO manager
    B. The functional manager
    C. The team
    D. The project sponsor

13. A project manager must publish a project schedule. Activities, start/end times, and resources are identified. What should the project manager do next?
    A. Distribute the project schedule according to the communications management plan.
    B. Confirm the availability of the resources.
    C. Refine the project management plan to reflect more accurate costing information.
    D. Publish a bar chart illustrating the timeline.

14. During every project team meeting, the project manager asks each team member to describe the work they are doing, and then assigns new activities to team members. The length of these meetings has increased because there are many different activities to assign. This could be happening for all the following reasons except:
    A. Lack of a WBS
    B. Lack of a responsibility assignment matrix
    C. Lack of resource leveling
    D. Lack of team involvement in project planning

15. A team member is not performing well on the project because they are inexperienced in system development work. There is no one else available who is better qualified to do the work. What is the best solution for the project manager?
    A. Consult with the functional manager to determine project completion incentives for the team member.
    B. Obtain a new resource more skilled in development work.
    C. Arrange for the team member to get training.
    D. Allocate some of the project schedule reserve.

16. A project has several teams. Team C has repeatedly missed deadlines in the past. This has caused team D to have to crash the critical path several times. As the team leader for team D, you should meet with:
    A. The leader of team C
    B. The project manager
    C. The project manager and management
    D. The project manager and the leader of team C

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17. The project manager and the team are excited about the new project. This is the project manager's first assignment as project manager, and the team feels they will be able to complete work that has never been tried before. There are 29 people contributing to the product description, and the team consists of nine experienced experts in their fields.

    Partway through planning, three highly skilled technical team members are disagreeing about the scope of two of the deliverables. One is pointing to the draft WBS and saying that two additional work packages should be added. Another is saying that a particular work package should not even be done. The third team member agrees with both of them. How should the project manager best deal with the conflict?

    A. She should listen to the differences of opinion, determine the best choice, and implement that choice.
    B. She should postpone further discussions, meet with each individual, and determine the best approach.
    C. She should listen to the differences of opinion, encourage logical discussions, and facilitate an agreement.
    D. She should help the team focus on points on which they agree and build unity by using relaxation techniques and common-focus team building.

18. For your upcoming change-driven project, you are assigned a newly formed development team. The team members haven't worked together before, and they don't know each other very well. As their servant leader, what can you do to help them come together as a cohesive unit?

    A. Encourage them to come to you whenever they run into a problem they can't solve.
    B. Guide them in finding the best way to do the work so they can get off to a productive start.
    C. Share the project vision, then leave them alone to figure out how to achieve those goals.
    D. Facilitate team-based planning sessions to help them learn to work together.

19. A project is in the middle of the executing effort when a stakeholder suggests a change that would result in the third major overhaul of the project. At the same time, the project manager discovers that a large work package was not completed because a team member's manager moved her to another project that had a higher priority. Of the following, who is the best person for the project manager to address these issues with?

    A. The team
    B. Senior management
    C. The customer
    D. The sponsor

20. The installation project has a CPI of 1.03 and an SPI of 1.0. There are 14 team members, and each team member had input into the final project management plan. The customer has accepted the three deliverables completed so far without complaint, and the responsibility assignment matrix has not changed since the project began. The project is being completed in a matrix environment, and there are no contracts needed for the project.

    Although the sponsor is happy with the status of the project, one of the team members is always complaining about how much time his project work is taking. Which of the following is the best thing for the project manager to do?

    A. Review the reward system for the project.
    B. Try to improve schedule performance of the project.
    C. Meet with the customer to try to extend the schedule.
    D. Gain formal acceptance in writing from the customer.

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21. Which set of interpersonal skills would be most important for the manager of a change-driven project who wants to be an effective servant leader?
    A. The ability to resolve interpersonal conflicts among the team members
    B. The ability to understand and influence the emotions of other people
    C. The ability to balance the differing needs of diverse stakeholders
    D. The ability to make rational decisions independently, based on data

22. The project has been challenging to manage. Everyone has been on edge due to pressure to complete the project on time. Unfortunately, the tension has grown to the point where team meetings have become shouting matches, with little work accomplished during the meetings. One team member asks to be excused from future team meetings, as all the shouting upsets him. Meanwhile, the sponsor has expressed interest in attending future team meetings to hear how the project is going and to better understand the issues involved in completing the project. In addition, the customer has started discussions about adding scope to the project. In this situation, it would be best for the project manager to:
    A. Ask the sponsor if the information needed could be sent in a report rather than have her attend the meetings.
    B. Inform the team member who asked to be excused from the meetings of the value of communication in such meetings.
    C. Involve the team in creating new ground rules for the meetings.
    D. Hold a team-building exercise that involves all the team members.

23. Project performance appraisals are different from team performance assessments in that project performance appraisals focus on:
    A. How an individual team member is performing on the project
    B. An evaluation of the project team's effectiveness
    C. A team-building effort
    D. Reducing the staff turnover rate

24. You just found out that a major subcontractor for your project consistently provides deliverables late. The subcontractor approaches you and asks you to continue accepting late deliverables in exchange for a decrease in project costs. This offer is an example of:
    A. Confronting
    B. Compromise
    C. Smoothing
    D. Forcing

25. During the first half of the project, five team members left for other projects without being replaced, two team members went on vacation without informing you, and other team members expressed uncertainty about the work they were to complete. In this situation, it is best if you update which of the following for the second half of the project?
    A. Communications management plan
    B. Resource histogram
    C. Resource management plan
    D. Responsibility assignment matrix

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26. As the manager of an agile project, you normally attend the team retrospectives as an observer; however, last week you were out of the office and unable to attend. Upon returning, you review the action points listed on the meeting whiteboard, and everything seems fine. The mood in the team room appears to be normal, and everyone is busy. However, one of the team members approaches you privately with a concern about the meeting. He says that the two lead developers had a heated exchange about whether the team's development approach was working as planned, making everyone else feel uncomfortable. The team didn't take any actions to resolve the issue, and the disagreement wasn't documented on the meeting whiteboard. What should you do?
    A. Continue to observe the team, and encourage them to discuss the issue in the next meeting.
    B. In the next meeting, announce that all development issues must be resolved promptly, not deferred.
    C. You don't need to do anything; it sounds as if this team member is just trying to cause trouble.
    D. Tell the team lead that all disagreements need to be documented on the meeting whiteboard.

27. A large project is underway when one of the team members reviews the project status report. He sees the project is currently running late. As he looks at the report further, he notices the delay will cause one of his activities to be scheduled during a time he will be out of the country and will be unable to work on the activity. This is of great concern to the team member because he is committed to the success of the project and does not want to be the cause of the project being further delayed. What is the best thing for him to do?
    A. Contact the project manager immediately to provide the project manager with his schedule.
    B. Include the information in his next report.
    C. Request that the issue be added to the project issue log.
    D. Recommend preventive action.

28. Many work packages have been successfully completed on the project, and the sponsor has made some recommendations for improvements. The project is on schedule to meet an aggressive deadline when the successor activity to a critical path activity suffers a major setback. The activity has 14 days of float and is being completed by four people. There are two other team members with the skill set to assist the troubled activity, if needed.

    The project manager finds out that three other team members are attempting to be removed from the project because they do not feel the project can be successful. When the project manager investigates, she discovers that those team members have issues that have not been addressed.

    Which of the following is the best thing to do to improve the project?
    A. Have the team members immediately assist the troubled activity.
    B. Investigate why the project schedule is aggressive.
    C. See who can replace the three team members.
    D. Create an issue log.

29. In determining the physical resource requirements of the project, the team has identified the need for a highly specialized piece of testing equipment that will be used for approximately six months. The organization only owns one of these units, and it has been committed to other projects during the time this team will need it. Purchasing another similar unit is assumed to be cost-prohibitive. Which of the following is the least effective action for the project manager to take?
    A. Negotiate with the project manager that has reserved the equipment during the time it is needed by this team.
    B. Consult with the procurement department about the possibility of leasing a similar unit.
    C. Request that the sponsor intervene on behalf of the project.
    D. Adjust the schedule so that the work requiring the equipment can be done when the equipment is available.

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30. A project is being completed by a virtual team with team members from six countries. From their various locations, the team members are arguing about which office will take the lead on the project, disagreeing over meeting schedules, and questioning the abilities of individuals whom they have not worked with before. In which stage of the Tuckman ladder is this team functioning?
    A. Forming
    B. Reforming
    C. Storming
    D. Resourcing

31. A team member has missed the last two team meetings. Several of his assigned deliverables were completed late, and not all were of acceptable quality. He requests a meeting with the project manager, where he explains that he has been dealing with a number of personal issues, which he realizes have affected his work. Although this has been concerning for the project manager, as he has had to smooth the irritation of other team members and even taken on some of the team member's responsibilities, the project manager shows concern to the team member. He works with the team member to reschedule his work to allow him long weekends to deal with his personal situation and still get his activities completed on time. This is an example of:
    A. Expectancy theory
    B. Theory Y management
    C. Emotional intelligence
    D. Problem-solving

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Answers

1. **Answer** D
   Explanation When someone is given the job of project manager, they will have formal, reward, and penalty power. But just having the position does not make the project manager either a technical or project management expert. Expert power has to be earned.

2. **Answer** D
   Explanation This question is asking which of the *following* is the highest. Self-actualization is not listed, so the next best choice is esteem.

3. **Answer** C
   Explanation The halo effect refers to the tendency to rate team members high or low on all factors due to the impression of a high or low rating on one specific factor. It can result in a decision to move people into a different technical field because they are good in their current technical field. However, just because a person is good in one technical field does not mean they will also be good in another technical field.

4. **Answer** B
   Explanation Although the sponsor may help plan some of the activities, it is not their exclusive duty. Some project constraints come from the sponsor, but they should be considered necessary. The project management plan is created with the team and approved by the sponsor and other management. Since the project objectives are stated in the project charter, and it is the sponsor who issues the project charter, helping to prevent unnecessary changes to project objectives is the correct answer.

5. **Answer** D
   Explanation Problem-solving (also referred to as collaborating) normally takes more time, but it gets buy-in from everyone, generating a more lasting solution.

6. **Answer** B
   Explanation Know the top four sources of conflict on projects (schedules, project priorities, resources, and technical opinions) so you can be prepared to answer questions that relate to sources of conflict and how to deal with them. Don't be fooled because "personality" is on the list. It is not a major cause of conflict.

7. **Answer** C
   Explanation Delaying the issue is called withdrawal.

8. **Answer** A
   Explanation The responsibility assignment matrix maps specific resources to the work packages from the WBS. On a resource histogram, the use of resources is shown individually or by groups over time.

9. **Answer** C
   Explanation: While any of these options might sound plausible, we have to pick the best answer based on the information provided. The scenario says this project is using a lean approach, which focuses on eliminating waste and delivering value as quickly as possible. This means the team should be focused on reducing lead time—the time it takes to deploy a new feature after it's been identified. There isn't enough information to identify any of the other options as a higher priority.

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10. **Answer** C
Explanation Kaizen is a continuous improvement process where workers are encouraged to make small, incremental improvements to their work processes on their own initiative. So the best answer is that this means the team will be empowered to make continuous improvements to the way they work. Keeping the backlog reprioritized and updated is iterative scope management. While we can think of that as a form of continuous product improvement, it isn't the best answer. The remaining two answer options are incorrect.

11. **Answer** A
Explanation The resource histogram shows the number of resources used in each time period. In its pure form, a bar chart shows only activity and calendar date. The organizational chart shows who reports to whom. The responsibility assignment matrix shows who will do the work.

12. **Answer** B
Explanation In a matrix organization, power is shared between the functional manager and the project manager, so the project manager needs to negotiate with the functional manager for the resources.

13. **Answer** B
Explanation The project schedule remains preliminary until resource assignments are confirmed.

14. **Answer** C
Explanation The lack of a WBS, responsibility assignment matrix, or team involvement in planning could contribute to excessively long meetings during which resources are assigned to activities. Resource leveling refers to maintaining the same number of resources on the project for each time period and would not impact the length of meetings.

15. **Answer** C
Explanation The job of the project manager includes providing or obtaining project-specific training for team members. This kind of training may be a direct cost of the project.

16. **Answer** D
Explanation Those involved in the problem should resolve the problem. The fact that team D has had to crash the critical path several times implies that team D has already tried to deal with this problem. In this case, the two team leaders need to meet. The extent of this situation requires the project manager's involvement as well.

17. **Answer** C
Explanation Do not get confused by the wordiness of the question. Ask yourself what the best way is to resolve any conflict, and you can get the answer. Most of the details provided are distractors. Problem-solving (collaborating) and compromising are the two most important conflict resolution techniques. Conflict management is a key interpersonal and team skill.

18. **Answer** D
Explanation This question deals with the best approach to team building, and it also draws upon the Dreyfus model of skills acquisition. To support this new team, you want to provide just enough structure to help them develop a shared understanding and approach, while giving them as much autonomy as possible. So the best answer is to facilitate team-based planning sessions. Sharing the vision and then leaving them alone to figure out what to do would work fine with an experienced agile team. However, this team needs to first build trust and cohesion and learn how to work together. The remaining two answers (solving their problems or telling them how to do the work) would be too much micromanagement; those approaches wouldn't allow the team members to build their sense of autonomy and confidence.

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19. **Answer** D
Explanation It is the sponsor's role to prevent unnecessary changes and to set priorities among projects. The situation described in this question implies that such work is not being done. The project manager must therefore go to the root of the problem: the sponsor.

20. **Answer** A
Explanation Although it would seem to be a good idea to improve schedule performance, the SPI is good. The schedule has been approved as it is. It would be better for the project manager to spend more time controlling the project to make sure it finishes according to plan.

This also means there is nothing wrong with the schedule performance of the project that would require an extension. Gaining formal acceptance from the customer will need to be done, but will not affect the team member's dissatisfaction.

The only real problem presented in this situation is that the team member is complaining. The team member was involved in creating and approving the project management plan, which included details about his own involvement in the project. Because the responsibility assignment matrix has not changed, the team member has not even been assigned different duties since the project began. The project manager should investigate and find out if the reward system is ineffective.

21. **Answer** B
Explanation The correct answer is being able to understand and influence the emotions of others; this is a key component of emotional intelligence. Change-driven approaches such as agile emphasize collective decision making, rather than relying on the servant leader to make decisions independently. The servant leader should allow most conflicts between team members to be resolved by those directly involved unless they start to escalate. Balancing the diverse requirements of the project stakeholders would be primarily the responsibility of the product owner or value management team, not the project manager.

22. **Answer** C
Explanation Here is a situation in which all four choices could be done, but there is one best answer. Asking the sponsor if the information could be sent in a report does not solve the root cause of the problem described. Informing the team member of the value of communication in meetings merely dismisses the concerns of the team member. A team-building exercise would take planning, so it could not be done right away. Remember, the sponsor might be attending the next meeting, and at least one team member might not attend because of past problems. The best thing to do would be to set up new ground rules governing team behavior and then plan a team-building exercise.

23. **Answer** A
Explanation The best thing to do is to look at the two terms used here (project performance appraisals and team performance assessments), and review in your mind what each means before looking at the choices. Team performance assessments evaluate the project team's effectiveness as a whole. Project performance appraisals deal with how each team member is performing on the project.

24. **Answer** B
Explanation Both parties are giving up something. This is a compromise.

25. **Answer** C
Explanation The resource histogram shows the resources used per time period, but it would provide limited benefit in this situation. The responsibility assignment matrix cross-references resources with the activities or work packages they are to accomplish to help give clarity to the team members on their assignments, but it does not show when they will be required to do their work. The resource management plan, which describes when resources will be brought onto and taken off the project as well as how team members should communicate with the project manager, would provide the most benefit for this project.

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26. **Answer** A
Explanation This question deals with conflict management. The disagreement described appears to be a level 1 conflict, where people are simply debating their different opinions. While this might make others uncomfortable, a frank exchange of views is important for an agile team, which relies on divergent opinions to arrive at the best collective decisions. It appears that for now this team has been able to table the debate and move forward with the work. It wouldn't be helpful to require that all development issues be resolved immediately. It can take time to work through uncertainty and come to a consensus. While you don't need to get involved yet, dismissing this information wouldn't be proactive, either. The problem may escalate and cause issues later. Since agile team debates are not uncommon, requiring that all disagreements be documented in writing would add unnecessary busywork (and be difficult to enforce).

27. **Answer** D
Explanation Providing the project manager with his schedule, including the information in a report, and requesting that the issue be added to the issue log have one thing in common. They involve the team member asking the project manager to do something. In reality, it may well be the team member who will come up with a solution (for example, decreasing the scope of the activity, fast tracking, or specific suggestions about changes to predecessor activities). Therefore, recommending preventive action is the best choice for the team member. Recommended corrective or preventive actions can come from the team or stakeholders in addition to the project manager.

28. **Answer** D
Explanation After you read the answer options, you should realize that the data in the first paragraph is completely extraneous. The troubled activity has float and so does not need immediate attention.

Investigating why the schedule is so aggressive should have been done before the project began. Replacing team members does not solve the root cause of the problem. It would be more effective to discover the root cause of those team members' concerns so the problem does not surface again later. The creation of an issue log will let the troubled team members know their concerns have been heard, are noted, and will be resolved. This might be enough to stop them from leaving and avoid the resultant project delays and confusion if new team members must be added.

29. **Answer** C
Explanation It is a professional responsibility of the project manager to consider the needs of the entire organization, not only those of his project. It is also the project manager's responsibility to attempt to deal with the situation before involving the sponsor. For these reasons, involving the sponsor is not the best thing to do. All the other choices are options the project manager should consider first.

30. **Answer** C
Explanation The team's disagreements are indicative of the storming stage of development. As they continue working together, they will move into the norming stage.

31. **Answer** C
Explanation Emotional intelligence enables a project manager to bring out the best in coworkers and team members by making them feel valued and important. In this case, he was able to show empathy while still working out a plan for the team member to fulfill his project responsibilities.

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Communications

TEN

How often do you skip sending a message thinking you'll get to it later? Or maybe you've sent a message but summarized the communication instead of including all the details. If someone needs more data, they'll ask for it, right? Or have you ever received a message and reviewed it quickly thinking you understood the main point? Project communications can sometimes feel like overkill, especially when communication is constantly going on throughout any given day. Many beginning project managers rely on a mix of these casual exchanges and some type of formal reporting as a way to manage all necessary communication needs. But this almost always leads to missed information, which ultimately results in a negative impact on the project.

It's no surprise that project managers typically identify communication-related issues as the #1 problem they experience most frequently on projects. Add to that the list of factors that impact communications. Here are just a few examples:

- The sheer number of communications involved on a project indicates there will be communication problems. Almost everything we do involves communication.
- Projects often involve virtual teams, leading to more complex communications strategies.
- The rapid rate of change on projects causes the need to continually revisit communications strategies and past communications.
- The growing number of diverse communication tools that project managers and their teams have at their disposal.

Only one solution results in a successful outcome: communications must be planned, managed, and continuously monitored throughout the life of a project. Managing communications may include assessing the communication needs of stakeholders and determining what methods will be best for the project. Communication channels will also need to be reviewed, along with the frequency and level of detail of all project communications. Most importantly, project managers need to ensure effective communications so they are understood and appropriate feedback loops are completed.

QUICKTEST

- Communications management process
- Communications management plan
- Flow of communication
- Communication types
- Communication models
- Communications technology
- Communication methods
  - Interactive communication
  - Push communication
  - Pull communication
- Meetings
- Communication channels
- Project Reporting
  - What should be reported
  - Types of reports
    - » Status report
    - » Progress report
    - » Trend report
    - » Forecasting report
    - » Variance report
    - » Earned value report
    - » Progress metrics
    - » Retrospective findings
    - » Lessons learned
- Communication blockers
- Knowledge sharing
  - Information radiators

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Effective project managers create communications management plans that go beyond formal and traditional reporting structures. They also continually reassess stakeholder communication needs, communicating face-to-face whenever possible to establish good ongoing relationships. These positive working relationships ease the effectiveness of each opportunity to exchange information and move project goals forward. Effective project managers also frequently revisit communications strategies to limit the potential for communication problems. To pass the exam, you should have this type of mindset about communicating on projects.

The following tables should help you understand how communications management fits into the overall project management process.

PMBOK® Guide: Communications Management	Done During
Plan Communications Management	Planning process group
Manage Communications	Executing process group
Monitor Communications	Monitoring and controlling process group

ECO Domain II: Process
Task 2: Manage Communications

These tables illustrate that the communications management process from the *PMBOK® Guide* can be most closely mapped to the *Examination Content Outline* (ECO) task 2, Manage Communications. However, the management of resources and stakeholders closely align with tasks related to communications management. For examples related to stakeholders and resources, see domain I (People) tasks 4, 5, 9, and 13 and domain II (Process) tasks 4, 12, and 16. The following domain I tasks all require a project manager to have an understanding of communication models and blockers along with careful attention to communication types, technology, and methods: manage conflict (task 1), lead and build a team (tasks 2 and 6), support team performance (task 3), build shared understanding (task 10), and engage and support virtual teams (task 11). In fact, communications management is involved in almost everything you do on a project.

Although this chapter is not particularly difficult, it is one you should take seriously. Be sure to find your gaps regarding project communications, and be aware that communications questions are frequently combined with other topics. For example, a WBS, story backlog, and release maps are used as communications tools although they are primarily scope tools (see the "Scope" chapter). Another example is risk response strategies, which should be communicated to stakeholders (see the "Risk" chapter). You may also see questions linking communications management to stakeholder engagement.

To prepare for the exam, it's important to solidify your knowledge and understanding of the basics and overall foundation of project communications.

The Foundation of Communications PAGE 360

To effectively conduct and facilitate project communications, you need to have a good understanding of the foundation and basics of communications. This means you must understand communications technology, methods, and models. You must also take into account the performing organization's established processes and procedures for communicating about projects, its historical records and lessons learned from previous projects, and other stored information (organizational process assets). In addition, you must consider the performing organization's environment and approved communication systems, including its culture and expectations (enterprise environmental factors). Let's first look at a model of how the flow of communications should work on projects.

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TRICKS OF THE TRADE

Project communications occur internally and externally to the core project team—vertically (up and down the levels of the organization) and horizontally (between peers). Make sure your planning includes communicating in all directions, as shown in figure 10.1.

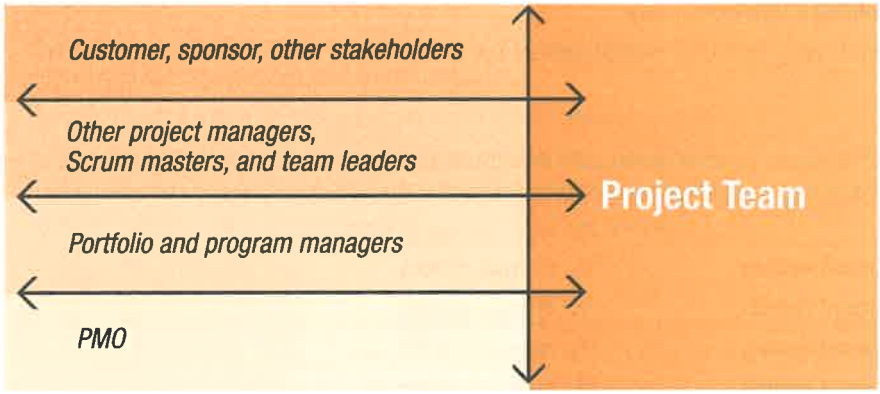

FIGURE 10.1 *Flow of communication on a project*

Communication Types The first step in effective communication is choosing the best type of communication for each situation. Information can be expressed in different ways—formally or informally, written or verbal. You need to decide what approach to use for each instance of communication. Make sure you understand the following chart.

Communication Type	When Used
Formal written	Project charter, planning documentation, backlogs, contracts, and reports; can be physical and electronic
Formal verbal	Planned meetings and stakeholder briefings; stand-up meetings and retrospectives; can be face-to-face or remote
Informal written	Email, handwritten notes, text messages, instant messaging, social media, and websites
Informal verbal	Unscheduled meetings, conversations, and other casual discussions

10.1 Exercise Test yourself! What is the best type of communication in the following situations? Write the answer in your Exercise Notebook.

Situation
1. Updating project communications strategies
2. Giving presentations to management
3. Trying to solve a complex problem
4. Updating the product backlog
5. Making notes regarding a telephone conversation
6. Making changes to a contract
7. Scheduling a meeting
8. Clarifying a work package
9. Requesting additional resources

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Situation
10. Trying to discover the root cause of a problem
11. Sending an email to ask for clarification of an issue
12. Holding a milestone party
13. Conducting an online bidder conference

Answer Imagine these as situational questions. Exam questions may have more words, but they will boil down to straightforward situations like the ones described in the exercise table.

1. Formal written	8. Formal written
2. Formal verbal	9. Formal written
3. Formal written	10. Informal verbal
4. Formal written	11. Informal written
5. Informal written	12. Informal verbal
6. Formal written	13. Formal written
7. Informal written	

The Five Cs of Communication Certain qualities of written communication enhance the likelihood that communications will be correctly interpreted and understood by the recipients. The following qualities should be incorporated by the project manager to ensure that messages are effective:

- Correct grammar and spelling
- Concise and well-crafted
- Clear and purposeful
- Coherent and logical
- Controlled flow of words and ideas

Communication Models Many of us do not think systematically about our communications. For example, we may just send an email and expect that it will be read and interpreted properly. The most basic communication model only ensures that a message has been delivered, but excellent project communication requires a more complete approach to communications.

A more comprehensive communication model, interactive communication, includes three main components: the sender, the receiver, and the confirmation that the message is correctly understood. Each message is encoded by the sender and decoded by the receiver. The receiver acknowledges receipt of the message, and both the sender and receiver are responsible for confirming that it has been properly interpreted by the receiver.

Factors such as working with different languages and cultures are important, but even the receiver's perception of the message, everyday distractions, or a lack of interest can affect the way the receiver decodes a message. Communication models often refer to these types of factors as "noise" because they can interfere with the receiver's ability to understand the message.

More complicated communication models exist, and different models may be appropriate for different projects or components of a single project. Keep the interactive model of communication, as shown in figure 10.2, in mind when answering communications questions on the exam.

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Sending Effective Communication The sender should determine which communication method to use to send a message, and then encode the message carefully and confirm that it is understood. When encoding the message, the sender needs to be aware of the following communication factors:

- **Nonverbal** A significant portion of in-person communication is nonverbal; this can include gestures, facial expressions, and body language.
- **Verbal** There are two important aspects of verbal communication:
  - The words and phrases a sender chooses are essential components of the message, but their meaning can be obscured by the accompanying nonverbal factors.
  - Pitch and tone of voice also help to convey a spoken message.

To confirm the message is understood, it's helpful for the sender to ask for feedback using questions such as, "Could you rephrase what I've said in your own words?" But it's also up to the receiver to make sure they have received and understood the entire message.

This is especially true in situations involving cross-cultural communication. Senders and receivers of communications must be aware of cultural differences, including age, gender, and nationality, and take those factors into account when planning, transmitting, and interpreting communications.

If a message is not understood, the receiver should acknowledge the message by saying something like, "I'm not sure I understand. Can you explain that again?" Like the sender, the receiver needs to encode their response carefully, keeping in mind the potential effects of verbal and nonverbal communication, when giving feedback to the sender, as illustrated in figure 10.2.

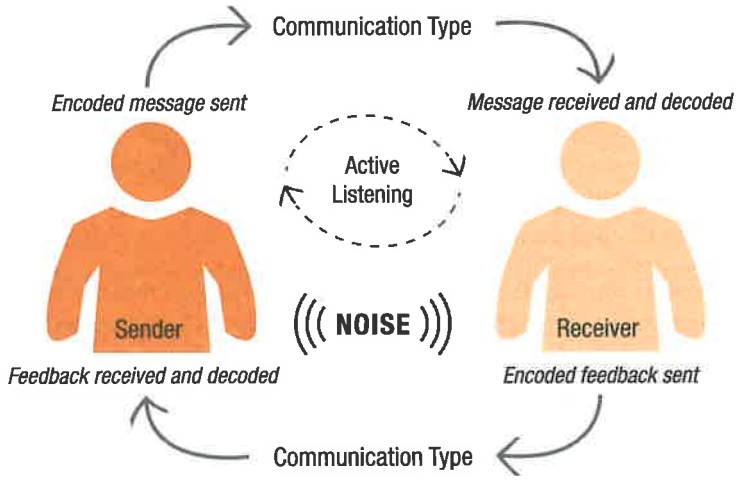

FIGURE 10.2 *The interactive communication model*

These factors apply to individual interactions as well as to project communications. It's possible to plan not just the types of communications to be used, but also ways for the sender to confirm the receiver has interpreted the message as intended. A project manager provides guidance to stakeholders regarding what to communicate and when to communicate it. It can be included in planning documents, information radiators, and verbally, and may also include direction on how to confirm the understanding of communications.

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Effective Listening So what should a receiver do during in-person communication to accurately decode a message and confirm it has been understood? The receiver should pay attention to the sender's gestures and facial expressions, and try to focus on the content of the message without distraction. It's also important that a receiver practices active listening. Active listening means the receiver confirms they are listening, accurately reflects back on the speaker's remarks, expresses agreement or disagreement, and asks for clarification as necessary.

Communication Blockers[1] Like noise in a communication channel, blockers can range from a lack of cultural sensitivity to a failure to provide concise messages. Blockers cause miscommunication and can lead to disagreement and confusion. The exam has often included one or two questions that ask, "What can get in the way of communication?" or "The following has occurred; what is wrong?" The correct answer may include:

- Noisy surroundings
- Distance between those trying to communicate
- Improper encoding of messages
- Language
- Culture

Communication Technology Communications can take place in many ways: face-to-face, over the phone, in writing, through instant messaging, and via email. These means of communicating are collectively referred to as communications technology. A key aspect of planning communications is determining the optimal technology with which to communicate information. Agile emphasizes more face-to-face communication, while more formal written communications are necessary when utilizing a predictive approach. You can use the following list of questions to determine the appropriate technology based on the situation:

- Would it be better to communicate this information in person or virtually?
- Would it be better to communicate the information through an email or a phone call?
- What technology is the team familiar and comfortable with?
- How quickly and how often does the information need to be communicated?
- Are there security or confidentiality issues that should be considered when choosing a means of communicating information?
- Would a letter sent through the mail get more attention?

It's also important to consider the complexity of the information that needs to be communicated. Alistair Cockburn developed a communication effectiveness model that compares common communication methods in terms of their effectiveness and their richness, or "temperature."[2] Figure 10.3, which is based on Cockburn's model, maps two key factors—interactivity and information density—for several communication technologies. This concept is especially important in agile environments where complex information is communicated in less formal methods. Interactivity and information density on this model indicate a communication technology's ability to transfer complex information efficiently.

In the figure, paper-based communications are the lowest in terms of interactivity and information density. Written documents take a long time to create and, because they are not interactive, the documents have to be written in such a way that all project stakeholders can understand the information, regardless of their level of knowledge or expertise. Paper documents are also low in bandwidth, so they typically do not convey the writer's emotional tone, feelings about the information, or implicit assumptions.

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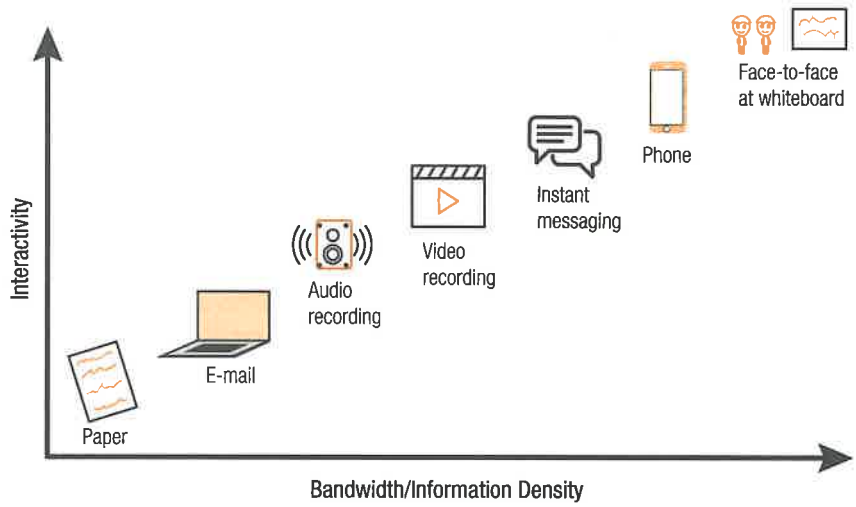

FIGURE 10.3 *Information transfer efficiency via technology*

At the other end of the scale, face-to-face communication at a whiteboard has the highest efficiency. Here, the participants (such as the project team, for example) can both converse and draw their ideas on the whiteboard. They can use shortcuts for well-understood concepts to speed the exchange of information, and they can ask each other questions and get immediate feedback. Such conversations convey a lot of emotional bandwidth through nonverbal communication such as gestures, facial expressions, and tone of voice. Face-to-face communication allows for the most information to be transferred in a given period of time, but it is less convenient than other forms of communication. Can you see how this approach would be helpful for the project team, but may be impossible with all of the stakeholders on a project? Think about how you would use this model for your real-world projects.

TRICKS OF THE TRADE As you read this chapter, you may come across many new terms. You can learn most of these terms without memorization as long as you understand that project communications requirements for all stakeholders must be collected, analyzed, and accounted for on an ongoing basis. And while face-to-face communication is often most effective, we also often work with dispersed teams. For example, can you guess what "push communication" might be before reading the next section?

Communication Methods When planning communications, it's also important to determine the communication method. These methods can be grouped into the following categories:[3]

- **Interactive communication** This method is reciprocal and involves two or more people. One person provides information; others receive it and then respond to the information. Examples of interactive communication include conversations, phone calls, meetings, instant messaging, and video calls.
- **Push communication** This method involves a one-way stream of information. The sender provides information to the people who need it but does not expect feedback from the recipients. Examples of push communication are status reports, emailed updates, blogs, and company memos.
- **Pull communication** In this method, the sender places the information in a central location. The recipients are then responsible for retrieving the information from that location. This method is often used to distribute large documents or to provide information to many people.

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In choosing a communication method, you should consider whether feedback is needed or if it is enough to simply provide the information. Where possible, it's worth involving stakeholders in the final decision about which methods will meet their communication needs. Such decisions will support the stakeholder engagement efforts on the project.

Communication Channels[4] A quick note on communication channels. When you add one more person to the team, does the number of communication channels simply increase by one? No. In fact, there is a substantial increase in communication channels. As a result, communication needs can grow rapidly with each added stakeholder.

Communication channels can be calculated using the following formula:

$$\frac{n(n-1)}{2} \qquad n = \text{the number of stakeholders}$$

Note that n equals the total number of stakeholders.

Let's practice using this formula with an example. If you have four people on your project and you add one more, how many more communication channels do you have? To get the answer you calculate the number of communication channels with a team of four and with a team of five, and then subtract to identify the difference.

For a team of four: calculate 4 times 3 (which is $n - 1$) to get 12, and then divide by 2 to reach the answer, which is 6. For a team of five: calculate 5 times 4 (which is $n - 1$) to get 20, and then divide by 2 to reach the answer, which is 10. The difference between 10 and 6 is 4. Simple!

You may or may not see this formula when taking the exam. But just in case, be sure to understand the concept, and know how to calculate the number of communication channels.

Communications Planning PAGE 366

PMBOK® Guide
PG: Planning
Process: Plan Communications Management

ECO
Domain: II
Task: 2

When determining what to include in your communications management plan, it's important to consider the overall communications approach for your project. The plan should also be based on the information needs of stakeholders and of the project. It should have flexibility to change as the project progresses and those needs change. The plan should also identify what systems and processes are already in place to support communications, as well as what processes and documents must be created to maximize the effectiveness and efficiency of communications on the project. This effort includes planning what information will be communicated, to whom, when, using what method, and how frequently. Ultimately, the plan will guide you and the project team in managing and monitoring communications to ensure information is getting to the people who need it, is clear and understandable, and allows stakeholders to take action as necessary.

You'll need to refer to the project charter and other relevant documentation, such as requirements documentation, the stakeholder register, and plans for stakeholder engagement. Your communications plan should explain how project communications will support this other related area.

On your projects, do you take the time to ask stakeholders about their communications requirements? Remember, you need to gather requirements from your stakeholders that relate not only to how they want the product of the project to function, but also how they want to communicate and be communicated with on the project. These communications requirements need to be analyzed to determine how they can be met and to make sure that meeting them will add value to the project and will be worth the effort and cost involved.

Project size, life cycle, and development approach are all factors for consideration in communications planning. You'll need to be equally comfortable with planning communications for large projects as well as small projects, and using predictive, adaptive, or hybrid development approaches. A large project may have

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a team of 300 people located in different countries, speaking different languages, and with diverse approaches to communication that are influenced by their culture. A small project may be accomplished entirely from one location. It is critical to thoroughly plan communications but to also tailor that planning effort depending on the project.

In hybrid environments, for example, project managers communicate some project information through both predictive and agile methods. Leaders of agile teams in hybrid environments must often produce weekly status reports, update Gantt charts, and create earned value reports in addition to tracking agile metrics, like throughput and velocity. Also keep in mind that an important role of a project manager is to protect the team, which will allow them to operate in a more agile way.

Many project managers fail to recognize not only the impact of communications on a project but also the complexity of sharing information. When we teach communications in our Project Management Tricks of the Trade® class, this topic is one that most people are not initially interested in, yet they find the communication activities we offer in class to be some of the most valuable.

This topic is important on the exam. It shouldn't be difficult for you—as long as you feel comfortable recognizing the type of project from the information in the question and answering accordingly. A basic concept is that communications should be efficient (providing only the information needed), effective (providing information in the right format at the right time), and should add value to the project. Think about your real-world communications. Do you do the following?

- Ask people what information they need and when.
- Tailor standardized communication practices within your organization to project size, complexity, life cycle, and development approach.
- Use multiple methods of communicating.
- Plan how you will confirm communication is received and understood.
- Realize that communication goes in multiple directions, to and from people at all levels, and internal and external to the organization.
- Analyze how factors such as location, culture, security, privacy, and language will impact communications on the project.
- Plan communications for each stakeholder or group based on individual needs and interests.
- Have a system for storing, maintaining, and retrieving project information.

10.2 Exercise Test yourself! In your Exercise Notebook, write down what information and documents need to be communicated on a project.

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Answer

Some possible answers are:

- Project charter
- Project management artifacts like plans, release maps, and other documentation
- Impacts to and from other projects
- User stories, backlog, WBS, network diagram, and dependencies
- When resources will be needed
- Team norms
- Working agreements
- Definition of done
- Burn charts
- Information radiators
- Meeting schedule
- Work assignments
- Status
- New risks uncovered
- Uncertainties
- Problems
- Successes
- Changes to project scope and product scope
- Schedule of management reviews and planning updates
- Results of change requests
- Upcoming work such as scheduled WBS components or iteration backlogs
- Delays
- The date of the next milestone completion
- Performance reports
- Retrospective results and lessons learned
- Issue logs
- Configuration management issues
- What types of emails will be sent to each stakeholder or group
- Contact information for stakeholders

Communications Requirements Requirements analysis will help you correctly understand stakeholders' information requirements. Understanding and fulfilling these requirements will help you maintain stakeholder engagement by ensuring that communication needs are met. If you skip this step, you risk not meeting the communication needs of stakeholders, and potentially misunderstanding requirements altogether.

Use the following information to determine and analyze communication requirements:

- Stakeholder register
- Stakeholder personas
- Stakeholder engagement plan
- Locations of stakeholders
- Number of communication channels

Finalizing Communications Planning As a result of planning on your project communications, you should have a documented description of the communications needs of stakeholders and a strategy to meet those needs. Components of this plan may include what communications should be prepared, disseminated, and received among all project stakeholders, how communications should be named and stored, who has access to the communications, who has the ability to edit communications, and who has responsibility for sending and receiving project communications. The plan may also include tailored approaches related to language and cultural differences, and may have information on how the effectiveness of project communications will be evaluated.

Because communications are so complex, a communications management plan should be in writing for most projects. Figure 10.4 shows some of the considerations for what you might include in communications planning.

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What Needs to Be Communicated	Why	Between Whom	Best Method for Communicating	Responsibility for Sending	When and How Often

FIGURE 10.4 *Sample portion of a communications management plan*

Effective Communications PAGE 379

The communications needs of stakeholders are determined and documented. Then, ongoing throughout the project, you and the project team will meet these needs through meetings and other in-person communication, as well as through the distribution of communications artifacts, such as reports, graphics, information radiators, and emails.

PMBOK® Guide
PG: Executing
Process: Manage Communications

ECO
Domain: II
Task: 2

Communication is the process through which project constraints are managed, and work to build the product of the project gets completed. Almost nothing on the project gets done without communications. It also includes making sure information is flowing back and forth on the project in accordance with the documented strategy. Communicating effectively is about facilitation and practicing flexible approaches in dynamic environments. It also includes providing opportunities for stakeholders to request additional information and clarification. While project reports and other formal written communications are archived as part of the project's historical records, they should not require a lot of dedicated time from a project manager, agile coach, or team member.

Communicating effectively also means adapting messages. For example, in hybrid environments, a project manager might discuss "points," "planning poker," "velocity," and "blockers" with the project team while using more traditional terminology like "completed work," "progress," "team estimates," and "threats" with a more traditionally focused PMO. The long-term goal is to educate both sets of stakeholders and facilitate collaboration, so briefly using and explaining the alternative term can help.

Let's review another example. When working with their team, a project manager might say, "I have a stakeholder meeting to discuss progress. I'll be taking our average feature completion rates and velocity data to calculate percent complete figures." Likewise, with the PMO, a project manager might say, "At the daily stand-up meetings where the team discusses progress and issues, the problem of not being able to talk to the business to confirm requirements has been raised several times as a 'blocker' or threat to timely delivery." By exposing each group to new words along with explanations in familiar terms, the barriers to communication are removed.

Using the appropriate technology, models, and methods established for the project is vital to successful communications management. It is important to make sure communications are received, effective, efficient, and understandable. The communications management plan, project documents, work performance reports, and everyday interactions will give you information about what needs to be communicated. Whether it's information from recent risk reviews, forecasts on project performance, or details about changes that have gone through an integrated change control process, a project manager will need to follow the communications management plan to effectively share information.

Although a communications management plan provides good practices for project communications, the project manager may need to tailor their communications in response to feedback from stakeholders. Also keep in mind that the culture of the organization and the political environment within which the project and its stakeholders exist will need to be regularly assessed.

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Be aware that as an outcome of your communications management efforts, you may need to update your communications plan to reflect changes in the approach to managing communications on the project and to changing stakeholder requirements. You may also need to use an issue log, which documents issues regarding communications.

Communication Tools Interpersonal skills, meetings, and reports are just some of the tools and techniques used to communicate effectively on projects. What communication skills do you use? Do you practice active listening? How do you handle conflict? Do you pay attention to cultural differences between stakeholders? Utilizing a range of communication skills, as well as relying on interpersonal skills can help you better manage communications.

Meetings Meetings are often key elements of the effort to manage communications. Early in the project, the project manager and the team are likely to decide how information will be communicated on the project.

Keep in mind that hybrid environments may present unique communication challenges in relation to meetings. Let's say an agile team is working within a largely predictive environment. In this situation, the agile team's normal practices might not provide enough communication to the stakeholders. One way to resolve this issue is to invite stakeholders to observe the agile team's daily stand-up meeting. This type of attendance is a great way to learn about the team composition and current work activities. Think about this example. Does this approach apply to your real-world projects?

When handled properly, meetings provide a way to communicate efficiently and effectively with stakeholders. It's also equally important to understand that meetings may have a negative impact on a project if a team is unclear about the goal (or purpose) and appropriate duration. That's why having a strategy for meetings that includes how and when meetings will be conducted, who needs to attend, and when they're appropriate is so critical to overall meeting success.

When planning meetings, consider the following rules:

- Schedule recurring meetings in advance.
- Meet with the team regularly as appropriate.
- Have a purpose for each meeting.
- Adhere to inherent rules for particular types of meetings (such as a daily stand-up, for example).
- Set a time limit and keep to it.
- Create an agenda with team input.
- Distribute the agenda beforehand.
- Stick to the agenda.
- Let attendees know their responsibilities in advance.
- Bring the right people together.
- Chair and lead the meeting with a set of rules.
- Make all participants, not just the meeting facilitator, responsible for enforcing the rules.
- Assign deliverables and time limits for all work assignments that result from meetings.
- Document and publish meeting minutes, as appropriate.

Project Reporting Project reporting involves communicating to stakeholders about how the project is going and how it is projected to go in the future. Much of that information comes from work performance reports. It also involves asking for feedback from stakeholders to ensure they have received the information they need and have understood it, and to determine whether they need more. Outside of daily interactions and information radiators, this communication may take the form of presentations, blog updates, or

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written reports, as outlined in the communications management plan. There probably is not much here that you do not already know, but make sure you remember the following about reports. They should:

- Provide information and at the level of detail required by stakeholders.
- Be designed to fit the needs of the project.
- Use the most appropriate communication method when sending information.
- Include measurements against the performance measurement baseline set for the project, phase, or iteration.
- Be truthful and not hide what is really going on. This seems logical, but because untruthful reporting sometimes occurs, there may be exam questions relating to reports and professional and social responsibility.
- Provide information on cost, schedule, scope, and quality performance.
- Help team members know when they need to recommend and implement corrective actions.
- Help team members and the sponsor determine what preventive actions are needed.

In addition, feedback from stakeholders who receive reports as part of this process should be analyzed to allow for tailoring of future communications to better meet their needs.

Types of Reports There are different types of reports used in project management. A project manager might issue the following types of reports:

- **Status report** This report describes where the project currently stands in relation to the performance measurement baseline.
- **Progress report** A progress report describes what has been accomplished.
- **Trend report**[5] This report examines project results over time to see if performance is improving or deteriorating.
- **Forecasting report**[6] This report predicts future project status and performance.
- **Variance report**[7] A variance report compares actual results to baselines.
- **Earned value report**[8] An earned value report integrates scope, cost, and schedule measurements to assess project performance.
- **Progress metrics** Reports such as Cumulative Flow Diagrams and burnup charts are used to assess performance.
- **Retrospective findings** This report is used to inspect, adapt, and improve project and team performance.
- **Lessons learned** Lessons learned report on performance and may be used for future projects.

Knowledge Sharing Knowledge sharing is a key component of agile methods; this is an important concept to consider when managing project communications. Information (i.e., knowledge) is a basic component of any project, so it must be distributed and shared. Have you managed a project in which the project team communicated that they didn't have all necessary information? Let's say a team member was unable to complete a task or activity because of missing information or knowledge. How would that impact the project? What could have been done differently to avoid such an issue? If the project team properly shared knowledge, that team member may have asked the project team for more information until they gathered enough knowledge in order to complete their work.

Agile projects embrace knowledge sharing using several tools: daily stand-ups, product demos, Kanban boards, information radiators, personas, and wireframes are examples of knowledge-sharing tools that may be used when managing projects. These tools all support knowledge sharing by ensuring the

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project information is available. In a similar way, agile emphasizes collaborative planning, estimating, and retrospectives, which allows the project team to have and share key project information.

Information Radiators[9] Information radiator is an agile term for highly visible displays of information, including large charts, graphs, and summaries of project data. These tools, sometimes referred to as visual controls, are usually displayed in high-traffic areas to maximize exposure, where they can quickly inform stakeholders about the project's status.

Data displayed on an information radiator may include:

- The features delivered to-date versus the features remaining to be delivered
- Who is working on what
- The features selected for the current iteration
- Velocity and defect metrics
- List of threats and issues
- Story maps
- Burn charts

TRICKS OF THE TRADE

Retrospective Findings Retrospective findings may also be included on an information radiator. In hybrid environments, retrospective findings serve as an ongoing lessons learned log. Project managers in this environment are expected to gather and produce lessons learned reports at the end of the project, so they often build this content using the project's retrospective findings. Teams in hybrid environments usually hold retrospectives that gather information and ideas on how processes are performing and what experiments should be run. This information can be very useful for generating final lessons learned artifacts.

Monitor Communication Effectiveness PAGE 388

PMBOK® Guide
PG: Monitoring & Controlling
Process: Monitor Communications

ECO
Domain: II
Task: 2

The project manager should assess how communications are going throughout the project to ensure information is flowing as planned—in the right way, to the right people, and at the right time—to effectively keep stakeholders informed and maintain the desired levels of stakeholder engagement. The communications plan provides details on how to measure the effectiveness and efficiency of communications. If you're not familiar with data collection and evaluation techniques, you'll need to think about how you would use them on a large project and how they may differ on other types of projects.

This process involves measuring to determine whether the communications management plan is being followed, confirming communications and feedback are understood, and whether communications are meeting the needs of the stakeholders. If not, you need to identify where communication is breaking down, and adjust as necessary to meet those needs. How can you tell if communication is breaking down? In addition to the metrics you've established, you may rely on soft skills as an alternative approach. Encourage stakeholders to tell you whether the project communications are meeting their needs. Project stakeholders may let you know, for example, if they're not getting the reports or information they're meant to receive. Or you'll be informed if the project team isn't following-up on action items established through earlier communications. Do you encourage this type of feedback on your projects?

As mentioned earlier, you should ask stakeholders for feedback on project reports and other communications they receive. Also, project team members should report any communication problems they experience and help to identify ways communications can be improved on the project.

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10.3 Exercise Test yourself! Based on what you've learned, do you understand what you need to monitor communications? In your Exercise Notebook, write how these inputs are used within the process of monitoring project communications.

Inputs

- Project managment plan
- Project communications
- Issue Log
- Lessons learned register
- Work performance data
- Enterprise environmental factors
- Organizational process assets
- Stand-up meetings

Answer

Input	How Is It Used in Monitor Communications?
Project management plan	The communications management plan and other planning components are important to this process. They provide details on what needs to be distributed, why, how, when, and to whom, along with information on roles and responsibilities, and allow you to compare actual communication against what was planned.
Project communications	Compare actual communications to the communications management plan. How do the various reports and other communications hold up against the plan ? Are they providing the intended outcomes?
Issue log	An issue log documents and tracks issues on the project—areas of confusion, disagreement, conflict, and concern that require attention. It is updated to reflect issue resolution. The issue log helps you assess the causes of issues and their impacts on the project. It can also assist in planning corrective actions. This is a useful tool that lets you capture and communicate about issues so you're handling them proactively rather than reactively, with the goal of preventing problems and unnecessary changes.
Lessons learned register	Actively documenting lessons learned (or retrospective findings) during a project can help you learn from previous problems and avoid repeating the same mistakes. These should be shared for other ongoing projects as appropriate. They become part of the historical records and the organization's lessons learned repository, and thereby provide to future projects the benefit of past experience with communications issues.
Work performance data	Work performance data is information about what has occurred during a project. It can help you measure the efficiency and effectiveness of communications against planned metrics. You can also use it in root cause analysis to evaluate the cause of poor communications or to analyze variances from the plan to determine if changes are necessary.
Enterprise environmental factors	Organizational culture, existing communications tools and systems, and common practices for communicating are influencing factors that need to be considered when evaluating the effectiveness of communications.

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Input	How Is It Used in Monitor Communications?
Organizational process assets	You need to refer to your organization's available or required procedures, reporting formats, standards, tools, and security policies related to communication to make sure communications are meeting organizational expectations.
Stand-up meetings	Stand-up meetings may be used to share information between team members and other stakeholders. They may also be used to learn about progress, opportunities, threats, and issues.

Confirmation of communication effectiveness will result in work performance information, possible change requests, and possible updates to the project management plan and project documents.

This concludes the Project Communications chapter. For the exam, keep in mind that communication is essential to success and affects all areas of a project. Poor communication can cause major problems and rework. Therefore, a project manager should take a structured approach to communication by creating a communications plan. As the project work is being done, the project manager or agile coach and other project stakeholders need to follow the plan to distribute information about the project, make sure communication is flowing as planned, feedback loops are complete and appropriate, and adjust the communications approach as necessary.

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Practice Exam

1. A team member has been late to several recent team meetings, and the last two deliverables he submitted were not acceptable. The project manager decides he can no longer wait for things to improve and must address the issue with the team member. What is the best form of communication for addressing this problem?
   A. Formal written communication
   B. Formal verbal communication
   C. Informal written communication
   D. Informal verbal communication

2. Communications are often enhanced when the sender _____ the receiver.
   A. Speaks up to
   B. Uses gestures when speaking to
   C. Speaks slowly to
   D. Shows concern for the perspective of

3. The new project manager has a team including several individuals for whom English is not their first language. He frequently uses technical jargon from his former company, which is unfamiliar to these team members, when discussing work activities with his team members. The most likely result of communication blockers is that:
   A. The project is delayed.
   B. The trust level is enhanced.
   C. Conflict occurs.
   D. Senior management is displeased.

4. Formal written correspondence with the customer is required when:
   A. Defects are detected.
   B. The customer requests additional work not covered under contract.
   C. The project has a schedule slippage that includes changes to the critical path.
   D. The project has cost overruns.

5. What is the most important factor in choosing how to communicate project progress to business stakeholders?
   A. Whether the approach is predictive, change-driven, or hybrid
   B. How much information the stakeholders expect you to provide
   C. What reporting methods the team has used before and is familiar with
   D. How much time you are able to allocate to the reporting task

6. A large, one-year telecommunications project is about halfway done when you take the place of the previous project manager. The project involves three different sellers and a project team of 30 people. You would like to see the project's communications requirements and what technology is being used to aid in project communications. Where will you find this information?
   A. The stakeholder management plan
   B. The information distribution plan
   C. The bar chart
   D. The communications management plan

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7. Changes to some project deliverables have been documented in the project management plan. These changes, along with other project information, have been distributed according to the communications management plan. One stakeholder expressed surprise to the project manager upon hearing of a documented change to a project deliverable. All stakeholders received the communication providing notification of the change. What should the project manager do?
   A. Determine why the stakeholder did not receive the information, and let him know when it was published.
   B. Ask the functional manager why the stakeholder did not understand his responsibility.
   C. Review the communications management plan, and make revisions if necessary.
   D. Address the situation in the next steering committee meeting, so others do not miss published changes.

8. Communication is key to the success of a project. As the project manager, you had three stakeholders with whom you needed to communicate. Therefore, you had six channels of communication. A new stakeholder has been added with whom you also need to communicate. How many communication channels do you have now?
   A. 7
   B. 10
   C. 12
   D. 16

9. Two people are arguing about what needs to be done to complete a work package. In addition to the words being spoken, if the project manager wants to know what is going on, she should pay most attention to:
   A. What is being said and when
   B. What is being said, who is saying it, and the time of day
   C. Physical mannerisms and when during the schedule this discussion is taking place
   D. The pitch and tone of their voices, along with their gestures

10. What's the best way for your agile team to share their progress with other project stakeholders?
   A. Information radiators
   B. Memos
   C. Stand-up meetings
   D. Retrospectives

11. A project manager has a project team consisting of people in four countries. The project is very important to the company, and the project manager is concerned about its success. The length of the project schedule is acceptable. What type of communication should he use?
   A. Informal verbal communication
   B. Formal written communication
   C. Formal verbal communication
   D. Informal written communication

12. You have just been assigned as project manager for a large manufacturing project. This one-year project is about halfway done. It involves five different sellers and 20 members of your company on the project team. You want to quickly review where the project now stands. Which of the following reports would be the most helpful in finding such information?
   A. Work status
   B. Progress
   C. Forecast
   D. Communications

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13. A team member is visiting the manufacturing plant of one of the suppliers. Which of the following is the most important thing to be done in any telephone calls the project manager might make to the team member?
    A. Ask the team member to repeat back what the project manager says.
    B. Review the list of contact information for all stakeholders.
    C. Ask the team member to look for change requests.
    D. Review the upcoming meeting schedule.

14. A project manager overhears a conversation between two stakeholders who are discussing how unhappy they are with the impacts of the project on their own departments. Stakeholder A asks if the project is on time, and stakeholder B replies that the SPI is 1.05. Stakeholder A asks if the project manager for the project knows of stakeholder B's concern. Stakeholder B responds that he is not sure. What is the best thing for the project manager to do?
    A. Make sure the stakeholders are aware that the project manager overheard. Then ask them to direct any questions to the project manager in writing.
    B. Make a presentation to all the stakeholders regarding the status of the project.
    C. Send both stakeholders a copy of the issue log, and ask for additional comments.
    D. Arrange a meeting with both stakeholders to allow them to voice any concerns they may have.

15. Things have been going well on the project. The work authorization system has allowed people to know when to start work, and the issue log has helped keep track of stakeholders' concerns. The sponsor has expressed his appreciation for the team members' efforts by hosting a milestone party. The project manager gets a call from a team member saying the results from the completion of her activity's predecessor are two days late. Which of the following reasons would best describe why this occurred?
    A. The project manager was focusing on the sponsor's needs.
    B. Functional management was not included in the communications management plan.
    C. The successor activities should have been monitored, not the predecessors.
    D. The right people were not invited to the milestone party.

16. A project manager has just been assigned a team comprised of team members from many countries including Brazil, Japan, the United States, and Britain. What is her best tool for success?
    A. The responsibility assignment matrix (RAM)
    B. The teleconference
    C. Team communication with the WBS
    D. Well-developed interpersonal skills

17. What's the best way to handle knowledge sharing on the agile projects you are managing?
    A. Encourage knowledge sharing if possible, where the team shows an interest.
    B. Give the team many tools and opportunities to share knowledge.
    C. Facilitate a team meeting if there is time left at the end of an iteration.
    D. Make sure the team is holding regular stand-up meetings.

18. A project manager at a large consulting firm is asked to report on the actual project results versus planned results. The project is going well, and the marketing department wants to see if the current results can be used in a future marketing campaign. This project manager should prepare a:
    A. Trend report
    B. Forecasting report
    C. Status report
    D. Variance report

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19. The project has 13 team members and affects more than 15 departments in the organization. Because the project is 20 percent complete to date and the team has had successful performance reports from five of the affected departments, the project manager holds a party to celebrate. The project manager invites key stakeholders from all of the departments to the party in order to give those providing good reviews an informal opportunity to communicate good things to those departments that have not yet been affected by the project. At the party, the project manager walks around to try to discover any relevant information that would help her make the project even more successful. She happens to hear a manager of one of the departments talking about setting up more regular meetings on the project.

    The best thing for the project manager to do would be to first:

    A. Record the effectiveness of the party in the project lessons learned.
    B. Review the effectiveness of the project's communications management plan.
    C. Hold a meeting of all the stakeholders to discuss their concerns.
    D. Make sure the manager has a copy of the communications management plan so that he is reminded that such concerns should be sent to the project manager.

20. The requirements of many stakeholders were not approved for inclusion in your project. Therefore, you had a difficult time gaining formal approval of the project management plan. The stakeholders argued and held up the project while they held meeting after meeting about their requirements. The project was finally approved and work began six months ago. All of the following would be good preventive actions to implement except:

    A. Keep a file of what requirements were not included in the project.
    B. Make sure the change control process is not used as a vehicle to add the requirements back into the project.
    C. Maintain an issue log.
    D. Hold meetings with the stakeholders to go over the work that will not be added to the project.

21. The sponsor has suggested that your agile team skip the in-person demo meetings and just send the product owner a link to try out the latest increment of working software. She says that will give your team more time to deliver value. You want to explain the importance of an in-person demo meeting with the product owner. What will you say?

    A. An in-person meeting helps ensure that the product owner will weigh their feedback carefully and not ask for any unneeded rework.
    B. It usually takes more time to set up and test a virtual communications tool than to meet in person.
    C. The team needs to see the product owner's body language and facial expressions to understand what they really want.
    D. The team will be able to address the product owner's needs better if they can have a conversation and ask questions.

22. The project manager is expecting a deliverable to be submitted by email from a team member today. At the end of the day, the project manager contacts the team member to notify him that it has not been received. The team member apologizes and explains that he was not able to email the deliverable, and it was sent through the mail instead. The team member goes on to remind the project manager that he had informed the project manager during a phone conversation that this would occur. "Was that the conversation we had when I told you I could not hear you well due to poor cell phone coverage?" asks the project manager. "Yes," replies the team member. What could have been done to avoid this problem?

    A. Verbal communication
    B. Adding to the issue log after the phone call
    C. Better attention to determining communications requirements
    D. Feedback during the communication

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Answers

1. **Answer** D
Explanation It is best to start this discussion informally. The project manager should also document the problem and include a summary of the conversation with the team member. If informal communication does not solve the problem, formal written communication is the next course of action.

2. **Answer** D
Explanation An understanding of the receiver's perspective allows the sender to direct the communication to meet the receiver's needs.

3. **Answer** C
Explanation Communication blockers can range from a lack of cultural sensitivity to a failure to provide concise messages. Blockers cause miscommunication and can lead to disagreement and confusion. The major result of communication blockers and miscommunication as a whole is conflict.

4. **Answer** B
Explanation Everything we do is more formal in a procurement environment than in other project activities. Therefore, formal written communication is required when the customer requests work not covered under the contract.

5. **Answer** B
Explanation: It's important to plan your communications to a stakeholder or group based on their needs and interests. In this case, you are reporting to the business stakeholders, so their needs are paramount. The development team can communicate their performance data to you in any way that works, since you will be converting it into the most effective method of communicating that information to the intended audience. The project approach and the amount of time you can spend will also be considerations, but they won't be the most important factor to consider.

6. **Answer** D
Explanation This information is found in the communications management plan.

7. **Answer** C
Explanation The question states that all stakeholders received the information, so the issue is not that this stakeholder did not receive it. The problem presented here illustrates that there is something missing in the communications management plan. The best answer is to review the communications management plan in order to prevent future problems and to find any instances of similar problems.

8. **Answer** B
Explanation Did you remember that the project manager needs to be included when calculating the number of communication channels? Therefore, there are actually four stakeholders to begin with and six channels of communication. The question is asking how many total channels of communication you have with a team of five people. The formula is $[n \times (n - 1)]/2$ or $(5 \times 4)/2 = 10$.

9. **Answer** D
Explanation Nonverbal communication represents a major part of all communication. The choice including verbal communication (pitch and tone) as well as gestures is the best choice.

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10. **Answer** A
Explanation: The most popular tools agile teams use to share their progress with other project stakeholders are the large visible displays of information known as information radiators. Memos are inefficient. Stand-up meetings share information within the team but not outside it. Retrospectives are primarily for the benefit of the team—and they are focused on improving the team's processes, not sharing progress.

11. **Answer** B
Explanation Because of the differences in culture and the distance between team members, formal written communication is needed.

12. **Answer** B
Explanation The key word is quickly. The status report is too detailed for a quick look. The forecast report only looks into the future. The progress report summarizes project status, and would be the most helpful for a quick review.

13. **Answer** A
Explanation There are many choices that are reasonably correct. Look for the most immediate need. Here, the team member is in a manufacturing environment. That means communications will most likely be blocked by noise. It is best for the project manager to ask the team member to repeat back what he says, to ensure the team member correctly heard what the project manager communicated.

14. **Answer** D
Explanation This is another question with more than one right answer. Would asking for something in writing be the best way to communicate? In this particular situation, asking for the concern to be put into writing might alienate the stakeholders. The issue log is where the issue should be listed, but the situation does not say if the project manager knows what the stakeholders' concern is. Therefore, using the issue log cannot be the best choice. Why not make a presentation to all the stakeholders regarding the status of the project? The concern was being voiced only by stakeholders A and B, so it is unnecessary to involve all the stakeholders. This problem would likely require informal verbal communication to discover the real problem. Arranging a meeting with the concerned stakeholders is therefore the best choice.

15. **Answer** B
Explanation Since there is no information about the sponsor or his needs in this situation, focusing on his needs cannot be best. The statement that successor activities should have been watched, rather than the predecessors, is not a correct statement. A project manager should watch both predecessor and successor activities. Attendance at the party and the issue at hand (the late results) are not related. Often forgotten in communications management plans are the managers of team members (functional management, in a matrix organization). Including the managers of team members in communications planning, requirements gathering, risk management, and other areas of project management helps make the project better. In addition, it helps the functional managers manage their resources effectively. If the functional manager of the team member assigned to the predecessor activity had been included in the project planning processes, he would have known when the team member was needed to do work for the project and the impact, if any, of delay. The communications management plan should also have included a method to communicate potential delays.

16. **Answer** D
Explanation Working with people from different cultures who may have different values and beliefs necessitates an understanding of both basic definitions and areas of cultural impact. Project managers need good interpersonal skills and a willingness to adapt to other cultures.

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17. **Answer** B
Explanation Knowledge sharing is central to many agile practices. It is true that stand-up meetings help the team members share information, but they are not the primary event for knowledge sharing. This practice is too important to be considered optional if the teams show an interest, or if there is time.

18. **Answer** D
Explanation This situation describes the need to compare. A trend report shows performance over time. A forecasting report looks only to the future. A status report is generally static (relating to a moment in time). The only choice that compares project results is a variance analysis to the plan.

19. **Answer** B
Explanation Many of these choices could be done, but ask yourself, "What is the most effective thing to do?" The party may well generate lessons learned, and recording them would certainly be a good idea, but the question asked what to do first. There is a more immediate issue—the manager. Meeting with all the stakeholders could be useful, but there is only one stakeholder, the manager, who definitely has an issue. Besides, a good project manager would be holding regular meetings with the stakeholders already. Making sure the manager has a copy of the communications management plan might be a good idea, as the manager apparently is not communicating with the project manager. However, this would not be enough to ensure the manager does communicate.

The manager is, in effect, saying he is not getting the information he needs, which is causing him to suggest more meetings. However, too many meetings can be a problem on projects. A great project manager does not just add meetings, but rather solves the real problem in the best way.

A goal of communications management is to get information to those who need it. The project manager may decide to adjust her communications management process by changing the format of a report or sending existing reports to the manager with the issue, rather than adding meetings. Therefore, the correct choice is to review the methods of providing project information to the stakeholders.

20. **Answer** D
Explanation This issue should be over, but since there were so many meetings and arguments about the requirements being removed, it is unlikely the issue will be dropped by the stakeholders. However, as it has not come up again and the project was started six months ago, spending time in a meeting is excessive. The other choices are easier, have less impact on the project, and are, therefore, things that could be done.

21. **Answer** D
Explanation: Since agile methods rely on the product owner's feedback to deliver value, it's essential to use the communication method with the highest level of interactivity and information bandwidth. An in-person meeting is the richest and most interactive communication method. It is sometimes difficult for the product owner to identify or explain what they really need, and the team can help clarify that by listening and asking questions. While it may be helpful to see the product owner's body language and facial expressions, that isn't the best answer. Agile welcomes change, rather than avoiding rework. A virtual communication tool wouldn't be the best forum for this project-critical feedback since it lacks the immediacy and rich bandwidth of an interactive in-person exchange.

22. **Answer** D
Explanation The pitch and tone of voice (verbal communication) is not relevant here, as the project manager could not even hear all that was being said. There were no issues recognized after the conversation, so none could be added to the issue log. This issue is not related to communications requirements, so that choice cannot be best. Saying, "I am not sure I properly heard what you said," during the conversation or repeating the message back to the team member would have prevented this problem. Giving and requesting feedback during the communication is the best option.

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Risk

ELEVEN

Let's start this chapter with a story. A project manager was working on a hardware and software installation in an area where hurricanes are a relatively frequent occurrence. Then a hurricane struck.

Not long after the hurricane was over, the project manager was telling people what a great job his team had done and how quickly they had recovered from the disaster. Would you have been proud of yourself if you were the project manager? Before you answer, consider the following information:

- The activity the team was working on required three days to complete.
- The project manager had warning that the hurricane was coming.
- They had to recover from the disaster.

Instead of being excited about how quickly his team was able to recover from the hurricane, the project manager—and the sponsor—should have questioned the wisdom of scheduling the implementation at a time when there was a strong probability of a hurricane happening or keeping to that schedule if the hurricane prediction had come after scheduling was complete.

A project manager's work should focus on preventing problems rather than on dealing with them. Had the project manager performed risk management[1] he would have considered the threat of a hurricane and worked with his team to identify possible actions to take if a hurricane was forecast during implementation weekend. Then, when one was forecast, the team could have responded according to the plan, probably moving the implementation to another weekend and avoiding the damage and rework that resulted from the disaster. This is the value of risk management.

Think about your own projects. How would it feel if you could say *No problem; we anticipated this, and we have a plan in place that will resolve it* whenever a problem occurs? How much time and money would you save that would have otherwise been spent addressing the problem? How much less stress would you

QUICKTEST

- Definition of risk management
- Risk management process
- Threats and opportunities
- Uncertainties
  - Spikes
  - Fast failure
- Risk factors
- Risk appetite
- Risk threshold
- Risk averse
- Inputs to risk management
- Risk register
- Risk management plan
- Risk report
- Risk categories
- Risk breakdown structure (RBS)
- Overall project risk
- Individual project risk
- Types of risk
- Probability and impact matrix
  - Watch list
  - Variance and trend analysis
- Risk response strategies
  - Avoid
  - Mitigate
  - Transfer
  - Exploit
  - Share
  - Enhance
  - Accept
  - Escalate
- Residual risks
- Contingency plans
- Fallback plans
- Risk owner
- Secondary risks
- Risk trigger
- Workarounds
- Reserve analysis
- Risk reviews and audits
- Simulation
- Checklist analysis
- SWOT analysis
- Pre-mortems
- Risk backlog
- Technical performance analysis
- Retrospectives
- Risk burndown charts

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have in your life? Project risk management helps prevent many problems and make others less likely or less impactful. Conversely, it helps to increase the probability and/or impact of positive risks, or opportunities. When you eliminate threats and increase opportunities, schedule and cost estimates can be decreased, reflecting the results of risk management efforts.

If you do not practice project risk management systematically this may be a difficult chapter for you. You need to recognize that risk management activities are an integral part of a project manager's daily work and the impact of risk management is an important concept. The exam tests your knowledge of risk management at a sophisticated level. You may be given a situation on the exam and then asked to determine which risk management process is being performed, or what should be done next, based on the information provided.

This chapter provides an overview of risk management, mostly from the perspective of a large project with a predictive life cycle. Agile terms and concepts have also been included in this chapter, as it's important to understand how risk management may be tailored to each specific project. The following should help you understand how each part of risk management fits into the overall project management process.

The Risk Management Process	Done During
Plan Risk Management	Planning process group
Identify Risks	Planning process group
Perform Qualitative Risk Analysis	Planning process group
Perform Quantitative Risk Analysis	Planning process group
Plan Risk Responses	Planning process group
Implement Risk Responses	Executing process group
Monitor Risks	Monitoring and controlling process group

ECO Domain I: People	Domain II: Process
Task 7: Address and Remove Impediments, Obstacles, and Blockers for the Team	Task 3: Assess and Manage Risks
	Task 15: Manage Project Issues

As with other management areas, domain II (Process) from the *Examination Content Outline* (ECO) has a task specific to managing risk that is closely related to the process of risk management as defined in the *PMBOK® Guide*. Other tasks that closely align to managing risk include domain I task 7 (Address and Remove Impediments, Obstacles, and Blockers for the Team), and domain II task 15 (Manage Project Issues). As with all other knowledge areas, take time to review the ECO and note any additional tasks that may be applicable. For example, risk management may rely on work to Ensure Knowledge Transfer for Project Continuity (domain II, task 16). And if there's conflict on your project, isn't it a risk to leave it unresolved? Task 1 from domain I (Manage Conflict) is pertinent to risk management, as is Ensure Team Members/Stakeholders are Adequately Trained (domain I, task 5). What other tasks can you recognize as possibly impacting risk? Taking time to think about this now will help you be more prepared for the exam.

Introduction to Risk Management

As you read this chapter, remember the important concepts discussed next. Make sure you are prepared to deal with exam questions that test your knowledge of them in the context of any stage of the process and in any given scenario.

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Risk Management Risk management is the process of identifying, evaluating, and planning responses to events, both positive and negative, that might occur throughout the course of a project. Through risk management, you increase the probability and impact of opportunities on the project (positive events), while decreasing the probability and impact of threats to the project (negative events). Risks are identified and managed starting in initiating and planning. While the project is underway the project manager and the team look at what has happened, the project's current status, and what is yet to come—and reassess the planned risk strategy.

Good risk management directly affects a project manager's ability to realize the benefits and objectives of a project. In fact, the concept of risk is closely related to value, so much so that we can think of negative project risks (threats) as anti-value—factors that have the potential to erode, remove, or reduce value if they occur. If value is the "heads" side of a coin, then risk is the "tails" side. Think of the value you create with your project as deposits into a bank account. Risks, or at least threats that actually occur and become an issue, are similar to withdrawals (or outflow). To create the most value, maximinze the deposits and minimize the withdrawals.

Given the iterative nature of project management, a response strategy for a newly discovered risk may create other project risks, which must be identified and managed. Be prepared for exam questions that test your knowledge and understanding of risk management's ongoing nature.

Threats and Opportunities A risk event is something identified in advance that may or may not happen. If it does happen, it can have positive or negative impacts on the project. Project managers often just focus on threats—what can go wrong and negatively impact the project. Do not forget that there can also be positive impacts—good risks, called opportunities! Opportunities can include such things as:

- If we can combine orders for the ZYX equipment to buy more than 20 items at once, the cost will be 20 percent less per item than planned.
- If we provide a training class to improve efficiency, work package number 3.4 could be completed two days faster than expected.
- If we can obtain a resource with more experience and a higher level of productivity, work on the critical path activity 4.7.2 could be done 10 percent faster.

The vast majority of the threats identified and investigated can be eliminated by changing how the project work is planned and performed. Strategies such as using an adaptive life cycle, outsourcing some or all of the work, or selecting more skilled people within the organization to do the work may reduce risk on a project.

Uncertainty Uncertainty is a lack of knowledge about an event that reduces confidence in conclusions drawn from the data. The work that needs to be done, the cost, the time, the quality needs, the communications needs, etc., can be uncertain. The investigation of uncertainties may help identify risks. Agile uses a tool called a spike[2] (or special iteration) in the development process to explore uncertainty. A spike is a short effort (usually timeboxed) that is devoted to exploring an approach, investigating an issue, or reducing a project risk. Spikes often take the form of brief exploratory iterations (called a risk-based spike) or proof-of-concept efforts (called an architectural spike) that are done at the start of a project, before the main development effort begins.

Spikes can help a project manager reach a condition known as fast failure[3]: failing quickly and early before failure becomes more costly. As long as failure is quickly determined and the whole project hasn't been based on the failed approach, the project manager can move forward. Figure 11.1 illustrates how fast failure can benefit a project.

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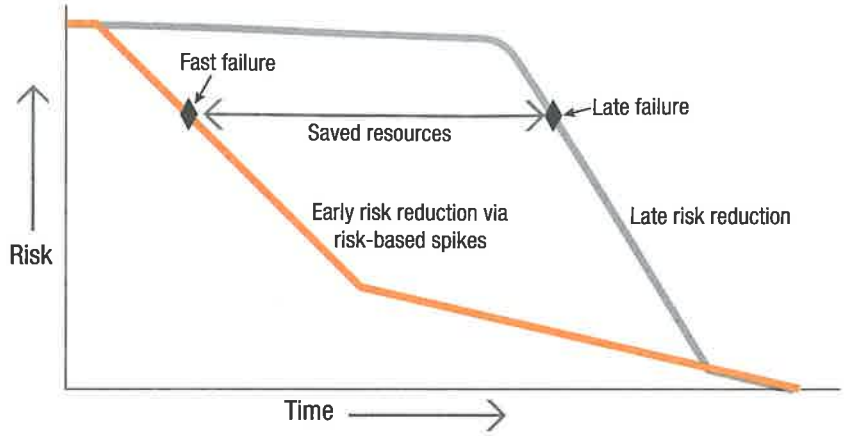

FIGURE 11.1 *Fast failure*

Risk Factors When assessing risk, it's necessary to determine the following:

- The probability that a risk event will occur (how likely)
- The range of possible outcomes (impact or amount at stake)
- Expected timing for it to occur in the project life cycle (when)
- The anticipated frequency of risk events from that source (how often)

Risk Appetites and Thresholds These terms refer to the level of risk an individual or group is willing to accept. Risk *appetite* (which is also referred to as risk tolerance) is a general description of the level of risk acceptable to an individual or an organization. For example, a sponsor may be willing to accept little risk to the schedule on a project. Risk *threshold* refers to the specific point at which risk becomes unacceptable. For example, the sponsor will not accept a risk of the schedule being delayed 15 days or longer. An individual or organization with a very low appetite for the negative impact of threats is called *risk averse*.

Risk appetites and thresholds vary and can include any project constraints (scope, schedule, cost, quality, etc.) as well as risks to reputation, customer satisfaction, and other intangibles depending on the individual or organization and the risk area. For example, an organization may have more tolerance for cost-related risks than for risks that affect customer satisfaction or their reputation in the marketplace.

Look for information about individual and organizational risk appetites and thresholds to answer situational exam questions related to risk response[4] strategies.

The Risk Management Process For the exam, assume that risk management has been planned properly according to the concepts in this chapter. This means the following:

- There are no longer huge "fires" to put out every day—they are eliminated with risk response plans.
- Risks are reviewed in every meeting, triggers are monitored, and risks are addressed before they happen.
- Normally, if a risk event does occur, there is a plan in place to deal with it. Hectic meetings to develop responses are a rarity, and are only needed when an unknown risk event occurs and requires the development of a workaround.

Think of the sequence of risk management processes as you study the rest of this chapter. As with all knowledge areas, planning is important.. You and the project team identify risks and gather as much information about them as possible into a risk register. Then you do a qualitative analysis on each identified risk and based on that decide which risks move on to quantitative risk analysis, using different ways of measuring probability and impact analysis for each type of analysis. Once risks have been analyzed you plan responses for those you have decided warrant a planned response, while the remaining risks are kept on a watch list.

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Managing from there is a matter of implementing planned responses for those risks that occur and monitoring to decide what strategy changes are needed, which includes evaluating the effectiveness of risk responses that have occurred, planning for new risks that are identified, and reevaluating the portions of the budget set aside for risks (reserves).

TRICKS OF THE TRADE® Although the initiating and planning processes are more likely done in sequence, remember that planning is often iterated and initiating is repeated when a phase-gate system is used on large projects with phases. New risks can be identified and planned for at any time.

TRICKS OF THE TRADE® Many people confuse qualitative and quantitative risk analysis. Remember for the exam that qualitative risk analysis is a subjective evaluation, even though numbers are used for the rating. In contrast, quantitative risk analysis is a more objective or numerical evaluation; the rating of each risk is based on an estimate of the actual probability and amount at stake (impact). Therefore, while the rating for a risk in qualitative risk analysis might be a 3 (on the subjective scale of 1-5), that same risk might be quantified as a $40,000 cost impact in quantitative risk analysis.

Plan Risk Management PAGE 401

PMBOK® Guide
PG: Planning
Process: Plan Risk Management

ECO
Domain: I
Task: 7
Domain: II
Task: 3, 15

The project manager, sponsor, team, customer, other stakeholders, and experts may be involved in planning risk management. Part of planning involves determining at a high level the amount and areas of potential risk on the project. Risk management efforts should be appropriate not only to the size and complexity of the project but also to the experience and skill of the project team. Although risk checklists from previous projects can be helpful in creating a plan and identifying risks, each project's process should be tailored.

The Plan Risk Management process answers the question of how much time should be spent on risk management based on the needs of the project. This includes evaluating the risk appetite of management and other key stakeholders and identifying who will be involved and how the team will go about performing risk management. Organizational procedures and templates related to risk, such as standard probability and impact matrices, are identified and adapted.

When you have completed risk management planning, you should, of course, have a risk management plan. Your risk management plan may include:

- **Risk strategy** This is an overall approach to managing risk throughout the life of the project.
- **Methodology** This defines how risk management will be performed to meet the needs of the specific project. Low priority or low risk projects will likely warrant less of a risk management effort than high priority or high-risk projects.
- **Roles and responsibilities** This section explains who will do what risk management work. Did you realize that the project manager does not do it all and that stakeholders outside the project team may have roles and responsibilities regarding risk management?
- **Funding** There is a cost of doing risk management but overall risk management saves the project time and money by avoiding or reducing threats and by taking advantage of opportunities. This section includes a plan for utilizing reserves in response to risks on the project.
- **Timing** This section specifies when to do risk management depending on estimated timing for the occurrence of identified risks. Also note that time needs to be allocated in the schedule for risk management activities.
- **Risk categories** These are discussed next in the Identify Risks section.
- **Stakeholder risk appetite/thresholds** The risk appetites and thresholds of key stakeholders are documented and considered in the risk management plan. This information is also considered when ranking risks based on probability and impacts, and when prioritizing which risks will be addressed in risk response planning.

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- **Definitions of probability and impact** Would everyone who rates the probability of a particular risk a 7 on a 1-to-10 scale in qualitative risk analysis mean the same thing? A person who is risk averse might think of 7 as very high, while someone who is risk prone might think of 7 as a low figure. The definitions and the probability and impact matrix (discussed later in this chapter) help standardize these interpretations and also help compare risks between projects.
- **Reporting** This section of the plan describes what risk-related reports will be created, what they will include, and to whom they will be sent. In addition, the composition of the risk register for the project is defined here.
- **Tracking** The tracking section describes how the risk management process will be audited and how the results of risk management efforts will be documented.

Identify Risks PAGE 409

PMBOK® Guide
PG: Planning
Process: Identify Risks

ECO
Domain: I
Task: 7
Domain: II
Task: 3, 15

In this process, risks to the project and their characteristics are identified. This effort should involve all stakeholders and might even include literature reviews, research, and communicating with non-stakeholders. Sometimes, the core team will begin the process and then other team members will become involved, or there could be a special, dedicated risk team—a part of the project team focused on risk management efforts.

TRICKS OF THE TRADE

When you get a question about who should be involved in risk identification, the best answer is "everyone"! Each stakeholder has a different perspective of the project and can provide thoughts on opportunities and threats.

Project managers should begin looking for risks as soon as a project is first discussed. In fact, an assessment of overall project risk is included in the project charter. However, the major risk identification effort occurs during planning. The project manager will need to have skills to facilitate the identification of all risks (or as many risks as reasonably possible).

Because risk identification primarily occurs during project initiating and planning, the exam has often said that the major part of risk identification happens at the onset of the project. But keep in mind that smaller numbers of risks may also be identified later in the project. Risks should be continually reassessed. For the exam, understand that risk identification is also done during integrated change control, when working with contracts, when working with resources, and when dealing with project issues.

Risk Categories A standard list of risk categories can help ensure areas of risk are not forgotten on your projects. These categories are broad, common areas or sources of risk that the company or similar projects have experienced. They can include things such as technology changes, lack of resources, regulatory hurdles, or cultural issues. Organizations and project management offices should maintain standard lists of risk categories that all projects can use as prompt lists to help identify and group individual project risks. When leading risk identification efforts, you should make sure each category is considered. A risk breakdown structure (RBS) is a hierarchical chart (which looks like an organizational chart) that can help you identify and document risk categories.

Research has shown over 300 potential categories of risk, including risks caused by:

- The customer
- Lack of project management effort (yes, a lack of project management effort can add risk)
- Lack of knowledge of project management by the project manager and stakeholders
- The customer's customers
- Suppliers
- Resistance to change
- Cultural differences

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Specific risk categories include but are not limited to:

- **External** Regulatory, environmental, or governmental issues; market shifts; problems with project sites, etc.
- **Internal** Changes to schedule or budget; scope changes; inexperienced team members; issues with people, staffing, materials, and equipment, etc.
- **Technical** Changes in technology, technical processes, or interfaces, etc.
- **Commercial** Customer stability, terms and conditions within contracts, sellers, etc.
- **Unforeseeable** Only a small portion of risks (about 10 percent) are actually unforeseeable.

The following are additional examples of sources of risk:

- **Schedule** "The hardware may arrive earlier than planned, allowing work package XYZ to start three days earlier."
- **Cost** "Because the hardware may arrive later than planned, we may need to extend our lease on the staging area—at a cost of $20,000."
- **Quality** "The concrete may dry to our quality standards before winter weather sets in, allowing us to start successor work packages earlier than planned."
- **Scope** "We might not have correctly defined the scope for the computer installation. If that proves true, we will have to add work packages at a cost of $20,000."
- **Resources** "Our designer may be called away to work on the new project everyone is so excited about. If that occurs, we will have to use someone else, and our schedule will slip between 100 and 275 hours."
- **Customer satisfaction (stakeholder satisfaction)** "There is a chance the customer will tell us they are unhappy with the XYZ deliverable, causing at least a 20 percent increase in time to rework the deliverable and test plans."

TRICKS OF THE TRADE

Expect the phrases "sources of risk" and "risk categories" to be used interchangeably on the exam.

In addition to risk categories, risks can be classified under two main types:

- **Business risk** Risk of a gain or loss
- **Pure (insurable) risk** Only a risk of loss (such as fire, theft, or personal injury, etc.)

You may also see references to risks described as non-event risks, which fall under the following categories:

- **Variability** Risks caused by the inability to predict future changes
- **Ambiguity** Risks caused by a lack of understanding

Tools Used to Identify Risks The primary tools and techniques used in this process relate to data gathering and data analysis. They include brainstorming, interviewing, documentation reviews, root cause analysis, analysis of assumptions, constraint analysis, SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis, and checklist analysis. In root cause analysis[5] the identified risks are reorganized by their root causes to help identify more risks. SWOT analysis[6] examines the project to identify strengths and weaknesses as well as the opportunities and threats that could originate, and checklist analysis is most often used with risk category prompt lists discussed earlier.

Agile Project Pre-Mortems[7] A project pre-mortem is a facilitated team exercise that aims to identify the possible failure points on a project before they happen, so that we can avoid and/or minimize those threats. The project manager describes a scenario and tells the team the project has failed and that their task is to

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explain what happened. After generating a list of potential failure points, the team looks for ways to adapt the project plan to avoid or mitigate any issues. A pre-mortem exercise typically includes four steps:

- Imagine the Failure
- Generate the Reasons for the Failure
- Consolidate the List
- Revisit the Plan

Risk Register[8] The Identify Risks process results in the creation of the risk register. Think of the risk register as one document for the entire risk management process that will be constantly updated with information as the risk management processes are completed.

TRICKS OF THE TRADE Notice that the risk register is a project document update as an output of several of the risk management processes. Read exam questions carefully, and remember that the risk register contains different information at different points in the risk management process. For example, if the project has just started and you are in the Identify Risks process, the risk register will contain the identified risks and potential responses, not the selected response plans, which come later.

Besides the list of risks, the risk register at this point in the risk management process includes potential risk owners and the potential risk responses they will own, root causes of risks where they have already been identified, and updated risk categories. Other information that can be documented in the risk register includes risk triggers (defined later in this chapter), potential impacts, when each risk could occur, and when each risk will no longer present a threat or opportunity.

TRICKS OF THE TRADE A tricky question on the exam might ask, "When in the risk management process are risk responses documented?" The answer is both during Identify Risks (as potential responses) and during Plan Risk Responses (as selected response plans).

Perform Qualitative Risk Analysis[9] PAGE 419

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As you begin this process, you should have a long list of risks documented in the risk register. But it would be too expensive and take too much time to plan responses to all of them, so they need to be prioritized. Qualitative Risk Analysis involves subjectively analyzing the identified risks for their probabilities and impacts on the project. Common subjective analysis scales include Low, Medium, High and 1 to 5 or 1 to 10 ratings.

Besides the project management plan, project documents, and organizational influencing factors, the risk register is also an important input to the Perform Qualitative Risk Analysis process. The desired outcomes of this process may include updates to those same artifacts but also the assumption log and issue log. Also note that the risk register may be updated with analysis results: A profile and understanding of which risks will move forward in the risk management process and which are moved to a watch list. A risk report also includes the results of risk prioritization and a list of the highest-ranking risks.

Data collection and analysis tools and techniques specific to this process include a risk data quality assessment, further use of the risk categorization discussed earlier, a probability and impact matrix, and analyses of other risk parameters.

Risk Data Quality Assessment Risk Data Quality Assessment is about assessing the data available on a given risk for accuracy and reliability to determine if the risk is valid and whether more research is needed to understand it. Imagine, for example, a risk given to you anonymously. You might allow for anonymous contributions during risk identification, but all the identified risks must be defined well enough to perform a qualitative assessment.

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Risk Categorization Assigning risks to categories may be helpful when planning risk responses. It's also important to know that a risk breakdown structure allows a project manager to represent risk sources into a chart-like structure, which can help answer questions such as "What will we find if we regroup the risks by category? By source? By work package?" Using risk categories may also allow a project manager to eliminate several risks at once. Think about how useful it would be to have not only a subjective assessment of the total amount of risk on a project, but also a breakdown of the risks that shows which work packages, processes, people, or other potential causes have the most risk associated with them.

Probability and Impact Matrix[10] A probability and impact matrix is a data representation technique used to plot risks in order to sort and rate them to help determine which risks to promote to quantitative risk analysis.

The matrix template itself follows a simple and standard matrix design going from higher to lower starting from the lower left corner and moving up and to the right on the axes, as shown in figure 11.2. But because qualitative risk analysis is based on subjective evaluation, organizations frequently have a standard rating system to promote a common understanding of what each risk rating means, as shown in figure 11.3.

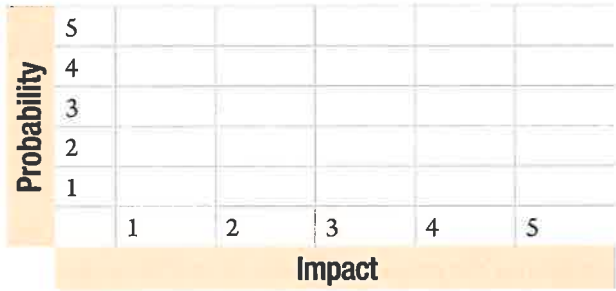

FIGURE 11.2 *Probability and impact matrix*

Probability Scale

Rating	Interpretation
1	Low
2	Medium
3	Medium-High
4	High
5	Fact

Impact Scale

Rating	Interpretation
1	No real impact
2	Small to medium reduction of time or cost reserves
3	Medium to large reduction of time or cost reserves
4	Over budget or behind schedule or both (0-15%)
5	Unacceptably over budget or behind schedule or both (over 15%); possible project failure

FIGURE 11.3 *Ratings interpretation for probability and impact matrix*

Risk Parameters Assessments In addition to creating a short list of risks, qualitative risk analysis includes identifying risks that should move more quickly through the process than others due to factors that are referred to as risk parameters. Some examples of risk parameters include the following:

- **Urgency** The urgency parameter indicates if the risk is likely to occur soon (requiring the response to be implemented quickly) or if the risk requires a particularly long time to plan a response. Urgent risks may be moved directly or more quickly into risk response planning.
- **Dormancy** Dormancy is the anticipated time between when a risk occurs and when its impact is felt.
- **Manageability and controllability** The manageability and controllability parameter indicates the level of difficulty involved in dealing with an identified risk, should it occur.

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- **Strategic impact** Strategic impact is the degree to which the occurrence of a risk would affect the strategic goals of the performing organization.

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Qualitative risk analysis can be used to do the following.

- Compare the risk of the project to the overall risk of other projects.
- Determine whether the project should be continued or terminated.
- Determine whether to proceed to the Perform Quantitative Risk Analysis or Plan Risk Responses processes (depending on the needs of the project and the performing organization).

At the end of this process, the following documents may be updated: the assumption log, issue log, risk register, and the risk report. Can you think of other outcomes of performing qualitative risk analysis?

Perform Quantitative Risk Analysis[11]

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The Perform Quantitative Risk Analysis process involves numerically analyzing the probability and impact (the amount at stake or the consequences) of risks that ranked highest in qualitative risk analysis. Quantitative risk analysis also looks at how risks could affect the objectives of the project. The purpose of quantitative risk analysis is to:

- Determine which risk events warrant a response plan.
- Determine overall project risk (risk exposure).
- Determine the quantified probability of meeting project objectives (for example, "We only have an 80 percent chance of completing the project within the six months required by the customer," or "We only have a 75 percent chance of completing the project within the $80,000 budget").
- Determine cost and schedule reserves.
- Identify risks requiring the most attention.
- Create realistic and achievable cost, schedule, or scope targets.

While you should always do qualitative risk analysis, proceed with quantitative risk analysis only if it is worth the time and money, or move directly to risk response planning. For some projects, you may have a subset of risks identified that require further quantitative analysis. But why spend time quantitatively assessing risks for a low-priority or short-term project or when the effort will provide minimal return?

The Perform Quantitative Risk Analysis process can include a lot of calculation and analysis. Luckily, the details of these efforts are not a focus of the exam. You need to know that the following actions are part of quantitative risk analysis but not how to do them beyond what is explained in this chapter:

- Further investigate the highest-rated risks on the project and other results of qualitative analysis.
- Perform data analysis to determine which risks have the most impact on the project.
- Determine how much quantified risk the project has through data analysis.

Quantitative probability and impact can be determined in a variety of ways that make use of some or all of the following tools:

- Expert judgment from trained risk specialists and team members
- Data-gathering techniques, such as interviewing
- Data analysis techniques, such as sensitivity analysis, decision tree analysis, and influence diagrams
- Interpersonal and team skills
- Representations of uncertainty
- Cost and schedule estimating
- Use of historical records from previous projects

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Simulations Simulation techniques, such as Monte Carlo analysis in which schedule and cost estimates are used to "perform" the project many times to simulate results, can be extremely valuable. Traditionally, there has been only one or two questions about Monte Carlo analysis on the exam.

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You do not need to know how to perform this calculation for the exam. Rather, you should just understand that Monte Carlo analysis:

- Is usually done with a computer program because of the intricacies of the calculations
- Evaluates the overall risk in the project
- Determines the probability of completing the project on any specific day or for any specific cost
- Determines the probability of any activity actually being on the critical path
- Takes into account path convergence (places in the network diagram where many paths converge into one activity)
- Translates uncertainties into impacts to the total project
- Can be used to assess cost and schedule impacts
- Results in a probability distribution

Sensitivity Analysis[12] Sensitivity analysis is a technique to analyze and compare the potential impacts of identified risks. A tornado diagram[13] may be used to graphically depict the results of this analysis. Risks are represented by horizontal bars: the longest and uppermost bar represents the greatest risk, and progressively shorter horizontal bars beneath represent lower-ranked risks. The resulting graphic resembles a funnel cloud, or tornado, as shown in figure 11.4.

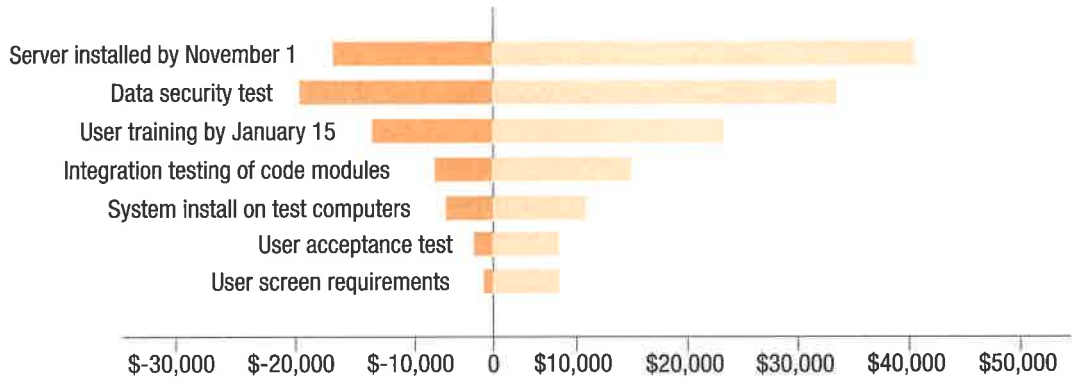

FIGURE 11.4 *Tornado diagram*

Expected Monetary Value (EMV) Expected monetary value can be used in several ways but is often used to estimate the impact of a risk by calculating its probability (as a percentage) times its estimated cost.

$$EMV = P \times I$$

Example: 65% x $40,000 = $26,000

The resulting EMV values for risks in a quantitative risk analysis are later summed to calculate contingency reserves. Questions on the exam may ask "What is the expected monetary value of the following?" Do the following exercise to give this a try! The exam could also ask you to calculate the expected monetary value for cost, the expected value (or just "value") for the schedule of a path, or the value of your decision.

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11.1 Exercise In your Exercise Notebook, calculate the expected monetary value for each of these work packages. The math is not difficult but completing this exercise will help you remember this calculation for the exam.

Work Package	Probability	Impact
A	10%	$20,000
B	30%	$45,000
C	68%	$18,000

Answer See the answers in the following table.

Work Package	Expected Monetary Value
A	$2,000
B	$13,500
C	$12,240

Note that for opportunities, expected monetary value is often presented as a positive amount (e.g., $3,000), whereas threats are usually presented as a negative number (e.g., –$3,000).

Decision Tree[14] Analysis There have traditionally been only one or two questions about decision trees on the exam, but since they are unfamiliar to many people we will talk about them here. You should know what a decision tree is and be able to calculate a simple one from data within an exam question.

A decision tree is analyzed by calculating the value of each branch (another way of using EMV). The outcome of this calculation will show the best option to select. You should also know the following about decision trees:

- It considers future events.
- It calculates the expected value (probability multiplied by impact) in more complex situations (for example, a project manager could evaluate the costs or schedule implications and benefits of several risk responses at once to determine the best option).
- It involves mutual exclusivity.

TRICKS OF THE TRADE® Some examples of decision trees have the costs occurring only at the end of the project, while others have costs occurring early or in the middle of the project. Because a decision tree models all the possible choices to resolve an issue, costs can appear anywhere in the diagram, not just at the end. When you are taking the exam, don't get confused when you look at examples of decision trees. Pay attention to the data provided in the question so you can correctly interpret the answer.

The following exercise includes a decision tree analysis. The box represents a decision to be made, and the circles represent what can happen as a result of the decision.

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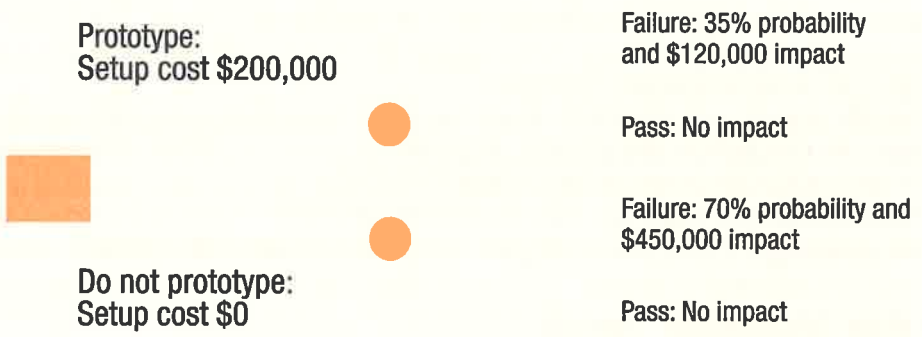
11.2 Exercise A company is trying to determine if prototyping is worthwhile on a project. They have come up with the following impacts (see the diagram) of whether the equipment works or fails. Based on the information provided in the diagram, what is the expected monetary value of each option? Which is the cheaper option—to prototype or not to prototype? Do the calculations and write the answer in your Exercise Notebook.



Answer If you just look at the setup cost of prototyping, it would seem like an unwise decision to spend money on prototyping. However, the analysis proves differently. Taking into account only the one future event of whether the equipment works or fails, the decision tree reveals that it would be cheaper to do the prototyping. The expected monetary value of prototyping is $242,000; the expected monetary value of not prototyping is $315,000.

Prototype	35% × $120,000 = $42,000 $42,000 + $200,000 = $242,000
Do Not Prototype	70% × $450,000 = $315,000

TRICKS OF THE TRADE® Project management saves time and money on projects. Getting your organization's executives to understand that fact can be difficult at times. How beneficial would it be if you could prove the value of project management?

Imagine that you have just done the first calculation of the expected value of all the high ranking and priority risks in qualitative risk analysis, or that you have completed a Monte Carlo analysis for the project. In either case, you calculate that you need a $98,000 contingency reserve on the project to accommodate risks. Let's try this example. The team moves on to the Plan Risk Responses process and eliminates some risks and reduces the probability or impact of others. The expected monetary value calculation or Monte Carlo analysis is then redone, showing a revised need for only a $12,000 reserve. You have just saved $86,000 and you have not even started the project yet.

The Perform Quantitative Risk Analysis process results in updates to the risk register and other project documents, including:

- **Prioritized list of quantified individual project risks** What risks are most likely to have a negative effect on the critical path? What risks need the most contingency reserve?
- **The quantified probability of meeting project objectives** For example, "We only have an 80 percent chance of completing the project within the six months required by the customer." Or, "We only have a 75 percent chance of completing the project within the $800,000 budget."

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- **Trends in quantitative risk analysis** As you repeat quantitative risk analysis during project planning and when changes are proposed, you can track changes to the overall risk of the project and see any trends.
- **Initial contingency time and cost reserves needed (finalized in Plan Risk Responses)** For example, "The project requires an additional $50,000 and two months of time to accommodate the risks on the project."
- **Assessment of overall project risk exposure** Use overall project success (how likely it is that the project will achieve all key objectives) and any variables that may still affect the project to fully understand the overall risk exposure of the project.
- **Possible realistic and achievable completion dates and project costs, with confidence levels, versus the time and cost objectives for the project** For example, "We are 95 percent confident that we can complete this project on May 25th for $989,000."
- **Recommended risk responses** After quantitative risk analysis is performed, the risk register may include suggested responses to overall project risks and individual project risks.

Plan Risk Responses PAGE 437

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The Plan Risk Responses process involves figuring out, "What are we going to do about each top risk?" The project's risk responses may include doing one or a combination of the following for each top risk:

- Do something to eliminate the threats before they happen.
- Do something to make sure the opportunities happen.
- Decrease the probability and/or impact of threats.
- Increase the probability and/or impact of opportunities.

For the remaining (residual) threats that cannot be eliminated:

- Do something if the risk happens (contingency plans). Contingency plans should be measurable so you can evaluate their effectiveness.
- Do something if contingency plans are not effective or are only partially effective (fallback plans).

This is what risk management is all about. If a change to a team member's availability is a top risk, you can investigate the possibility of replacing that team member with another team member who has similar skills. If a work package is causing a large amount of risk, you might look at changing the deliverable, modifying the work to produce it, or removing scope from the project. There are always options to respond to risks.

In addition to avoiding or exploiting risks, you and the team determine what to do about each of the residual risks (those that cannot be eliminated or exploited through risk response strategies). This might mean accepting these residual risks, or planning additional risk responses. You then assign the work involved in the responses to risk owners—individuals who watch out for the occurrence of a risk and implement preplanned responses.

When you are taking the exam, assume that all major potential problems that could have been identified in advance as risks were determined before they occurred and that there was a plan for each risk. With this in mind, the best answer to a question describing a major problem on the project will be the choice that talks about implementing a contingency plan, rather than one that involves discussing possible solutions to a problem after it has occurred. Many people have said that these types of questions were the reason they failed the exam. They simply made the wrong choices in situational questions. Be sure to make the transition to this way of thinking if it is unfamiliar to you.

Here are a couple of other points that can be tricky on the exam:

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- Can you eliminate all threats on a project? Remember that threats can be eliminated and opportunities exploited, but the time and trouble involved in eliminating all the threats and exploiting all the opportunities on a project would probably not be worthwhile.
- Did you know that qualitative risk analysis, quantitative risk analysis, and risk response planning occur throughout the life of a project? As noted in other parts of this book, planning is iterative. You need to review risks throughout the project, including while the project work is being done or when checking results. Newly identified risks need to go through the risk planning process.

The primary input to this process is the risk register, which has been updated throughout the risk management process and now includes a list of risks that have been qualitatively (and possibly quantitatively) analyzed. The risks have been prioritized based on their probability and impact, among other factors. These are the risks for which responses will be planned. The cost baseline describes the contingency reserve that will be used in addressing identified risks. (See the discussion on reserves later in this chapter.)

Risk Response Strategies When completing risk response planning, a thorough analysis must be done of the potential responses for each risk. Some of these risk response strategies, also known as risk mitigation strategies or strategies for threats and opportunities, involve changing the planned approach to completing the project, such as changes to the WBS, quality management plan, resources, communications, schedule, or budget. Other strategies, called contingency plans, involve coming up with a plan to be implemented when and if a risk occurs.

The choices of response strategies for threats include:

- **Avoid** Eliminate the threat by eliminating the cause, such as removing the work package or changing the person assigned to do work. Avoiding the threat might even involve expanding the scope of the project. Imagine, for example, there's an estimated 75 percent likelihood of a threat occurring, but an additional level of testing or an additional activity would likely prevent this threat; expanding the scope of the project in this way would help avoid the threat.

  On an overall project level, if the threat is beyond the organization's risk threshold, the project manager will need to take action to make the project acceptable. This could include removing pieces of the project that are too risky in order to avoid cancelling the entire project.
- **Mitigate** Reduce the probability and/or the impact of an individual or overall project threat, thereby making it a smaller risk and possibly removing it from the list of top risks on the project. Options for reducing the probability are considered separately from options for reducing the impact. Any reduction will make a difference, but the option with the most probability and/or impact reduction is often the option selected.
- **Transfer (deflect, allocate)** Make a party outside of the project responsible for the threat by purchasing insurance, performance bonds, warranties, or guarantees, or by outsourcing the work. Here is where the strong connection between risk and procurement (contracts) begins. In the world of properly practiced project management, risk analysis is completed before a contract is signed, and transference of risk is included in the terms and conditions of the contract.

Avoidance and mitigation are generally used for high-priority, high-impact risks. Transference, escalation (discussed next), and acceptance (also discussed next) may be appropriate for low-priority, low-impact risks as well as those with higher impact.

A response to pure risks[15]—such as fire, property damage, or personal injury—is to purchase insurance. Insurance exchanges an unknown cost impact of a known risk for a known cost impact. In the example of a risk of fire, the cost impact of the risk is unknown depending on the extent of the fire. But when insurance is purchased, the cost impact of a risk of fire becomes known; it is the cost of the insurance and the deductible. Transferring the risk by purchasing insurance does not eliminate all impacts. There may still be residual risks. For example, a project could experience schedule delays due to a fire even if fire insurance was purchased, or the cost of damage caused by the fire could exceed the amount of insurance purchased.

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Transferring a risk will also leave some risk behind. For example, there is a risk that if the third party has trouble, they could cause a schedule delay. So you still need to decide what to do about any such secondary risks.

The choices of response strategies for opportunities include:

- **Exploit (the reverse of avoid)** Add work or change the project to make sure the opportunity occurs. This could be on the individual project risk level or on the overall project risk level.
- **Enhance (the reverse of mitigate)** Increase the likelihood (probability) and/or positive impacts of the opportunity occurring. This could be related to the overall approach to scope and schedule, resources used, and project replanning, as well as to individual project risks.
- **Share** Allocate ownership or partial ownership of the individual or overall project opportunity to a third party (forming a partnership, team, or joint venture) that is best able to achieve the opportunity.

Response strategies for both threats and opportunities include:

- **Escalate** A threat or an opportunity should be escalated if it is outside the scope of the project or beyond the project manager's authority. Any risks that are escalated will typically be managed at the program or portfolio level—not at the project level. Remember that escalated risk needs to be accepted by the program or portfolio manager, at which point, data on the escalation is documented, and the risk is no longer monitored at the project level.
- **Accept** Passive acceptance means to do nothing and to essentially say, "If it happens, it happens." This leaves actions to be determined as needed (workarounds) if the risk occurs. Active acceptance involves creating contingency plans to be implemented if the risk occurs and allocating time and cost reserves to the project.

Whether responding to threats or opportunities:

- Strategies must be timely.
- The effort selected must be appropriate to the severity of the risk—avoid spending more money preventing the risk than the cost of the impact of the risk had it occurred.
- One response can be used to address more than one risk.
- More than one response can be used to address the same risk.
- A response can address the root cause of risk and thereby address more than one risk.
- The team, other stakeholders, and experts should be involved in selecting a strategy.

Watch out for questions about communicating risk-related information on the exam! Your risk response strategies must be communicated to the sponsor, management, and stakeholders. These parties will need to know that you are in control of the project even if there is a problem, and they may need to approve the resources to make the risk response strategies happen. Communicating about risk is essential for gaining buy-in to the strategy.

11.3 Exercise Now let's see if you can apply what you have learned. Identify the type of risk response strategy (avoid, mitigate the probability, mitigate the impact, transfer, exploit, enhance the probability, enhance the impact, share, escalate, or accept) being described. Write the answer in your Exercise Notebook for each description.

	Description
1.	Remove a work package or activity from the project.
2.	Assign a team member to frequently visit the seller's manufacturing facilities to learn about problems with deliveries as early as possible.
3.	Move a work package to a date when a more experienced resource is available to be assigned to the project.

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	Description
4.	Begin negotiation for the equipment earlier than planned so as to secure a lower price.
5.	Outsource a work package so as to gain an opportunity.
6.	Notify management that there could be a cost increase if a risk occurs because no action is being taken to prevent the risk.
7.	Remove a troublesome resource from the project.
8.	Provide a team member who has limited experience with additional training.
9.	Train the team on conflict resolution strategies.
10.	Outsource difficult work to a more experienced company.
11.	Ask the client to handle some of the work.
12.	Prototype a risky piece of equipment.
13.	Notify the PMO that the testing software needed for the project could be used by three other IT groups if the enterprise solution is purchased.

Answer

	Risk Response Strategy		
1.	Avoid	8.	Mitigate the probability
2.	Mitigate the impact	9.	Mitigate the impact
3.	Exploit	10.	Transfer
4.	Enhance the impact	11.	Transfer
5.	Share	12.	Mitigate the probability
6.	Accept	13.	Escalate
7.	Avoid		

TRICKS OF THE TRADE® Potential risk response strategies and contingency plans must be analyzed to determine which strategy or strategies are most cost-effective and most likely to address the risk. Cost-benefit analysis and multicriteria analysis are techniques to evaluate and rank potential risk responses. You may see a question on the exam asking you to compare the cost effectiveness of various risk response options.

An outcome of planning risk responses may be change requests and updates to project artifacts. Planned risk responses may require changes to management plans that have been drafted in planning—at the overall project risk level as well as at the individual project risk level. In agile and hybrid environments the results of this work takes the form of reprioritizing the backlog, creating risk response stories, and updates to iteration and release plans and to iteration roadmaps. Spend a moment now thinking about how risk response planning might also lead to adjustments to the schedule, cost, quality, procurement, communications, and resource management plans, as well as to the scope, schedule, and cost baselines for the project. This concept is critical for understanding the impact risk management has on projects, especially if you don't currently do risk management on your projects.

Remember also that planning is iterative. To help you answer questions correctly on the exam and understand the flow of the planning processes, Rita's Process Chart™ (as desribed in the "Processes and Domains" chapter) represents this analysis, evaluation, and integration of the changes in the management plan during project planning as part of "Go back—iterations."

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The assumption log, cost forecasts, the lessons learned register, the project schedule, project team assignments, the risk register, and the risk report are all project documents that may be updated as an outcome of planning risk responses. The risk report is updated to communicate the risks of greatest threat or opportunity, the overall project risk exposure, and the outcomes of planning related to risk responses and any anticipated changes. Can you imagine how risk response planning might affect the roles and responsibilities on a project, your stakeholder management strategy, or your quality metrics?

Risk Register Updates The risk register is updated to add the results of risk response planning, including:

- **Residual risks**[16] These are the risks that remain after risk response planning. After you have avoided, exploited, mitigated, enhanced, transferred, shared, escalated, and accepted risks (and created related contingency plans and fallback plans), there will still be risks that remain. Those residual risks that are passively accepted should be properly documented and reviewed throughout the project to see if their ranking has changed.
- **Contingency plans** Contingency plans are plans describing the specific actions that will be taken if the opportunity or threat occurs.
- **Fallback plans** These plans are specific actions that will be taken if the contingency plans are not effective. Think how prepared you will feel if you have plans for what to do if a risk occurs and what to do if the original plan does not work.
- **Risk owners** A key concept in risk response planning is that the project manager does not have to do it all, and neither does the team. Each risk must be assigned to someone who will help lead the development of the risk response and who will be assigned to carry out the risk response or "own" the risk. The risk owner can be a stakeholder other than a team member. Think about how the application of risk management could change real-world projects. The risk occurs; the risk owner takes the pre-approved action determined in project planning and informs the project manager. No meeting is needed—just action! This can be very powerful.
- **Secondary risks** Any new risks created by the implementation of selected risk responses should also be analyzed as part of risk response planning. Frequently, a response to one risk will create the possibility of new risks. For example, if a portion of the project work is outsourced to a seller because the project team does not have the expertise to complete the work efficiently, there may be a secondary risk of the seller going out of business. The discovery of secondary risks may require additional risk response planning, including ensuring that the secondary risks are of a lower severity than the primary risk.
- **Risk triggers**[17] These are events that trigger the contingency response. The early warning signs for each risk on a project should be identified so risk owners know when to take action.
- **Contracts** Before a contract is finalized, the project manager should have completed a risk analysis and included contract terms and conditions required to mitigate threats and enhance opportunities. Any contracts issued to deal with risks should be noted in the risk register.
- **Reserves (contingency)**[18] Having reserves for time and cost is a required part of project management. You cannot come up with a schedule or budget for the project without them. Reserves are covered in the "Cost" chapter, but let's look at them again here.

Time and cost each have two types of reserves: contingency reserves and management reserves. Contingency reserves account for "known unknowns" (or simply "knowns"); these are items you identified in risk management. Management reserves account for "unknown unknowns" (or simply "unknowns"); these are items you did not or could not identify in risk management. Projects can have both kinds of reserves. As shown in the diagram in figure 11.5 (also shown in the "Cost" chapter), contingency reserves are calculated and become part of the cost baseline. Management reserves are estimated (for example, 5 percent of the project cost), and then these reserves are added to the cost baseline to get the project budget. The project manager has control of the cost baseline and can approve use of the contingency reserves, but management approval is needed to use management reserves. The same applies to reserves in the schedule.

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Make sure you understand that reserves are not an additional cost to a project. The risk management process should result in a decrease to the project's estimated time and cost. As threats are eliminated or their probability or impact reduced, there should be a reduction to the project's schedule and budget. Contingency reserves are allocated for the contingency plans and fallback plans to deal with the associated, accepted opportunities and threats that remain after the risk management planning processes have been completed. No matter what you do, risks will remain in the project, and there should be a time or cost allotment for them, just as time or cost is allotted to work activities on the project.

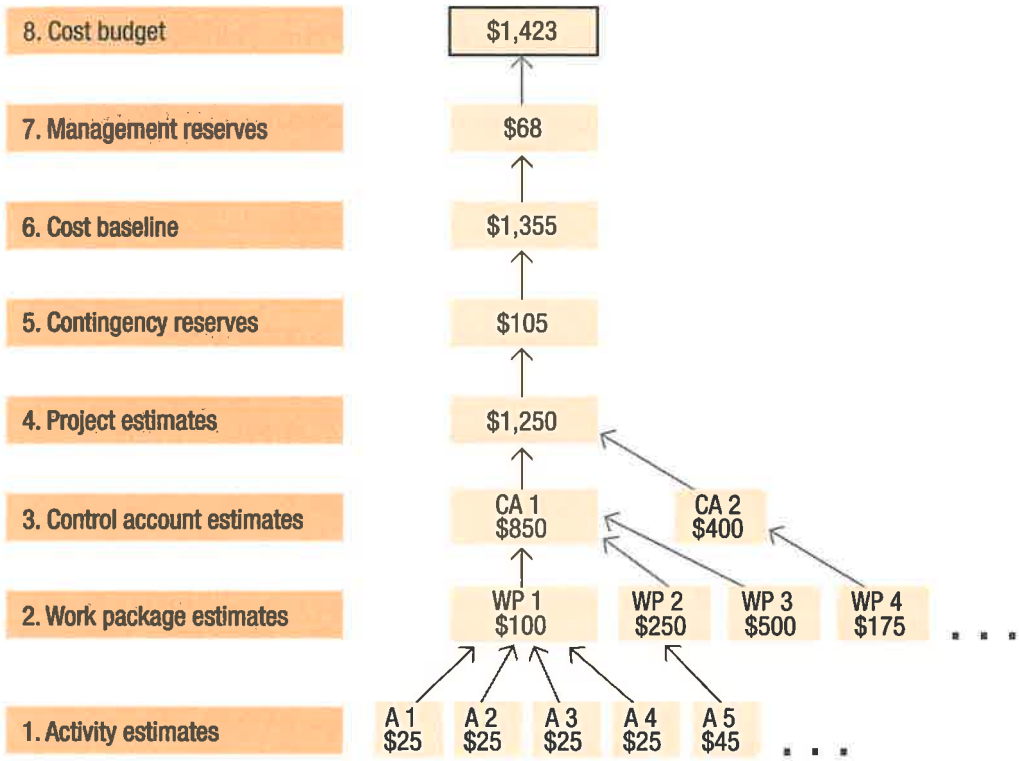

FIGURE 11.5 *Contingency and management reserves create a cost budget*

There may be questions on the exam that ask you to calculate the contingency reserve for several risk events, which may be a combination of opportunities and threats. To do this, you must calculate the value of each risk using the equation for expected value (P × I). On the exam, you may have to calculate contingency reserves for either schedule (expected value) or cost (expected monetary value). But think about this a minute. Let's use the example for cost impacts to projects. Can you just add all the expected monetary value amounts of the opportunities and threats together and come up with one grand total for the budget? No! You'll need to subtract the total expected monetary value of the opportunities from the total expected monetary value of the threats. Why?

Opportunities will save money and time on the project if they occur. This can reduce the cost or schedule baselines. Conversely, the threats will add cost and time to the project.

You're being told to subtract opportunities here, but weren't you told earlier that expected value is often presented as a positive amount for opportunities and a negative amount for threats? That's often true when the values are depicted on something like a decision tree, so you can easily identify positive and negative outcomes and their overall effect on project costs or schedule. But this example is specifically looking to determine how much money or time to set aside for the contingency reserves. Threats will require increasing the amount of contingency reserves, whereas opportunities will decrease the required reserves.

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Let's try an example of calculating a contingency reserve in the next exercise.

11.4 Exercise Imagine you are planning the manufacture of modifications to an existing product. Your analysis has come up with the following information. In your Exercise Notebook, calculate the cost contingency reserve for each of the following scenarios, and then calculate the total cost contingency reserve for the project.

	Project Data
1.	There is a 30 percent probability of a delay in the receipt of parts, with a cost to the project of $9,000.
2.	There is a 20 percent probability that the parts will cost $10,000 less than expected.
3.	There is a 25 percent probability that two parts will not fit together when installed, costing an extra $3,500.
4.	There is a 30 percent probability that the manufacture may be simpler than expected, saving $2,500.
5.	There is a 5 percent probability of a design defect, causing $5,000 of rework.

Answer You use the expected monetary value calculation (EMV = P × I) to determine the contingency reserve. The answer is $1,075 for the total cost contingency reserve. See the following table for the detailed calculations.

	Cost Contingency Reserve Calculations
1.	30% × $9,000 = $2,700 Add $2,700
2.	20% × $10,000 = $2,000 Subtract $2,000
3.	25% × $3,500 = $875 Add $875
4.	30% × $2,500 = $750 Subtract $750
5.	5% × $5,000 = $250 Add $250
Total Cost Contingency Reserve = $1,075	

Think about this exercise for a minute. Let's assume that the exercise had examples of threats and opportunities to the schedule. If you had a 30 percent probability of a 15-day activity delay, the expected value would be 4.5 days, which would be added to the schedule. And if the probability of an activity taking 10 days less than planned was 20 percent, the expected value would be -2 days. The resulting contingency for these two risks would be 2.5 days.

Now let's try another exercise. If the risk management process is new to you, the following exercise should help you put it all together by looking at it in a chart form.

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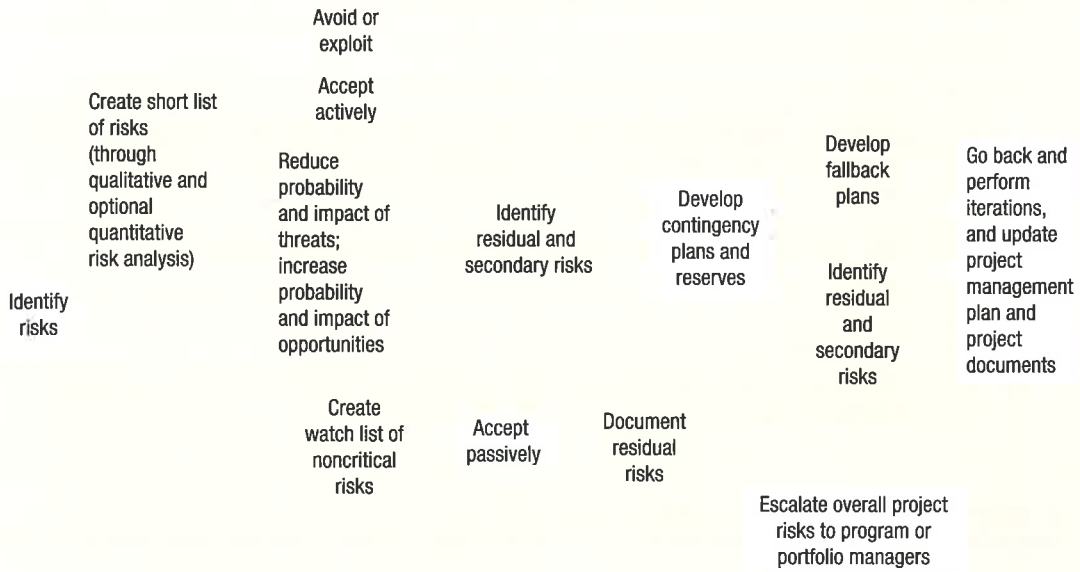
11.5 Exercise In your Exercise Notebook, create a flowchart of the risk process from Identify Risks through Plan Risk Responses.

Answer Creating this chart will help you check whether you have understood what you read in this chapter. Your flowchart could be different than the following depiction.



A quick note on approaching and adjusting a risk backlog[19] from an agile perspective. In an agile environment, a project's backlog is prioritized not just for features but for the risk responses that have been developed for identified risks. In planning each iteration, agile teams seek to balance delivering the highest-value features and mitigating the biggest threats that remain on the project. The backlog can now be referred to as a "risk-adjusted backlog," as illustrated in figure 11.6.

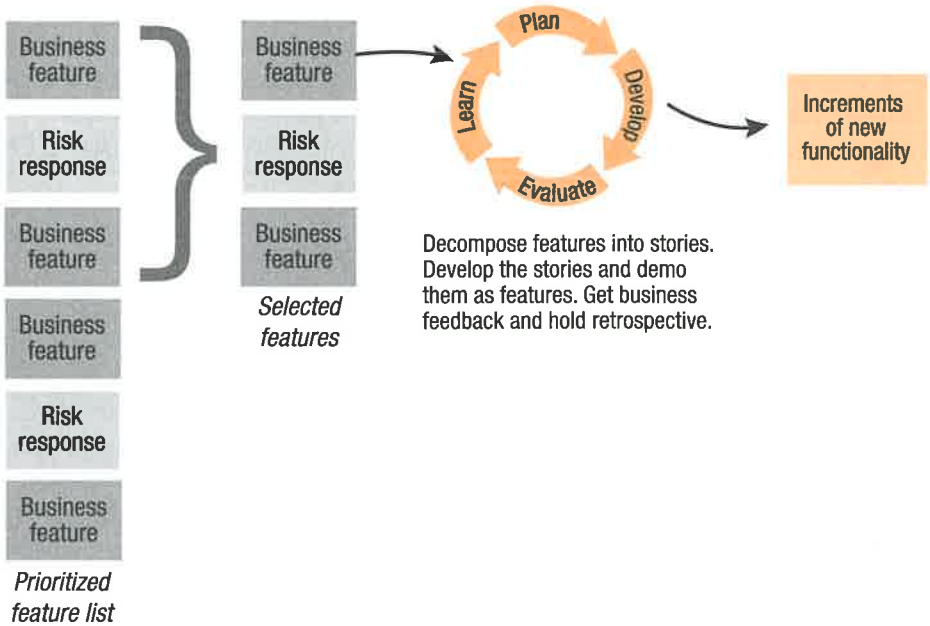


FIGURE 11.6 *Risk-adjusted backlog (prioritized feature list)*

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You are nearing the end of the "Plan Risk Responses" section. Let's examine some important concepts for the exam in this group of questions and answers. Take a few moments to test yourself.

Question What do you do with noncritical risks?
Answer Document them in a watch list, and revisit them periodically.

Question Would you choose only one risk response strategy?
Answer No, you can select a combination of choices.

Question What risk management activities are done during the execution of the project?
Answer Watching out for watch-listed (noncritical) risks that increase in importance, and looking for new risks; implement contingency plans if triggers indicate the risk is about to occur or is occurring.

Question What is the most important item to address in project team meetings?
Answer Risk.

Question How would risks be addressed in project meetings?
Answer By asking, "What is the status of risks? Are there any new risks? Is there any change to the order of importance?"

Implement Risk Responses PAGE 449

PMBOK® Guide
PG: Executing
Process: Implement Risk Responses

ECO
Domain: I
Task: 7
Domain: II
Task: 3, 15

Implementing risk responses is the heart of risk management, and where the value of proper risk management becomes most apparent. When the preliminary work has been done well, the Implement Risk Responses process can be handled smoothly, since the previously documented plans allow for timely and effective responses to risk events.

Throughout the project, the risk register and risk report are reviewed regularly, ensuring everyone is aware of potential risks and ready to implement the planned responses as needed. Information on triggers enables the project manager, risk owner, and team to recognize indications that a risk event is imminent. At that point, the risk owner, supported by the project manager, leads previously assigned resources in performing response activities. The consequences of threats are averted, or opportunities are taken advantage of. Risk thresholds[20] are documented in the plan along with an indication of what amount of relief is required from risk responses, so the success of the implementation can be evaluated.

The beginning of this chapter included the story of a project manager who was managing a hardware/software installation during a hurricane. Let's revisit that example.

If the project manager had performed proper risk management, he would have had a plan in place to avoid the risk of a hurricane impacting his project, for example, scheduling the project to happen before or after the forecasted hurricane. If the project manager and the risk owners had actively monitored known risk triggers (such as weather reports, including wind speeds and the projected path of the hurricane) and then implemented a risk response plan before the hurricane reached the area, they could have successfully avoided the rework and delays, along with the costs, resulting from the hurricane. Such preparation is critical to successfully implementing a risk response.

Sometimes carefully developed plans don't have the expected result. For example, let's assume that a risk owner or the project manager in the previous story implemented a risk response plan to reschedule the implementation, causing the schedule to be extended. Although the plan was executed as intended, the hurricane caused more damage than anticipated, and the schedule had to be extended beyond the planned number of days. Such unforeseen results are managed through change requests to the cost and schedule management plans.

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Project documents are updated as a result of the Implement Risk Responses process. The risk register and risk report are updated with information on responses taken, details on how well the responses addressed the risk and suggested changes to future risk response plans. The project manager adds information to the lessons learned register about what worked and what didn't work when the risk response was implemented. The risk report is updated with changes to the project's risk exposure and changes to planned risk responses. Ongoing issues, such as confusion or disagreement regarding the response as it was implemented, are added to the issue log.

Monitor Risks PAGE 453

PMBOK® Guide
PG: Monitoring & Contgrolling
Process: Monitor Risks

ECO
Domain: I
Task: 7
Domain: II
Task: 3, 10, 15

Risk-related questions on the exam assume that the project manager has done proper project management, including assigning risk owners, putting contingency plans in place, and taking actions as outlined in the plan. The exam also assumes the project is substantially less risky with this planning done. If you do not have experience using risk management in the real world, these exam questions may be difficult. Try the next exercise. It will help you understand what project management is like when it includes risk management.

11.6 Exercise Think about the previous paragraph. Because a project manager has completed risk management activities, they are no longer focusing on dealing with problems and figuring out what should be done. So what is the project manager doing?

Spend time really thinking through the actions involved in monitoring risks and write them down in your Exercise Notebook. Once you have completed your list of actions, compare that to our list. You could include things on your list that are not on ours, but check each one of those items to determine if they are accurate. If there are items on our list that you didn't include, then make sure you do these actions or at least understand what they are and why they are helpful to the project.

Answer With risk management and proper project management, you are not doing things like figuring out what work needs to be done on the project or determining who will do a piece of work. Those efforts were already done in project planning. You are not spending much time solving problems, because you already have a plan in place for major problems. Even well-trained and experienced project managers do not always do enough to monitor risk. Read the following list over carefully, and make sure you understand each of the actions. This is not a time for memorization; you are simply assessing what you know and do not know so that you can better understand these concepts and correctly answer situational questions on the exam.

Keep in mind that in an agile or hybrid environment, a project manager may accomplish this in a less formal manner than in a predictive environment. You may update risk burndown charts, review risks in a retrospective, and ask the project team how plans to reduce threats and maximize opportunities are going. Do you need to create any new stories to address new or escalating risks? Do you need to engage the product owner in discussions about reprioritizing the backlog based on new risk information?

The following is our list of actions involved in monitoring risks in a predictive environment.

- Look for the occurrence of risk triggers.
- Monitor residual risks.
- Identify new risks and then analyze and plan for them.
- Evaluate the effectiveness of the risk management plan. Is it working? Does it need adjustment?
- Develop new risk responses. If a plan no longer seems like it will work, based on experience or new information, an alternate risk response or responses may be more appropriate.

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- Collect and communicate risk status: "Four identified risks occurred last month, and all risk response plans were implemented successfully. Next month eight other risks may occur. Risk reserves are still considered adequate for covering the identified risks on this project."
- Communicate with stakeholders about risks: "Remember that one of the major risks on the project could occur next week."
- Determine if assumptions are still valid.
- Ensure proper risk management procedures are being followed.
- Revisit the watch list: "This change to the product scope might increase the impact of risk X, currently on our watch list. Let's analyze it."
- Recommend corrective actions to adjust to the severity of actual risk events: "This risk did not have the impact we expected; let's adjust the contingency plan and change what we will do if the risk reoccurs."
- Look for any unexpected effects or consequences of risk events: "We did not expect this risk to damage the construction site. We need to decide how to fix the damage after we finish implementing the already agreed-upon contingency plan."
- Reevaluate risk identification and qualitative and quantitative risk analysis when the project deviates from the baseline: "The project cost is over the cost baseline (or over the schedule baseline). This implies we missed some major risks. Let's hold another risk identification session."
- Look at the changes, including recommended corrective actions, to see if they lead to identifying more risks: "We keep having to take corrective action related to this problem. Let's look for the root cause and identify any risks to the remainder of the project that relate to the problem."
- Submit change requests to integrated change control.
- Update the project artifacts with approved changes and any relevant information from the analysis of work performance data.
- Create a database of risk data and lessons learned that may be used throughout the organization on other projects
- Perform variance and trend analysis on project performance data.
- Use contingency reserves and adjust for approved changes.
- Update the risk register and risk report with current risk exposure.
- Reevaluate assumptions and constraints, capture new issues, and update existing ones.
- Close out risks.

Other work that is part of the Monitor Risks process is outlined in the following sections.

Workarounds If the project has deviated from the baselines, the team may take corrective action to bring it back in line. Recommendations for such corrective actions may include workarounds. Whereas contingency responses are developed in advance, workarounds are unplanned responses developed to deal with the occurrence of unanticipated events or problems on a project (or to deal with risks that had been accepted because of unlikelihood of occurrence and/or minimal impact). Project managers who do not perform risk management spend a lot of their time creating workarounds.

Risk Reassessments Questions always seem to come up on the exam that require you to know that the team needs to periodically review the risk management plan and risk register and adjust the documentation as required. It is important to determine whether any changes or adjustments need to be made to what was planned based on information that becomes apparent once work begins. Reassessing risk is a good topic for a team meeting, a retrospective, or even a separate meeting, as part of risk reviews. Many of the actions in the previous exercise relate to this.

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Reserve Analysis Reserve analysis is a matter of checking to see how much reserve remains and how much might be needed. It is like checking the balance in your bank account. Reserves must be protected throughout the project life cycle.

Now let's talk about a concept that can be tricky on the exam, especially for those who are not experienced in using risk management. People wanting to change the project in response to problems that have occurred may suggest using the reserves instead of adding cost or time to the project. It is important to know that a contingency reserve may only be used to handle the impact of the specific risk it was set aside for. So, if the change is part of the risk response plan that was previously accounted for in the budget, the reserve designated for that response may be used. If it is not, the project manager must take preventive or corrective action, fast track, crash, or otherwise adjust the project to accommodate or make up for the impact of the problem and its resulting changes, or request new reserve line items.

Under certain circumstances, usually determined by the performing organization, management reserves may be used for situations that are within the scope of the project but were not previously identified. For example, assume that a change to the order functionality on a website has exposed a data-sharing incompatibility with the legacy inventory management system's real-time inventory data that was not previously identified. A workaround needs to be created to keep the project on track, and management reserves will be used to hire experts to fix the problem and keep the project close to the current schedule.

If identified risks do not occur, the associated time or cost reserves are returned to the company, rather than used to address other issues on the project. If you are inexperienced with risk management, make sure you understand how reserves are used and protected.

Technical Performance Analysis Technical performance analysis uses project data to compare planned versus actual completion of technical requirements to determine if there is any variance from what was planned. Any variance could indicate possible risks to the project, either opportunities or threats.

Risk Reviews and Audits For the exam, think of status meetings as team meetings in which the project manager can perform risk reviews and risk audits.[21]

- Risk reviews are held regularly to discuss the effectiveness of planned risk responses that have been implemented on the project, and may result in the identification of new risks, secondary risks created by risk response plans, and risks that are no longer applicable. Closing of risks allows the team to focus on managing the risks that are still open. The closing of a risk will likely result in the associated risk reserve being returned to the company.
- These audits can be performed during meetings to assess how well risk processes are working for the project. The auditing process is documented in the risk management plan.

Retrospectives and Risk Burndown Charts Retrospectives and risk burndown charts[22] are agile tools that allow for ongoing monitoring and controlling for risks.

- Retrospectives can occur throughout an agile project at the end of an iteration. Retrospectives offer a number of benefits for controlling risk including:
  - Improved productivity by identifying and applying lessons learned immediately.
  - Improved capability by providing a venue for spreading scarce knowledge (or tacit knowledge).
  - Improved quality by finding circumstances that have led to defects and removing the causes.
  - Improved capacity by finding process improvements which in turn improve a team's work capacity.
- Risk burndown charts may be used for planning, managing, and controlling risk. These charts allow stakeholders to easily see a risk profile on a project. Risk burndown graphs quickly inform stakeholders whether the threats are moving in the right direction (downward), or if they are excalating. See the example in figure 11.7 in which a project manager is building a container-based algae production unit to capture carbon dioxide (CO2) emissions. Figure 11.7 shows that a spike in January to explore

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cost-effective underwater lighting was successful. The associated risk was eliminated and in turn the overall project risk was reduced by early February.

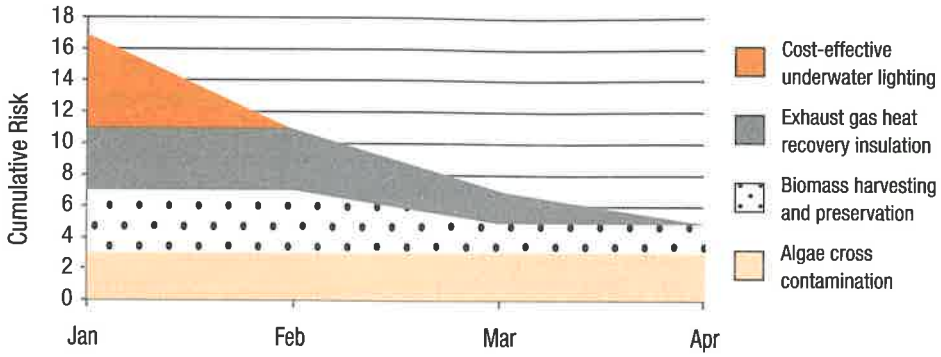

FIGURE 11.7 *Algae Project Risk Profile*

Outputs of Monitor Risks As with other risk management processes, change requests, updates to any project management plan component, the risk register, risk report and other project documents are a result of Monitor Risks, along with additional outputs listed here.

Work Performance Information This is the analysis of the work performance data gathered as part of project control. Examples include results of risk reviews and audits, performance measurements on schedule progress, determinations of which risks can be closed or are likely to close in the near future, and variance analyses comparing the planned versus actual risk data and time and cost of implemented risk responses. In agile and hybrid environments information is exchanged in a daily standup meeting about new accomplishments as well as impediments, and is documented through an updated backlog and burnup and burndown charts.

Risk Register Updates The Monitor Risks process will add the following to the risk register:

- Outcomes of risk reassessments and risk audits
- Results of implemented risk responses
- Updates to previous parts of risk management, including the identification of new risks
- Closing of risks that are no longer applicable
- Details of what happened when risks occurred
- Lessons learned

TRICKS OF THE TRADE Read situational questions describing suggested changes resulting from risk processes carefully to determine whether the actual work of the project has begun. You will have to determine what efforts are generating the change requests to help you evaluate answer choices. If the work of monitoring risks is being performed, new risks may be identified or planned risk responses may need to be adjusted based on project knowledge or an evaluation of risk processes. As a result of approved changes, risk planning must again be performed appropriately, and new risks must be evaluated and ranked, which may result in more risk response planning. This will generate change requests to integrated change control. The trick here is to remember that the approved project management plan and baselines are not static but changes to them must go through integrated change control.

Organizational Process Assets Updates The Monitor Risks process may include the creation or enhancement of risk templates, such as the risk register, checklists, and risk report, as well as updates to risk management processes and procedures. The project's risk breakdown structure, backlog, and other data may be added to organizational process assets as historical records for future projects.

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TRICKS OF THE TRADE The exam may describe situations where the wrong thing is being done as a way of testing whether you realize it is wrong. Some of the following common risk management mistakes can help you consolidate your knowledge of risk management:

- Risk identification is completed without knowing enough about the project and then not iterated.
- Padding is used instead of the risk management process.
- The processes of Identify Risks through Perform Quantitative Risk Analysis are blended, resulting in risks that are evaluated or judged as they come to light. This decreases the number of total risks identified and causes people to end risk identification too soon.
- The risks identified are general rather than specific (for example, "communications" rather than "poor communication of customer's needs regarding installation of system XYZ could cause two weeks of rework").
- Some things considered to be risks are not uncertain; they are facts, and are therefore not risks.
- Whole categories of risks (such as technological, cultural, marketplace, etc.) are missed.
- Only one method is used to identify risks (for example, only using a checklist) rather than a combination of methods. A combination helps ensure that more risks are identified.
- The first risk response strategy identified is selected without looking at other options and finding the best option or combination of options.
- Risk management is not given enough attention.
- Project managers do not explain the risk management process to their team during project planning.
- Contracts are signed long before risks to the project are discussed.

11.7 Exercise The Risk Management Process There may be many questions about the process of risk management on the exam. The following exercise tests if you understand what you have read.

In your Exercise Notebook draw seven columns with headings of the seven processes. Your table can be organized like the following table. Then recreate the risk management process, including the outputs. Check your answers against our answers when you are done. You may need to repeat this process after you have iterated your risk study process. Three attempts usually ensures you know the process well enough for the exam.

Plan Risk Management	Identify Risks	Perform Qualitative Risk Analysis	Perform Quantitative Risk Analysis	Plan Risk Responses	Implement Risk Responses	Monitor Risks
			Actions			
			Outputs			

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Answer

Plan Risk Management	Identify Risks	Perform Qualitative Risk Analysis	Perform Quantitative Risk Analysis Actions	Plan Risk Responses	Implement Risk Responses	Monitor Risks
• Answer the following questions: – How will you perform risk management on the project? – What risk management policies or procedures exist, and what new ones are needed? – When will the processes and procedures of risk management be performed? – How will risks be identified, and what tools will be used? – What are stakeholders' roles and responsibilities for risk management? – How will you budget for risk management? – What are the appetites and thresholds for risk?	• Identify all the risks on the project. • Use tools such as brainstorming, root cause analysis, documentation review, checklists, interviews, SWOT analysis, assumptions and constraints analysis, and prompt lists to facilitate risk identification. • Involve and engage stakeholders in the risk management process.	• Qualitatively determine which risk events warrant a response. • Assess the quality of the risk data. • Complete a risk urgency assessment. • Subjectively determine the probability and impact of all risks. • Determine if you will perform quantitative risk analysis or proceed directly to risk response planning. • Find ways to represent the analyzed data from qualitative risk analysis. • Document the watch list (noncritical risks). • Determine the overall risk ranking for the project.	• Numerically evaluate the top risks. • Quantitatively determine which risks warrant a response. • Determine initial reserves. • Create realistic time and cost objectives. • Determine the probability of meeting project objectives.	• Use risk response strategies to decrease project threats and increase opportunities. • Create contingency and fallback plans. • Determine secondary and residual risks. • Calculate final reserves. • Determine risk owners (if not already done). • Identify risk triggers. • Accept or escalate risks, where appropriate.	• Implement contingency and fallback plans (risk owner and resources). • Answer questions and facilitate clarification of plan details. • Communicate with stakeholders according to the plan.	• Respond to risk triggers. • Monitor residual risks. • Create workarounds. • Evaluate effectiveness of plans. • Look for additional risks; then qualify, quantify, and plan responses for them as necessary. • Revisit the watch list. • Analyze work performance data and look for trends. • Update plans. • Communicate risk status. • Close risks. • Recommend changes, including corrective and preventive actions. • Perform risk audits and risk reviews. • Perform reserve analysis.

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Plan Risk Management	Identify Risks	Perform Qualitative Risk Analysis	Perform Quantitative Risk Analysis	Plan Risk Responses	Implement Risk Responses	Monitor Risks
			Outputs			
• Risk management plan	• Risk register updates, including: – List of risks – Potential risk owners – List of potential risk responses • Risk report with summary information on risk details and the sources of overall project risk • Project documents updates, such as lessons learned in the identification of risks for the project, any issues, and new or existing assumption and constraint information	• Risk register updates, including: – Risk ranking of the project as compared to other projects – List of prioritized risks – Risks by category – Risks needing additional analysis and response – Watch list – Data on probability and impact analysis – Data on risk urgency – Assumptions and constraints analysis updates in assumption log	• Project document updates, including the following updates to the risk report: – Assessment of overall project risk exposure – Probability of meeting objectives – Interpreted quantitative analysis results, such as key sources of overall project risk – Prioritized list of individual project risks – Trends in quantitative risk analysis results – Recommended risk responses – Initial reserves • Updates to the risk register on the specific analysis for individual project risks	• Change requests • Updates to the project management plan and project documents, including: – Assumption log – Cost forecasts – Lessons learned register – Project schedule – Project team assignments – Risk report • Updates to the risk register, including: – Residual and secondary risks – Contingency and fallback plans – Risk owners – Triggers – Final reserves – Contracts – Accepted risks	• Change requests to project management plan, including schedule and cost baselines • Updates to project lessons learned register, including the effectiveness of risk responses and recommendations for managing future risks • Updates to the issue log regarding areas of confusion or disagreement • Updates to the risk report regarding: – Overall project risk exposure after implementing planned responses – Changes to planned risk responses • Updates to the risk register, including data on risk response implementations	• Work performance information • Updates to the risk register and other project documents, including: – Outcomes of risk reviews and audits – New risks – Closed risks – Details of risk occurrences – Lessons learned • Workarounds • Change requests, including recommended corrective and preventive actions • Updates to the project management plan and organizational process assets • Updates to the risk report

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Practice Exam

1. If a project has a 60 percent chance of a $100,000 profit and a 40 percent chance of a $100,000 loss, the expected monetary value (EMV) for the project is:
   A. $100,000 profit
   B. $60,000 loss
   C. $20,000 profit
   D. $40,000 loss

2. Assuming the ends of a range of estimates are +/– 3 sigma from the mean, which of the following range estimates involves the least risk?
   A. 30 days, plus or minus 5 days
   B. 22 to 30 days
   C. Optimistic = 26 days, most likely = 30 days, pessimistic = 33 days
   D. Mean of 28 days

3. Your new project is tasked with designing a robotic device. A successful outcome for this high-profile project would create a technological breakthrough and a significant market opportunity, but there is a lot of uncertainty about the technology and requirements. The CFO has asked you to determine as quickly as possible whether the project is viable. What would be the best approach for doing this?
   A. Ask the team to perform thorough proof-of-concept tests before starting development.
   B. Do a risk-based spike to determine if the Kansas testing facility is tornado-proof.
   C. Have the team begin planning and development, and see if they reach an impasse.
   D. Do an exploratory spike to research potential quality control issues and ways to mitigate them.

4. If a risk has a 20 percent chance of happening in a given month, and the project is expected to last five months, what is the probability that this risk event will occur during the fourth month of the project?
   A. Less than 1 percent
   B. 20 percent
   C. 60 percent
   D. 80 percent

5. If a risk event has a 90 percent chance of occurring, and the consequences will be $10,000, what does $9,000 represent?
   A. Risk value
   B. Present value
   C. Expected monetary value
   D. Contingency budget

6. Most of the project risks will be identified during which risk management processes?
   A. Perform Quantitative Risk Analysis and Identify Risks
   B. Identify Risks and Monitor Risks
   C. Perform Qualitative Risk Analysis and Monitor Risks
   D. Identify Risks and Perform Qualitative Risk Analysis

7. What kind of change-driven project would gain the most benefit from conducting a project pre-mortem exercise?
   A. A high-value project with clear specifications for technology and requirements
   B. An urgent, risky project with a hard deadline
   C. A project that will require process tailoring
   D. A long-term, high-visibility project

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8. You are iterating the project management plan and will be meeting with the sponsors to get approval. There have been some problems on recent projects because the projects were started quickly and it was assumed that there would be few challenges. You know the sponsors will want assurances that this project will not have similar issues. You have evaluated the approach and have planned the project, including how you will manage risk, in order to deliver a better outcome. You have a few minor risks on the watch list. What, if anything, should be done with those risks?
   A. Document them for historical use on other projects.
   B. Document them and revisit them during project monitoring and controlling.
   C. Document them and set them aside because they are already covered in your contingency plans.
   D. Document them and give them to the customer.

9. You are embarking on a new technology upgrade project that is considered key to future growth of the business. Because of the critical nature of the project, you recognize the importance of performing thorough risk management, and you want to make sure you have considered all relevant project information before beginning. All the following are always inputs to the risk management process except:
   A. Historical information
   B. Lessons learned
   C. Work breakdown structure
   D. Project status reports

10. Risk thresholds are determined to help:
   A. The team rank the project risks
   B. The project manager estimate the project
   C. The team schedule the project
   D. Management know how other managers will act on the project

11. A new project manager is beginning work on her first project. She is planning to use her training to implement many risk identification methods. She realizes that some identified risks will be managed throughout the project, while others will not be considered important enough to deal with. She is aware that risk management is ongoing throughout the project, as new risks may be identified, risk ratings may change, and the project itself may change. She realizes that all the following are common results of risk management except:
   A. Contract terms and conditions are created.
   B. The project management plan is changed.
   C. The communications management plan is changed.
   D. The project charter is changed.

12. You have identified several risks on your project for which purchasing insurance is a possibility. The insurance company your firm uses has quoted reasonable rates, and your analysis shows that purchasing insurance makes sense as a contingency plan in these cases. Your organization has a low threshold for risk but wants to keep costs in line as the profit margin on the product of this project is low. The strategy of purchasing insurance is best considered an example of risk:
   A. Escalation
   B. Transference
   C. Acceptance
   D. Avoidance

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13. The project has been chartered to address concerns of low levels of customer satisfaction with the help desk of a large online retailer. You and your team are considering options including upgrading computer systems and software programs, adding additional help desk staff, and improving help desk training. You realize the impact of such changes will be difficult to measure, and you are finding it challenging to evaluate the exact cost impact of risks and responses the team has identified. You should evaluate on a(n):
    A. Quantitative basis
    B. Numerical basis
    C. Qualitative basis
    D. Econometric basis

14. Outputs of the Plan Risk Responses process include:
    A. Residual risks, fallback plans, and contingency reserves
    B. Risk triggers, contracts, and a risk list
    C. Secondary risks, process updates, and risk owners
    D. Contingency plans, project management plan updates, and sensitivity analysis

15. Workarounds are determined during which risk management process?
    A. Identify Risks
    B. Perform Quantitative Risk Analysis
    C. Plan Risk Responses
    D. Monitor Risks

16. During which risk management process is a determination made to transfer a risk?
    A. Identify Risks
    B. Implement Risk Responses
    C. Plan Risk Responses
    D. Monitor Risks

17. A project manager has just finished the risk response plan for a $387,000 engineering project. Which of the following should he probably do next?
    A. Determine the overall risk rating of the project.
    B. Begin to analyze the risks that show up in the project drawings.
    C. Add work packages to the project work breakdown structure.
    D. Hold a project risk review.

18. A project manager analyzed the quality of risk data and asked various stakeholders to determine the probability and impact of a number of risks. He is about to move to the next process of risk management. Based on this information, what has the project manager forgotten to do?
    A. Evaluate trends in risk analysis.
    B. Identify triggers.
    C. Provide a standardized risk rating matrix.
    D. Create a fallback plan.

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19. Your team is designing a packaging robot for a pharmaceutical production line. The product owner is an engineer, and he tells you it's a waste of the team's time to create a risk-adjusted backlog. You reply that this tool will allow the team to:
    A. Maximize the expected monetary value of the key product features.
    B. Deliver the highest-value features while mitigating the most serious threats.
    C. Balance continuous improvement with progressive elaboration.
    D. Calculate the contingency reserve needed for all the opportunities and threats.

20. A project manager has assembled the project team. They have identified 56 risks on the project, determined what would trigger the risks, rated them on a risk rating matrix, tested their assumptions, and assessed the quality of the data used. The team is continuing to move through the risk management process. What has the project manager forgotten to do?
    A. Conduct a simulation.
    B. Perform risk mitigation.
    C. Determine the overall risk ranking for the project.
    D. Involve other stakeholders.

21. Your team has come up with 434 risks and 16 major causes of those risks. The project is the last in a series of projects that the team has worked on together. The sponsor is very supportive, and a lot of time was invested in making sure the project work was complete and signed off by all key stakeholders.

    During project planning, the team cannot come up with an effective way to mitigate or insure against a risk. It is not work that can be outsourced, nor can it be deleted. What would be the best solution?
    A. Accept the risk.
    B. Continue to investigate ways to mitigate the risk.
    C. Look for ways to avoid the risk.
    D. Look for ways to transfer the risk.

22. A project manager is quantifying risk for her project. Several of her experts are off-site, but wish to be included. How can this be done?
    A. Perform Monte Carlo analysis using the internet as a tool.
    B. Apply the critical path method.
    C. Determine options for recommended corrective action.
    D. Use facilitation techniques.

23. Having just been hired to manage a project to improve the efficiency of data processing in the accounting department, the project manager is most concerned about managing risk on the project. The timeline is short, and the sponsor's expectations are high. Which of the following would best help the project manager in her initial assessment of risks on the project?
    A. A sensitivity analysis
    B. Her project scope statement from the project planning process
    C. A review of enterprise environmental factors
    D. A conversation with a project manager who worked on a similar project

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24. You have been appointed as the manager of a new, large, and complex project. Because this project is business-critical and highly visible, senior management has told you to analyze the project's risks and prepare response strategies for them as soon as possible. The organization has risk management procedures that are seldom used or followed, and has had a history of handling risks badly. The project's first milestone is in two weeks. In preparing the risk response plan, input from which of the following is generally least important?
    A. Project team members
    B. Project sponsor
    C. Individuals responsible for risk management policies and templates
    D. Key stakeholders

25. What would be the best option for making sure your agile team is continually improving their processes and productivity?
    A. Encourage the team to do a decision tree analysis after each iteration.
    B. Conduct an iteration retrospective after each product demo.
    C. Invite key stakeholders to the team's standup meetings to provide immediate feedback.
    D. Conduct regular risk reviews to discuss the effectiveness of planned risk responses.

26. What trend are you hoping to see on the top line of your team's risk burndown chart?
    A. A reliable and consistent upward trend
    B. A steady, cumulative downward trend
    C. A rapid downward trend as quickly as possible
    D. A steady state with only minor variation upward or downward

27. You were in the middle of a two-year project to deploy new technology to field offices across the country. A hurricane caused power outages just when the upgrade was near completion. When the power was restored, all the project reports and historical data were lost, with no way of retrieving them. What should have been done to prevent this problem?
    A. Purchase insurance.
    B. Plan for a reserve fund.
    C. Monitor the weather and have a contingency plan.
    D. Schedule the installation outside of the hurricane season.

28. A system development project is nearing project closing when a previously unidentified risk is discovered. This could potentially affect the project's overall ability to deliver. What should be done next?
    A. Alert the project sponsor of potential impacts to cost, scope, or schedule.
    B. Qualify the risk.
    C. Mitigate this risk by developing a risk response plan.
    D. Develop a workaround.

29. The cost performance index (CPI) of a project is 0.6, and the schedule performance index (SPI) is 0.71. The project has 625 work packages and is being completed over a four-year period. The team members are inexperienced, and the project received little support for proper planning. Which of the following is the best thing to do?
    A. Update risk identification and analysis.
    B. Spend more time improving the cost estimates.
    C. Remove as many work packages as possible.
    D. Reorganize the responsibility assignment matrix.

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30. During project executing, a team member is coordinating with a supplier, and identifies a risk that is not in the risk register. It appears that the pieces of heavy equipment you have ordered from a supplier are larger than anticipated, and they may not all fit into the warehouse the team has leased to store them until they are needed. What should you do?
    A. Get further information on how the team member identified the risk because you already performed a detailed analysis and did not identify this risk.
    B. Disregard the risk because risks were identified during project planning.
    C. Inform the customer about the risk.
    D. Analyze the risk.

31. During project executing, the team member who is most experienced in the programming work required for the project informs you that he has accepted a new position at another company, and has given his two weeks' notice. This is a major problem that was not included in the risk register. What should you do first?
    A. Create a workaround.
    B. Reevaluate the Identify Risks process.
    C. Look for any unexpected effects of the problem.
    D. Tell management.

32. Which of the following is the primary responsibility of a risk owner?
    A. Identify new risks and create workarounds.
    B. Respond to risk triggers and implement the planned risk responses.
    C. Report to the project manager that a risk has occurred, and note the consequences.
    D. Quantitatively analyze risks as assigned by the project manager.

33. A project has had some problems, but now seems under control. In the last few months, almost all the reserve has been used, and most of the negative impacts of events that had been predicted have occurred. There are only four activities left, and two of them are on the critical path.

    Management now informs the project manager that it would be in the performing organization's best interest to finish the project two weeks earlier than scheduled in order to receive an additional profit. In response, the project manager sends out a request for proposal for some work that the team was going to do, hoping to find another company that might be able to do the work faster. The project manager can best be said to be attempting to work with:
    A. Reserves
    B. Opportunities
    C. Scope validation
    D. Threats

34. Monte Carlo analysis is used to:
    A. Get an indication of the risk involved in the project.
    B. Estimate an activity's length.
    C. Simulate possible quality issues on the project.
    D. Prove to management that extra staff is needed.

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35. A project team is creating a project management plan when management asks them to identify project risks and provide some form of qualitative output as soon as possible. What should the project team provide?
    A. Risk triggers
    B. Prioritized list of risks
    C. Contingency reserves
    D. Probability of achieving the time and cost objectives

36. A project manager is creating a risk response plan. However, every time a risk response is suggested, another risk is identified that is caused by the response. Which of the following is the best thing for the project manager to do?
    A. Get more people involved in the Identify Risks process, since risks have been missed.
    B. Make sure the project work is better understood.
    C. Spend more time making sure the risk responses are clearly defined.
    D. Document the new risks and continue the Plan Risk Responses process.

37. A watch list is an output of which risk management process?
    A. Plan Risk Responses
    B. Perform Quantitative Risk Analysis
    C. Perform Qualitative Risk Analysis
    D. Implement Risk Responses

38. During the Identify Risks process, a project manager and stakeholders used various methods to identify risks and created a long list of those risks. The project manager then made sure all the risks were understood and that triggers had been identified. Later, in the Plan Risk Responses process, he took all the risks identified by the stakeholders and determined ways to mitigate them. What has he done wrong?
    A. The project manager should have waited until the Perform Qualitative Risk Analysis process to get the stakeholders involved.
    B. More people should have been involved in the Plan Risk Responses process.
    C. The project manager should have created workarounds.
    D. Triggers should not be identified until the Implement Risk Responses process.

39. Since a template for team meetings does not appear to be available, you are creating one. You think it could also be used for future projects. You want to generalize the agenda template to include topics all project managers would use. Which of the following must be included as an agenda item at all team meetings?
    A. Discussion of project risks
    B. Status of current activities
    C. Identification of new activities
    D. Review of project problems

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Answers

1. **Answer** C
   Explanation Expected monetary value is calculated by EMV = probability × impact. We need to calculate both positive and negative values and then add them:
   0.6 × $100,000 = $60,000
   0.4 × ($100,000) = ($40,000)
   Expected monetary value = $60,000 – $40,000 = $20,000 profit

2. **Answer** C
   Explanation A mean of 28 days is not a range estimate, and so must be eliminated as a possible answer. When you look at the ranges of each of the other choices, you will see that 30 days, plus or minus 5 days = a range of 10 days. The range of 22 to 30 days = a range of 8 days. An optimistic estimate of 26 days, most likely estimate of 30 days, and pessimistic estimate of 33 days represents a range of 7 days. The estimate with the smallest range is the least risky, and is therefore the correct choice. Did you realize the words "+/– 3 sigma" are extraneous? Practice reading questions that are wordy and have extraneous data.

3. **Answer** A
   Explanation This scenario deals with the agile concept of fast failure, where we want to determine if a project is viable as fast as possible. If a risky project won't work, it's better to know that quickly so that resources can be reassigned to more productive efforts. To determine project viability, agile teams typically use architectural spikes to do proof-of-concept testing, so the correct answer is to perform proof-of-concept tests before starting development. While the word "spike" isn't used in that answer, it describes the work done in an architectural spike. Beginning development work before proving the concept would delay potential failure, costing more. The risk-based and exploratory spikes described in the other two answers might be helpful for specific issues, but they would not address the overall project viability.

4. **Answer** B
   Explanation No calculation is needed. If there is a 20 percent chance in any one month, the chance in the fourth month is 20 percent.

5. **Answer** C
   Explanation Expected monetary value is calculated by multiplying the probability times the impact. In this case, EMV = 0.9 × $10,000 = $9,000.

6. **Answer** B
   Explanation This is a tricky question. Although risks can be identified at any time throughout the project, most risks are identified during the Identify Risks process. Newly emerging risks are identified in the Monitor Risks process.

7. **Answer** D
   Explanation This question asks when a dedicated workshop for identifying potential risks would be most worthwhile. On an urgent, time-sensitive project we wouldn't be able to spare the time for such an effort. On a project with well-defined technology and requirements, the risks might not be significant enough to justify gathering the stakeholders for a pre-mortem. The option "a project that will require process tailoring" doesn't really tell us anything about the project concerned, which means that it can't be the best answer to the question. A long-term, high-visibility project as the correct answer.

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8. **Answer** B
Explanation Risks change throughout the project. You need to review risks at intervals during the project to ensure noncritical risks on the watch list have not become critical.

9. **Answer** D
Explanation Project status reports can be an input to risk management. However, when completing risk management for the first time, you would not have project status reports. Therefore, project status reports are not always an input to risk management.

10. **Answer** A
Explanation If you know the risk thresholds of the stakeholders, you can determine how they might react to different situations and risk events. You use this information to help assign levels of risk to each work package or activity based on their probability and impact.

11. **Answer** D
Explanation A contract is a tool to transfer risk. The project management plan could change to include a modified WBS and new work packages related to mitigating risk. The communications management plan could change as a way to address a risk. A change to the charter is a fundamental change to the project and may require a major adjustment to all aspects of the project management plan. It is not a common result of risk management efforts.

12. **Answer** B
Explanation A risk is only escalated if it is outside the scope of the project or beyond the project manager's authority, which is not the case in this scenario. Acceptance of risk means doing nothing (if it happens, it happens, or contingency plans are created). Avoidance of risk means we change the way we will execute the project so the risk is no longer a factor. Many people think of using insurance as a way of decreasing impact. However, purchasing insurance transfers the risk to another party.

13. **Answer** C
Explanation If you cannot determine an exact cost impact of the event, use qualitative estimates such as Low, Medium, and High.

14. **Answer** A
Explanation A risk list, process updates, and sensitivity analysis are not outputs of the Plan Risk Responses process. Residual risks, fallback plans, and contingency reserves are all outputs of the Plan Risk Responses process, making this the correct answer.

15. **Answer** D
Explanation Creating a workaround involves determining how to handle a risk that has occurred but that was not included in the risk register. The project must be in the Monitor Risks process if risks have occurred.

16. **Answer** C
Explanation Transference is a risk response strategy. Risk response strategies are determined in the Plan Risk Responses process.

17. **Answer** C
Explanation This situation is occurring during project planning. Planning must be completed before moving on. Determining the risk rating of the project is done during Perform Qualitative Risk Analysis, and should have already been done. Project risk reviews occur during Monitor Risks. Adding work packages that are part of the newly planned risk responses comes next in project planning. This is an example of iterating the project management plan.

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18. **Answer** C
Explanation The project manager is in the Perform Qualitative Risk Analysis process. This process includes risk data quality assessment along with probability and impact matrix development. It appears the project manager has not yet completed the matrix, which is used to sort risks based on their probability and impact ratings. Trend analysis, the identification of triggers, and the development of fallback plans will occur later in risk management.

19. **Answer** B
Explanation A risk-adjusted backlog allows an agile team to balance delivering the highest-value features and mitigating the highest-impact threats by prioritizing them in one list, based on impact. While creating a backlog involves estimating the expected monetary value of the product features, it won't change (or maximize) their value. An agile risk-adjusted backlog isn't used to calculate a contingency reserve, it is used to balance the priority of features and threats. Balancing "continuous improvement with progressive elaboration" is just mixed-up agile jargon.

20. **Answer** D
Explanation The process the project manager has used so far is fine, except the input of other stakeholders is needed in order to identify more risks.

21. **Answer** A
Explanation This question relates real-world situations to risk types. Did you realize the entire first paragraph is extraneous? Based on the question, you cannot remove the work to avoid it, nor can you insure or outsource it to transfer the risk. This leaves acceptance as the only correct choice.

22. **Answer** D
Explanation Current technology makes it possible to take advantage of input from experts, even when they are off-site. Virtual interviews or group meetings can be facilitated by the project manager for this purpose.

23. **Answer** D
Explanation Sensitivity analysis is a tool of quantitative risk analysis, and is used to compare risks to the project that have already been identified. Reviewing the scope statement is a good idea, but it will only provide an assessment of risk on that aspect of the project. Enterprise environmental factors involve company culture and organization, which also are not adequate to assess overall project risk. A conversation with a project manager who worked on a similar project would provide the most value, as the risks she dealt with on that project are likely to be similar to what the project manager will experience on this project.

24. **Answer** B
Explanation Team members will have knowledge of the project as well as the product of the project and will thus have a lot to contribute to risk responses. Those responsible for risk templates will be able to provide the templates from past projects (historical records) and will, therefore, be very important. Key stakeholders will know more about the technical work of the project and can help plan "What are we going to do about it?" Because of that, they are not likely to be the least important. The sponsor may have the least knowledge of what will work to address risks. Sponsors need to be involved in the project and help identify risks. They may even approve the response plans created by others, but they are not generally major contributors to response plans.

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25. **Answer** B
Explanation Holding regular retrospectives allows an agile team to continually improve their processes and productivity while the work is being done, so they can apply lessons learned immediately. That is the correct answer. Risk reviews are used to evaluate the effectiveness of the risk responses that have been implemented. The team's daily standup meeting is designed to allow the team members to share their progress with each other. Decision tree analysis is a tool for calculating the expected value of different risk responses or other decisions.

26. **Answer** C
Explanation A risk burndown chart is a stacked area graph that shows the project's cumulative risk severity. When the top line of this graph moves downward, it means that the project's cumulative risk is being reduced. So ideally you want to see a sharp downward trend as early as possible in the project, to show that the project risks are being quickly resolved. This means that the team is minimizing risk early, which is one of the ways that agile teams maximize value delivery.

27. **Answer** C
Explanation The risk is the loss of data due to a power outage. Purchasing insurance is not related to preventing the problem. It transfers the risk. Creating a reserve fund is acceptance of the risk, and would help address the cost factors after the power failure, but it would not reduce the probability or impact of the power failure. Avoiding the hurricane by scheduling the installation at a different time reduces the power outage risk, but could have a large negative impact on the project schedule and so is not the best choice. The best choice of the options provided is to monitor the weather and know when to implement the contingency plan.

28. **Answer** B
Explanation A workaround is an unplanned response to an event that is occurring. The risk discussed in the question has been identified, but it is not occurring at this time, so there is no need to take the action of creating a workaround. You need to analyze the problem before talking to the sponsor. You cannot mitigate the risk until you qualify it. Qualifying the risk will help you determine how to proceed.

29. **Answer** A
Explanation This project has deviated so far from the baseline that updated risk identification and risk analysis should be performed.

30. **Answer** D
Explanation First, you need to determine what the risk entails and the impact to the project, then determine what actions you will take regarding the risk.

31. **Answer** A
Explanation Because an unidentified problem or risk occurred, it is important to reevaluate the Identify Risks process as well as to look for unexpected effects of the problem. However, they are not your first choices. You might need to inform management, but this is reactive, not proactive, and also not the first thing you should do. Since this is a problem that has occurred, rather than a problem that has just been identified, the first thing you must do is address the risk by creating a workaround.

32. **Answer** B
Explanation A risk owner may be involved in developing risk responses for their assigned risk. They are also responsible for monitoring the project for triggers that indicate the risk is imminent and for managing implementation of the planned risk response.

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33. **Answer** B
Explanation The wording of this question can be confusing. Scope validation involves meeting with the customer to gain formal acceptance, so that cannot be the best choice. Reserve is mentioned in the situation, but the use of reserves is not the primary concern. The project manager is working to make a positive impact on the project more likely to occur. Therefore, he is working with an opportunity. This may include analyzing the appropriateness of using management reserves to cover the cost of exploiting the opportunity.

34. **Answer** A
Explanation A Monte Carlo analysis could indicate that an estimate for an activity needs to change, but it does not indicate what the activity estimate should be. Monte Carlo is a simulation, but it does not specifically address quality. It does not deal directly with staff or resource needs either. Project risk can be assessed using Monte Carlo analysis. By considering the inputs to the weighted estimates along with the network diagram, you can get a better idea of the overall project risk.

35. **Answer** B
Explanation This question essentially asks, "What is an output of Perform Qualitative Risk Analysis?" The probability of achieving time and cost objectives is determined during the Perform Quantitative Risk Analysis process. Risk triggers and contingency reserves are parts of the Plan Risk Responses process. A prioritized list of risks is an output of Perform Qualitative Risk Analysis.

36. **Answer** D
Explanation Did you realize this question describes secondary risks? Identifying secondary risks is an important part of completing the Plan Risk Responses process. With that in mind, the best thing to do is to document the newly identified risks and continue the Plan Risk Responses process.

37. **Answer** C
Explanation A watch list is made up of low-priority risks that, in the Perform Qualitative Risk Analysis process, were determined to be of too low priority or low impact to require further attention at this time.

38. **Answer** B
Explanation Stakeholders should be included in the Identify Risks process. Some triggers may be identified in the Identify Risks process, but they are generally identified and added to the risk register in the Plan Risk Responses process. Workarounds are created as unidentified risk events occur. The project manager's error was not including others in the Plan Risk Responses process. Plan Risk Responses must include the involvement of all risk owners and possibly other stakeholders as well.

39. **Answer** A
Explanation Risk is so important that it must be discussed at all team meetings.

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Procurement

TWELVE

A very experienced student in an RMC class was upset about a situation at work. He had arranged a meeting with a seller and the seller had not shown up. He rescheduled the meeting, and the seller still did not show up. When the instructor asked what kind of contract he was working with, the student had to contact his office and found out that he had a fixed-price contract. The instructor then asked him where in the contract it said the seller had to attend such meetings. The student then determined that meetings were not listed in the contract. Why would a seller attend a meeting if he was not getting paid for it?

For some people, procurement management is one of the hardest management areas on the exam. If you have worked with contracts before, you might have to fine-tune your knowledge by learning new terms for what you already do and by understanding the project manager's role a little better. If you are like many other people, however, you may have little experience in procurement, and you will have to spend more time in this chapter. Here we walk you through the procurement process and suggest ways you can most effectively prepare for this topic on the exam.

Think about what procurement management[1] means for a project manager. The basic procurement management skills required include the ability to help create, read, and manage contracts and any supporting documentation.

QUICKTEST

- Procurement management process
- Procurement management plan
- Procurement strategy
- Types of agreements
- Agile contracts
- Contract types
  - Fixed-price
  - Time and material
  - Cost-reimbursable
- Advantages/disadvantages of each contract type
- Customized contracts
- Contract change control system
- Termination
- Bid documents
- Make-or-buy analysis
- Source selection criteria
- Noncompetetive forms of procurement
- Types of procurement SOW
- Fixed-price work packages
- Closed procurements
- Bidder conferences
- Proposal evaluation
- Risk and contract type
- Make-or-buy decisions
- Weighting system
- Independent cost estimates
- Incentives
- Special provisions
- Standard contract
- Terms and conditions
- Change requests
- Breach
- Waivers
- Claims
- Product validation
- Procurement conflicts
- Procurment audit
- Formal acceptance
- Records management system
- Privity
- Centralized/decentralized contracting
- Price
- Profit
- Cost
- Target price
- Sharing ratio
- Ceiling price
- Letter of intent
- Presentations
- Nondisclosure agreement
- What makes a legal contract
  - Force majeure

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TRICKS OF THE TRADE® Be prepared to see the terms "contract" and "agreement" on the exam. Contracts can be written or verbal, are typically created with an external entity, and involve an exchange of goods or services for (usually monetary) compensation. A contract forms the legal relationship between entities, is mutually binding and provides the framework for how a failure by one side will be addressed and remedied, in court if necessary.

The broader term "agreement" includes documents or communications that outline internal or external relationships and their intentions. A contract is a type of agreement, but an agreement isn't necessarily a contract. Imagine that two divisions of a company want to combine resources to achieve a shared objective. They would create an agreement, but likely not a contract. Examples of agreements that are not contracts are the project charter and plan documents, internal service level agreements, memos or letters of intent, letters of agreement, emails, and verbal agreements.

So what does this mean for you? How you communicate, escalate, and solve problems will vary depending on whether your actions are governed by a contract or an internal agreement. For example, notifying a seller of a default on a contract term or condition should be done through formal written communication to create a record and ensure appropriate legal action can be taken if necessary. In comparison, failure to meet a term of an internal agreement might be handled in a conversation followed up by an email. Understanding whether a situational exam question describes an internal agreement or a contract might help you select the right answer.

In this chapter, we primarily use the term "contract," because the procurement process is used to acquire necessary resources that are outside the project team and involve legal documents between the buyer and seller.

TRICKS OF THE TRADE® If you have little or no experience working with contracts, you should obtain from your company some sample contracts, requests for proposals, and the resulting sellers' proposals. Spend some time reviewing them. To help you understand contracts, it might be helpful to contact your organization's contracts, procurement, or legal department. The exam assumes that you have a close working relationship with them, that as a project manager you have specific involvement in the procurement process even if you do not lead that process, and that the procurement process cannot occur without your involvement.

In this chapter we start with an introduction to the procurement process, including buyers and sellers, before moving on to discuss contracting within organizations, contract types, and incentives. We then discuss the procurement process in more detail. The following should help you understand how each part of procurement management fits into the overall project management process.

The Procurement Management Process	Done During
Plan Procurement Management	Planning process group
Conduct Procurements	Executing process group
Control Procurements	Monitoring and controlling process group

ECO Domain I: People	Domain II: Process
Task 8: Negotiate Project Agreements	Task 11: Plan and Manage Procurement

Although this task within the *Examination Content Outline* (ECO) maps most directly the processes of Plan Procurement Management and Conduct Procurements, it's important for you to understand that there are many tasks that overlap with procurement. For example, part of defining project scope is to determine whether the entire scope can be completed internally, or if part of it will be outsourced. This analysis results in make-or-buy decisions, which are directly related to project procurements. Managing procurements is in turn essential to managing scope. Additionally, efficient communications and stakeholder management, and the effective use of your interpersonal and team skills, along with conflict management, all contribute to procurement management success and good procurement practices should diminish project risk.

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Procurement Fundamentals

Typically, procurement is a formal process to obtain goods and services. When a decision has been made to buy goods or services, the project manager facilitates the creation of a plan for procurement, including a strategy for how each contract will be managed and a description of the work to be done by each seller (a procurement statement of work). Procurement management includes planning, conducting, and controlling procurements (which may also be summarized as planning and managing procurement), and includes negotiating and managing contracts.

Buyers and Sellers The company or person who provides goods and services may be called a contractor, subcontractor, supplier, designer, or seller. The *PMBOK® Guide* primarily uses the term "seller," but the exam may use any of these terms. The company or person who purchases the services is called the buyer. Many companies are a buyer in one procurement and a seller in another.

TRICKS OF THE TRADE® If no point of view is mentioned in an exam question, assume you are the buyer. Read questions carefully to see if the situation described makes the buyer's or seller's point of view explicit. Make sure you know the actions that you would take as the project manager for the buyer. This is important to understand for the exam because seller's and buyer's perspectives and the impacts of many situations are different.

TRICKS OF THE TRADE® For some projects, sellers will provide the full solution, rather than just augmenting a project team with additional resources. For example, you might add contract developers to your internal staff to help code software, or alternatively outsource all development work to an external resource who would plan and manage all developers, testers, etc. Unless an exam question indicates otherwise, assume the seller is providing all the work external to the buyer's team rather than supplying resources to supplement the team.

Procurement Process Overview

Assume for the exam that you have a procurement department that generally manages the process, but note that it may also be referred to as the contracting, purchasing, or legal department. Managing procurements requires legal knowledge and negotiation skills, and although project managers are not often expected to take the lead in legal matters and negotiations, you must be familiar with these aspects of procurement. You must also understand what the procurement experts need from you, provide them with that information and work with them throughout the project life cycle.

Planning may include make-or-buy decisions, and preparing artifacts that control procurements as procurement management is being conducted. A procurement statement of work (SOW) is combined with contract terms to document the scope of work and legal relationship between the buyer and the seller. These are at first known as bid documents that are later sent to prospective sellers (more on bid documents later in this chapter). For the SOW, the procurement department may review the scope of the work for completeness, and the project manager might add scope related to project management activities such as specific reporting requirements or required attendance at meetings. The type of bid document used is influenced by the contract type selected and the content within the procurement SOW. As you will see later in this chapter, different types of contracts require project managers to focus on different areas of management.

Prospective sellers review the bid documents,[2] develop a full understanding of what the buyer wants, then assess any risks and determine whether they will submit a proposal. They may have the opportunity to participate in a bidder conference or a pre-proposal meeting, and may be able to submit questions before

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the proposal deadline. All questions should be in writing and should relate to the bid documents. Buyer responses must be shared with all prospective sellers.

When a fixed-price contract is required, sellers should include these risks in the total detailed cost estimate, as well as other costs, such as overhead, and then add profit to come up with a bid or quote. In any case, the risk of the project is formally or informally assessed before sending the bid or proposal to the buyer.

As a buyer receives competing proposals, they may shorten the candidate list first or ask for presentations from all the candidates. Once presentations are completed, negotiations with the preferred seller or sellers is next. These require the involvement of the project manager. The procurement statement of work, terms and conditions, and any other components of the bid documents are negotiable. Finally, a seller is selected, a contract is signed, and other procurement management documentation is updated accordingly.

Managing a procurement involves making sure the requirements of a contract are met, controlling the contract, and making only approved changes. The procurement department helps the project manager resolve questions such as, "What is and is not in the contract?" or "What does a particular section of the contract really mean?"

When a procurement's work is complete and after the buyer accepts the final deliverables, the procurement is closed as soon as possible. This can happen within any phase of the project life cycle, as the contracted work is completed. For example, in a project to renovate a house, a seller may be contracted to install new plumbing, another may be contracted to install new landscaping, and still another may be contracted to paint the house. Activities to close out a procurement include an analysis of the procurement process to determine lessons learned (formally called a procurement audit). Final reports are submitted, lessons learned are documented, and final payment is made.

Could you now describe the procurement process and relationships to someone else? Be sure you understand this overview before continuing with the chapter.

Understanding Contracts

This section covers enterprise environmental factors for managing contracts, the project manager's role, types of contracts, and managing procurements using different types of contracts.

Centralized Contracting In a centralized contracting environment there is one procurement department. The procurement manager reports to the head of the procurement department and they may handle procurements on many projects. The project manager contacts the procurement manager or department when they need help or to ask questions and knows what authority the procurement manager has in each situation.

Decentralized Contracting In a decentralized contracting environment, there is no procurement department or procurement manager assigned. The project manager may be responsible not only for planning and managing procurement but also for conducting all work on procurements. There may be little standardization of procurement processes and contract language without a procurement department to regulate standards and improve knowledge in procurement management.

TRICKS OF THE TRADE When answering exam questions, assume a centralized contracting environment unless otherwise stated. Remember that whether contracting is centralized or decentralized, the project manager is responsible for knowing their required level of involvement. Use the scenario described in the question to determine how involved the project manager should be.

The Project Manager's Role in Procurement You might ask yourself, "If there is a procurement manager, why would a project manager need to be involved in procurements?" This is an important question, and you must fully understand the answer before you take the exam. Here are a few tricks to help you.

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TRICKS OF THE TRADE Remember that it is the project manager's project. The project manager must be fully informed and apply their expertise for the organization to fully realize the project's benefits. This trick is important for all processes and typically a large percentage of the questions on the exam focus on testing whether you know what you should do.

Here is a quick summary. Do not memorize it; instead, make sure you understand it.

- Know the procurement process so you understand what will happen when and can make the necessary plans.
- Make sure the contract includes all the scope of work and project management requirements, such as attendance at meetings, reports, actions, and communications deemed necessary to minimize problems and miscommunications with the seller(s).
- Incorporate allocation and mitigation of risks into the contract to decrease risk.
- Help tailor the contract to the unique needs of the project.
- Ensure sellers and suppliers have the right information and are set up for success.
- Estimate the time and cost of each procurement, including that required to complete the process. Include these estimates in the project schedule and budget.
- Be involved during contract negotiations to protect the relationship with the seller and promote the best interests of the project. If the seller feels they have had to give up too much profit or agree to undesirable terms and conditions in order to win the contract, this is a win-lose relationship and can negatively affect the project. As the project manager manages delivery to the contract, bad feelings on the part of the seller may create extra challenges.
- Define quality requirements for suppliers and check the quality of goods and services from suppliers.
- Protect the ability to get the work done by making sure the procurement process goes as smoothly as possible, investigating any issues and taking corrective action.
- Understand what contract terms and conditions mean so you can read and understand contracts. This will help you plan and manage procurements.
- Beyond the technical scope, ensure all the work in the contract is done, such as reporting legal deliverables, including the release of liens and ownership of materials.
- Make a formal contract change to ask for anything that is not in the contract.
- Work with the procurement department to manage contract changes.

TRICKS OF THE TRADE Project managers should be assigned on both the buyer's and seller's sides before a contract is signed! Many companies that sell their services make a huge but common mistake by not involving the project manager in the bidding and proposal process. Instead, only marketing and sales are involved until after the contract is signed. The project manager is then handed a project with a contract that may include unrealistic time or cost constraints. The project starts out in trouble.

Involving the project manager early in the procurement process is so important that the exam will test you to see if you know when the project manager should be involved, and why. For example, the project manager is often uniquely capable of answering (or getting answers to) many of the technical and project management questions that arise during bidder conferences. If the sellers' questions are answered incorrectly or incompletely, there may be an inadvertent change to a specification or the scope of the contract that was never intended by the buyer.

Agile Contracts While agile methods provide flexibility and allow you to manage changing requirements, this approach can also create problems when defining acceptance criteria for contracts. For example, an agile team may not deliver all the product functionality. Can you see how a customer may find that unacceptable? Most customers will typically expect a written contract so they can hold the seller or project manager accountable and will require a product to be delivered and include all functionality.

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Most project managers will utilize an agile method if tailored cooperation between the project team and the customer is required. This cooperation can help direct the team's efforts toward delivering value-adding features, and typically involves more overall trust in order to focus resources. Did you know that using an agile approach may also require the customer to be more involved in providing feedback on iteration deliverables, reprioritizing the backlog, and ranking the value of change requests against the remaining work items?

Contract Types[3] Many different types of contracts can be used to acquire goods and services. Boilerplate contracts or agreements used within an organization are organizational process assets. The procurement manager selects the contract type for each procurement based on the following considerations:

- What is being purchased (a product or a service)
- The completeness of the statement of work
- The level of effort and expertise the buyer can devote to managing the seller
- Whether the buyer wants to offer the seller incentives
- The marketplace or economy
- Industry standards for the type of contract used

Keep in mind that although the buyer initially proposes the contract type, the final contract type is subject to negotiation with the seller. The best contract type meets the needs of the procurement, results in reasonable seller risk, and provides the seller with the greatest incentive for efficient performance.

TRICKS OF THE TRADE® Some contract types can be referred to by more than one name. This can make it difficult to learn the contract types. Start out by understanding the three main categories of contract types, as shown in the following list. Then, when the exam asks a question relating to contract type, first see if knowing which category the contract is in helps you answer the question.

The three broad categories of contracts are:

- Fixed-price (FP)
- Time and material (T&M)
- Cost-reimbursable (CR)

You must understand the contract types and be able to recognize the differences between them. Situational questions on the exam may require you to recognize that the project manager's responsibilities and actions will vary depending on the type of contract being used. There may also be questions that require you to pick the most appropriate contract type based on a particular situation. Think through this section carefully!

Fixed-Price (FP) A fixed-price contract should be used for acquiring goods, products, or services with well-defined specifications or requirements. In general, with a fixed-price contract, a clearly defined statement of work along with competing bids mean you're likely to get a fair and reasonable price. This is one of the most common types of contract, though it's less likely to be used in something like information technology than in construction. If the costs are more than the agreed-upon amount, the seller must bear the additional costs. Therefore, the buyer has the least cost risk in this type of contract because the scope is well-defined. Note, however, that when fixed-price contracts are entered into and the statement of work is not sufficiently detailed, claims and disputes over what is in and out of the contract create higher risk of cost overruns or delay. The seller is most concerned with the procurement statement of work (SOW) in a fixed-price contract, since this will help them more accurately estimate time and cost for the work involved and determine a price that includes a fair and reasonable profit. The amount of profit is not disclosed to the buyer. Types

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of fixed-price contracts include firm fixed price, fixed price incentive fee, fixed price award fee, and fixed price with economic price adjustments. Purchase orders are also a type of fixed-price contract.

For the exam, be aware that even though the buyer may prefer a fixed-price contract as a way to control costs, it is not always the best choice, and in some cases, it may be inappropriate. Sellers in some industries may not have the detailed accounting records of past project activities required to accurately estimate future projects. Buyers may not have the expertise to prepare the clear and complete procurement statement of work required for a fixed-price contract.

Because many buyers are not knowledgeable about contracts, they often ask the seller to provide a fixed price even when the scope of work is not complete and accurate. Think about the following disadvantages if the procurement statement of work is not adequate for the seller to make a reasonable estimate:

- The seller is forced to accept a high level of risk.
- The seller needs to add significant reserves to their price to cover risk; therefore, the buyer pays more than they otherwise might have.
- The seller can more easily try to increase profits by cutting scope or claiming that work the buyer wants is outside the contract and thus requires a change order, and the buyer will not be able to state with certainty if it is within the scope of work or needs a change order. If the seller realizes they will not be able to make a profit they may try to take their best people off the project, cut out work that is specifically mentioned in the contract, cut out work that is not mentioned in the contract but is needed, decrease quality, or take other actions to save money.

The following sections discuss some of the most common forms of fixed-price contracts.

Fixed-Price (FP) In a FP contract, a fixed total price is set for the project, all requirements have been clearly described, and changes to scope should not occur.

Example: Fixed-Price Contract

Contract = $1,100,000.

Fixed Price Incentive Fee (FPIF) In a FPIF contract, profits (or financial incentives) can be adjusted based on the seller meeting specified performance criteria, such as getting the work done faster, cheaper, or better. The final price is calculated using a formula based on the relationship of final negotiated costs to the total target cost. (See more on incentives later in this section.)

Example: Fixed Price Incentive Fee Contract

Contract = $1,100,000. For every month early the project is finished, an additional $10,000 is paid to the seller.

Note: A variation on a FPIF is a FPIF Successive Target contract, in which the target for the incentive is changed after the first target is reached.

Fixed Price Award Fee (FPAF) In a FPAF contract, the buyer pays a fixed price plus an award (a bonus) based on performance. This is a type of incentive contract. Procedures must be in place in advance for determining the award to avoid the subjective judgement of awards.

The cost to administer the award fee versus the potential benefits must be weighed in the decision to use this type of contract.

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Example: Fixed Price Award Fee Contract

Contract = $1,100,000. For every month that performance exceeds the planned level by more than 15 percent, an additional $5,000 is awarded to the seller, with a maximum award of $50,000.

Note: This is similar to the FPIF contract except the total possible award amount is determined in advance. For example, the buyer might say there is a maximum $50,000 award, apportioned at the rate of $5,000 for every month production exceeds a certain amount.

Fixed Price with Economic Price Adjustments (FPEPA)[4] If a contract will cover a multiyear period, there may be uncertainties about future economic conditions. Future costs of supplies and equipment the seller might be required to provide may be unpredictable. In such cases, a buyer might choose a fixed-price contract with economic price adjustments.

Example: Fixed Price with Economic Price Adjustments Contract

Contract = $1,100,000, but a price increase will be allowed in year two based on the US Consumer Price Index report for year one.

Or

Contract = $1,100,000, but a price increase will be allowed in year two to account for increases in specific material costs.

Note: Think "economy" whenever you see this on the exam.

Graduated Fixed Price An agile contract that shares some of the risk and reward associated with schedule variance between the customer and supplier. If the supplier delivers early, they get paid for fewer hours but at a higher rate. If the supplier delivers on time, they get paid for the hours worked at their standard rate. If they deliver late, they get paid for more hours but at a lower rate.

Example: Graduated Fixed Price

Finish early = $110/hour. Customer is happy because the work is done early and they pay less overall. The supplier is happy because they make a higher margin.

Finish on time = $100/hour. Both parties are happy.

Finish late = $90/hour. Both parties are somewhat unhappy since they are both making less money, but at a gradual, sustainable rate that hopefully will not lead to the contract being terminated.

Purchase Order A purchase order is the simplest type of fixed-price contract. This type of contract is normally unilateral (signed by one party) instead of bilateral (signed by both parties). However, some buyers require the seller's signature on a purchase order before considering it official. In that case, the signature forms the acceptance needed for a contract.

Example: Purchase Order

Contract = 30 linear meters of wood at $9 per meter.

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Note: A purchase order is usually used for simple commodity procurements. They become contracts when the buyer accepts the terms. The seller then performs or delivers according to those terms (for example, equipment or products).

Time and Material (T&M) In this type of contract, the buyer pays on a per-hour or per-item basis. They are frequently used for service efforts in which the level of effort cannot be defined when the contract is awarded. It has elements of a fixed-price contract (in the fixed price per hour) and a cost-reimbursable contract (in the material costs and the fact that the total cost is unknown). Compared to other types of contracts, time and material contracts typically have terms and conditions that are simpler to allow for quick negotiations so that work can begin sooner.

If you were going to have to pay someone on a contract basis for every hour they worked, no matter how productive they were and no matter what they were doing, would you want to do this for a long period of time? Remember, the seller's profit is built into the rate, so they have no incentive to get the work done quickly or efficiently. For this reason, a time and material contract is best used for work valued at small dollar amounts and lasting a short amount of time. Knowing when it's best to use time and material contracts can help you get situational questions right on the exam.

To make sure the costs do not become higher than budgeted, the buyer may add a "Not to Exceed" clause to the contract and thus limit the total amount they are required to pay. With a time and material contract, the buyer has a medium amount of cost risk as compared to cost-reimbursable and fixed-price contracts.

Example: Time and Material Contract

Contract = $100 per hour plus expenses or materials at cost.

Or

Contract = $100 per hour plus materials at $5 per linear meter of wood.

Cost-reimbursable (CR) A cost-reimbursable contract is used when the exact scope of work is uncertain and, therefore, costs cannot be estimated accurately enough to effectively use a fixed-price contract. This type of contract provides for the buyer to pay the seller allowable incurred costs to the extent prescribed in the contract. Such contracts also typically include an additional fee or award amount added to the cost to allow for seller profit. Types of cost-reimbursable contracts include cost, cost plus fixed fee, cost plus incentive fee, cost plus award fee, cost plus fee, and cost plus percentage of costs.

A cost-reimbursable contract requires the seller to have an accounting system that can track costs by project. With a cost-reimbursable contract, the buyer has the most cost risk because the total costs are unknown. The seller provides an estimate to the buyer; the buyer can use the estimate for planning and cost management purposes, but it is not binding. What is binding is the buyer's responsibility to compensate the seller for legitimate costs for work and materials as described in the contract. Research and development or information technology projects in which the scope is unknown are typical examples of cost-reimbursable contracts.

The following section describes some of the most common forms of cost-reimbursable contracts.

Cost Contract A cost contract is one in which the seller receives no fee (profit). It is appropriate for work performed by nonprofit organizations.

Example: Cost Contract

Contract = Cost for work and materials.

There is no profit. The seller is reimbursed but does not make a profit.

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Cost Plus Fixed Fee (CPFF) A cost plus fixed fee contract provides for payment to the seller of actual costs plus a negotiated fee (the seller's profit, usually a percentage of the estimated cost) that is fixed before work begins. The fee does not vary with actual costs; thus, the seller does not have an incentive to increase or inflate costs.

Example: Cost Plus Fixed Fee Contract

Contract = Cost plus a fee of $100,000.

Note: The fee may be adjusted as a result of changes to the procurement statement of work.

Cost Plus Incentive Fee (CPIF) A cost plus incentive fee contract. The seller is paid for actual costs plus a fee based on specific performance objectives stated in the contract. An original estimate of the total cost is made (the target cost) and a fee for the work is determined (a target fee). The seller gets a percentage of the savings if the actual cost is less than the target cost, or shares the cost overrun with the buyer.

Example: Cost Plus Incentive Fee Contract

Contract = Cost plus a base fee plus award for meeting buyer-specified performance criteria. Maximum award available is $50,000.

Note: This is similar to the CPIF contract except the incentive is a potential award with no possibility of a penalty.

Cost Plus Award Fee (CPAF) In a cost plus award fee contract, the buyer pays costs and a base fee plus an award (a bonus) based on performance, determined in advance. This is a type of incentive contract. Procedures must be in place in advance for determining the award to avoid the subjective judgment of awards.

The cost to administer an award fee versus the potential benefits must be weighed in the decision to use this type of contract.

Example: Cost Plus Award Fee Contract

Contract = Cost plus a base fee plus award for meeting buyer-specified performance criteria. Maximum award available is $50,000.

Note: This is similar to the CPIF contract except the incentive is a potential award with no possibility of a penalty.

Cost Plus Fee (CPF) or Cost Plus Percentage of Costs (CPPC) A CPF or CPPC contract requires the buyer to pay for all costs plus a percentage of costs as a fee.

In the United States, this type of cost-reimbursable contract is generally not allowed for federal acquisitions or procurements under federal acquisition regulations, and it is bad for buyers everywhere. Can you see why?

If profit is based on a percentage of costs billed to the buyer, what incentive is there to control costs? Say a seller must purchase materials from one of two suppliers, both of which meet quality requirements, but one charges $4 per unit and the other charges $40. A seller might be tempted to choose the $40 per unit charge to maximize profit.

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Example: Cost Plus Fee or Cost Plus Percentage of Costs Contract

Contract = Cost plus 10 percent of costs as fee.

Note: It is possible to construct the contract so that the seller will need to prove they pursued the least expensive path in completion of the work when, for example, selecting materials or subcontracting portions of work. This contract type requires the buyer to carefully manage all invoices.

Advantages and Disadvantages of Each Contract Type Do you understand what you just read? Can you answer the following questions?

- You do not have a finalized scope. Which contract type is best?
- You do not have a complete scope of work, but you have a fixed-price contract. What problems can you expect to run into?

TRICKS OF THE TRADE A trick for the exam is to realize that buyers must select the appropriate type of contract for what they are buying. The following exercise will test whether you really understand the different types of contracts and will help you select the appropriate type of contract.

12.1 Exercise In your Exercise Notebook, write the advantages and disadvantages of each form of contract from the perspective of the buyer. The forms are:

- Fixed-price
- Time and Material
- Cost-reimbursable

Answer There can be more answers than listed here. Did you identify and understand these?

Fixed-Price Contract	
Advantages	**Disadvantages**
This requires less work for the buyer to manage.	If the seller underprices the work, they may try to make up profits by charging more than is necessary on change orders.
The seller has a strong incentive to control costs.	The seller may try to not complete some of the procurement statement of work if they begin to lose money.
Companies usually have experience with this type of contract.	This contract type requires more work for the buyer to write the procurement statement of work.
The buyer knows the total price before the work begins.	This can be more expensive than a cost-reimbursable contract if the procurement statement of work is incomplete. The seller also needs to add to the price of this contract to account for the increased risk.

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Time and Material Contract	
Advantages	Disadvantages
This type of contract can be created quickly because the statement of work may be less detailed.	There is profit for the seller in every hour or unit billed.
The contract duration is brief.	The seller has no incentive to control costs.
This is a good choice when you are contracting people to augment your staff.	This contract type is appropriate only for work involving a small level of effort.
	This contract type requires a great deal of day-to-day oversight from the buyer.

Cost-Reimbursable Contract	
Advantages	Disadvantages
This contract type allows for a simpler procurement statement of work.	This contract type requires auditing the seller's invoices.
This contract type usually requires less work to define the scope than a fixed-price contract.	This contract type requires more work for the buyer to manage.
This is generally less costly than a fixed-price contract because the seller does not have to add as much for risk.	The seller has only a moderate incentive to control costs.
	The total price is unknown.

Contract Type Based on Situation Did you understand that last exercise? In addition to knowing the advantages and disadvantages of contract types, it's also important to be able to choose a contract based on any given situation. Try this next exercise to test your knowledge and understanding of the types of contracts.

12.2 Exercise For each situation described in the table below, write in your Exercise Notebook the most appropriate contract type to use from the choices listed below. Read each situation carefully to determine whether the information is sufficient to indicate only that some type of cost-reimbursable (CR) or fixed-price (FP) contract would apply, or whether the details of the situation suggest a more specific type of cost-reimbursable (CPF or CPPC, CPFF, CPIF) or fixed-price contract (FPIF, FPAF, FPEPA) should be used.

Your choices are FP, FPIF, FPAF, FPEPA, purchase order, T&M, CR, CPF or CPPC, CPFF, CPIF, or CPAF contracts.

	Situation
1.	You need work to begin right away.
2.	You want to buy expertise in determining what needs to be done.
3.	You know exactly what needs to be done.
4.	You are buying a programmer's services to augment your staff for a short period.
5.	You need work done, but you don't have time to audit invoices.
6.	You need to rebuild a bridge as soon as possible after a storm.

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	Situation
7.	The project requires a high level of expertise to complete, and you want to have the best performance possible in the finished product.
8.	You need to hire a contractor to perform research and development.
9.	The scope of work is complete, but the economy is currently unpredictable.
10.	You are buying standard commodities.

Answer As you look over the answers, also try to think of other situations in which you would use each type of contract.

Type of Contract			
1.	T&M	6.	FPIF
2.	CR	7.	CPIF or CPAF
3.	FP	8.	CR
4.	T&M	9.	FPEPA
5.	FP	10.	Purchase order

TRICKS OF THE TRADE® Remembering the following general rules for situational questions involving contracts can help you get more questions right:

- Contracts require formality. Any correspondence, clarification, and notifications related to contracts should be formal written communication, which can be followed up with verbal communication as necessary. If issues develop requiring arbitration, mediation, or litigation, formal written communications are more enforceable and supportable than are verbal communications.
- All product and project management requirements for procurement work should be specifically stated in the contract.
- If it is not in the contract a formal change order to the contract is needed for the work to be done.
- If it is in the contract it must be done or a formal contract change order to remove it is needed.
- Changes to contracts must be submitted in writing.
- Contracts are legally binding; the seller must perform as agreed in the contract or they are in breach of contract.
- Contracts should help diminish project risk.
- Most governments back contracts within their jurisdiction through a court system for dispute resolution.

Customized Contracts On adaptive projects, project managers may use different types of contracts to create a customized contract that meets the needs of both the buyer and the seller. With such contracts, the customer retains flexibility to reprioritize work, and the seller is not penalized for sharing information about increased costs. Customized contracts also remove the incentive for the seller to add large contingencies to the project price.

Customized contracts can be highly beneficial to both parties, but you should understand that creating a contract between one party who wants to minimize the cost of a product or service and another party looking to maximize their revenue will always be a balancing act. On agile projects, procurement management is particularly challenging, since the details of the scope can't be fully defined earlier in the

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project. In addition, the intangible nature of products on adaptive projects can make it difficult to evaluate and get acceptance for the work.

Any type of procurement—whether for agile or predictive contracts—works best when both parties want successful results that lead to future work. A project's success is ultimately determined by the level of ongoing collaboration between the customer and the seller. Agile contracts cannot generate or enforce that collaboration, but with some work and creativity, they can at least be better structured to support it.

Risk and Contract Type The exam may ask questions that correlate risk with the different types of contracts. Figure 12.1 shows the amount of cost risk the buyer and seller have with each contract type. Use this diagram to better understand the different contract types and to help answer questions such as:

Question Who has the risk in a cost-reimbursable contract—the buyer or seller?

Answer The buyer. If the costs increase, the buyer pays the added costs.

Question Who has the cost risk in a fixed-price contract—the buyer or seller?

Answer The seller. If costs increase, the seller pays the costs and makes less profit.

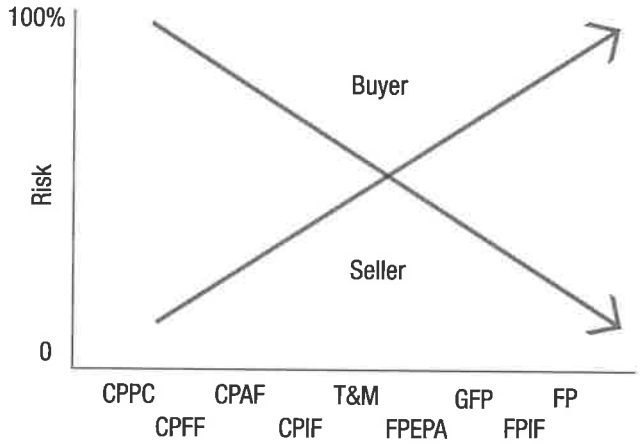

FIGURE 12.1 *Risk to buyer and seller according to contract type*

Contracting Terms to Know Some of the following terms are new. Although some of them have been used previously, they are defined here to avoid confusion:

- **Price** This is the amount the seller charges the buyer.
- **Profit (fee)** The amount of money the seller has after costs are paid. In a fixed-price or time and materials contract, a seller builds a profit margin into the amount they charge the buyer. In cost-plus contracts, the "plus" represents the profit, and that amount is typically negotiated by the buyer and seller.
- **Cost** This is how much an item costs the seller to create, develop, or purchase. A buyer's costs (or price) include a seller's costs and profits.
- **Target price**[5] This term is often used to compare the end result (final price) with what was expected (the target price). Target price is a measure of success. Watch for similar terms. Target cost plus target fee equals target price. (Remember, we are thinking about procurements from the buyer's point of view!)
- **Sharing ratio**[6] Incentives are usually expressed as a ratio, such as 80/20. This sharing ratio describes how the cost savings or cost overrun will be shared; the first number represents the buyer portion and the second number represents the seller portion (buyer/seller).

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- **Ceiling price**[7] This is the highest price the buyer will pay; setting a ceiling price is a way for the buyer to encourage the seller to control costs. The ceiling price is a condition of the contract that must be agreed to by both parties before signing. Keep in mind that answers to calculations on the exam can change when a ceiling price is mentioned.
- **Point of total assumption (PTA)**[8] This only relates to fixed price incentive fee contracts, and it refers to the amount above which the seller bears all the loss of a cost overrun. Costs over the PTA are assumed to be due to mismanagement: a design statement of work should have been created to allow for fair and reasonable contract negotiations for the required work, suggesting the seller either did not estimate correctly or did not manage the work well. Sellers will sometimes monitor their actual costs against the PTA to make sure they are still receiving a profit for completing the project.

Formula: Point of Total Assumption

$$\text{PTA} = \frac{\text{Ceiling price} - \text{Target price}}{\text{Buyer's share ratio}} + \text{Target cost}$$

- **Nondisclosure Agreement** For many procurements, there is a great need for confidentiality. Such a written agreement between the buyer and prospective sellers identifies the information or documents they will control and hold confidential; it also details who in the organization will have access to the confidential information. With a nondisclosure agreement in place, the buyer can talk more openly about their needs without fear that the public or one of the buyer's competitors will gain access to the information.
- **Standard Contract** Commonly created by the buyer, standard contracts are usually drafted—or at least reviewed—by lawyers and generally do not require additional review if used for the purpose for which they were intended. You should understand standard contracts, but also realize the project manager's role in special provisions (described next).
- **Special Provisions (Special Conditions)** The project manager must understand standard terms and conditions but also determine when additions, changes, or deletions from the standard provisions are required. By facilitating necessary adjustments, the project manager can make sure the resulting contract addresses the needs of the project. The project manager (remember when taking the exam that you are the buyer's project manager, unless a question states otherwise) meets with the procurement manager (if there is one) to discuss the needs of the project and to determine the final contract terms and conditions.

  Additions, changes, or deletions are sometimes called special provisions and can simply pertain to the type of project and project requirements, risk analysis and administrative, legal, or business needs.
- **Letter of Intent** In some instances, the seller may need to start hiring people or ordering equipment and materials before the contract is signed in order to meet the contract requirements. A letter of intent is not a contract, but simply a letter stating that the buyer intends to hire the seller. It is intended to give the seller confidence that the contract will be signed soon and to make them comfortable with taking the risk of ordering the equipment or hiring the staff that will eventually be needed.
- **Privity** Privity simply means a contractual relationship. The following explains privity and shows how questions on this topic may be asked.

  Question Company A hires company B to do some work. Company B subcontracts to company C. The project manager for company A is at the job site and tells company C to stop work. Generally, does company C have to listen?

  Answer No. Companies C and A have no contractual relationship. Company A needs to talk to company B, who needs to talk to company C.

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Can you see how this would be important to understand? Any directive that the project manager from company A may give to company C can cause liability for company A. For example, company A may have to pay delay claims to company B, plus the costs of delay to company C if company C stopped work at company A's direction.

Terms and Conditions There are many terms and conditions associated with procurements that may be considered. Let's start out with a story to better understand some of these terms and conditions.

A project manager (the buyer) needed his team members trained on some equipment. He contacted a seller to do the work and then had his procurement department send them a contract. Meanwhile, he arranged for team members to travel for the training. There were terms and conditions in the contract that said the buyer would have rights to create derivative works and copy handouts from class. The handouts were proprietary and already copyrighted. The seller could not and would not sign the contract. The class had to be cancelled while many people were already on planes to attend the training. Whose fault was this? The project manager should have made sure the procurement department understood what they were buying and also should have looked at the contract before it was sent to make sure its language was accurate. Creating a contract requires the involvement of both the project manager and the procurement manager. Do you work with a procurement manager to review contracts on your projects?

Terms and conditions (either standard or special) differ depending on what you are buying. For example, for buying work that includes equipment you need terms that describe when ownership will be transferred to the buyer and terms that require insurance for damages in transit. For professional services you need terms requiring professional liability or errors and omissions insurance. These terms are usually determined by the procurement manager, but the project manager should be familiar with most common terms.

The following are categories of terms and conditions that can make up standard or special provisions. Be familiar with these concepts and what impacts they would have on a contract. The exam will often simply use these terms in sentences such as, "There was a force majeure," and you'll need to understand what that means (force of nature, like a flood or a fire). Conversely, you need to know that "There was a flood that made the seller unable to perform," describes a force majeure.

- **Acceptance** How will you specifically know if the work is acceptable?
- **Agent** Who is an authorized representative of each party?
- **Arbitration** This method to resolve disputes uses private third parties to render a decision on the dispute. Arbitration is paid for by the parties and is used because it is usually faster and cheaper than the courts.
- **Assignment** This refers to the circumstances under which one party can assign its rights or obligations under the contract to another.
- **Authority** Who has the power to do what?
- **Bonds** These are the payment or performance bonds, if any, that must be purchased. For example, a payment bond would protect the buyer from claims of nonpayment by the seller.
- **Breach/default** This occurs when any obligation of the contract is not met. Watch out—a breach on the seller's part cannot be fixed by a breach on the buyer's part. For example, failure to complete an item in the procurement statement of work (seller's breach) cannot be handled by the buyer stopping all payments (buyer's breach).

  A breach is an extremely serious event. The exam may present situations in which seemingly little things in the contract are not done. The response to a breach must always be to issue a letter formally notifying the other party of the breach. The project manager must understand the legal implications of their actions. If they do not watch out for and send an official notice of breach, the project manager's company could lose its right to claim breach later.
- **Changes** How will changes be made? What forms will be used? What are the timeframes for notice and turnaround?

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- **Confidentiality/nondisclosure** What information must not be made known or given to third parties?
- **Dispute resolution** How will any disputes regarding the contract be settled? Some options for dispute resolution are to use the courts or an arbitrator.
- **Force majeure** This refers to a situation that could be considered an "act of nature," such as a fire or freak electrical storm, and it is an allowable excuse for either party not meeting contract requirements. If a force majeure occurs, it is considered to be neither party's fault. It is usually resolved by the seller receiving an extension of time on the project. Who pays for the cost of the items destroyed in a fire or other force majeure? Usually the risk of loss is borne by the seller and is hopefully covered by insurance. (See also "Risk of loss" below.)
- **Incentives** These are benefits the seller may receive for achieving the buyer's objectives of schedule, cost, quality, risk, and performance.
- **Indemnification (liability)** Who is liable for personal injury, damage, or accidents?
- **Independent contractor** This term means the seller is not an employee of the buyer.
- **Inspection** Does anyone have a right to inspect the work during execution of the project? Under what circumstances?
- **Intellectual property** Who owns the intellectual property (for example: patents, trademarks, copyrights, processes, source code, or books) used in connection with or developed as part of the contract? This may include warranties of the right to use certain intellectual property in performance of the contract.
- **Invoicing** When will invoices be sent? What supporting documents are required? To whom are they sent?
- **Liquidated damages** These are estimated damages for specific defaults, described in advance.
- **Management requirements** Examples of management requirements include attendance at meetings and approval of staff assigned to the project.
- **Material breach** This breach is so large that it may not be possible to complete the work under the contract.
- **Notice** To whom should certain correspondence be sent?
- **Ownership** Who will own the tangible items (such as materials, buildings, or equipment) used in connection with or developed as part of the contract?
- **Payments** When will payments be made? What are the late payment fees? What are reasons for nonpayment? Watch out for questions regarding payment management. For example, as a response to inaccurate invoices, the buyer cannot stop all payments; this would be a breach. They can, however, stop payments on disputed amounts.
- **Procurement statement of work** If it is not a separate document, this will be included as part of the contract.
- **Reporting** What reports are required? At what frequency? To and from whom?
- **Retainage** This is an amount of money, usually 5 percent or 10 percent, withheld from each payment. This money is paid when the final work is complete. It helps ensure completion.
- **Risk of loss** This allocates the risk between the parties to a contract in the event goods or services are lost or destroyed during the performance of a contract.
- **Site access** This describes any requirements for access to the site where the work will be performed.
- **Termination** Termination is stopping the work before it is completed.
- **Time is of the essence** Delivery dates are strictly binding. The seller is on notice that time is important and that any delay is a material breach.

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- **Waivers** These are statements saying that rights under the contract may not be waived or modified other than by express agreement of the parties. A project manager must realize that they can intentionally or unintentionally give up a right in the contract through conduct, inadvertent failure to enforce, or lack of oversight. Therefore, a project manager must understand and enforce all aspects of the contract, even if a procurement manager is involved in administering the contract.
- **Warranties** These are promises of quality for the goods or services delivered under the contract, usually restricted to a certain time period.
- **Work for hire** The work provided under the contract will be owned by the buyer.

Incentives Sellers are usually focused on the profits, while buyers may be focused on cost, performance, schedule, or a combination of these. Incentives are used to bring the seller's objectives in line with the buyer's and to motivate the seller towards efficiency. Think of an incentive as a bonus for the seller. The buyer will provide an additional fee if the seller meets some cost, performance, or schedule objectives.

Can you see how incentives can change the focus of the seller's work? If there is an incentive for cost savings, then the work is to complete the project and to look for cost savings. If the incentive is for some increased level of performance (the system can handle more capacity than contracted for, for example), then the work is to complete the project and to look for ways to increase performance. The seller gains profit from both activities.

Now that you understand the concepts, it is time to work through some examples. You may need to calculate incentives for the exam. As you do the following exercises, notice the terms "cost," "fee," and "price." These terms all have different meanings, as defined previously.

12.3 Exercise In this cost plus incentive fee contract, the cost is estimated at $210,000, and the target fee is set at $25,000. The project is complete, and the buyer has agreed that the costs were, in fact, $200,000. Because the seller's costs came in lower than the estimated costs, the seller shares in the savings: 80 percent to the buyer and 20 percent to the seller. In your Exercise Notebook, calculate the final fee and final price.

Target cost	$210,000
Target fee	$25,000
Target price	$235,000
Sharing ratio	80/20
Actual cost	$200,000

Answer Remember that for the exam you may have to calculate both the final fee and the final price.

Final Fee	$210,000 – $200,000 = $10,000 $10,000 × 20% = $2,000 $25,000 target fee + $2,000 = $27,000 fee
Final Price	$200,000 + $25,000 + $2,000 = $227,000

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12.4 Exercise Now try the following exercise from the seller's perspective. In this fixed price incentive fee contract, the target cost is estimated at $150,000, and the target fee is $30,000. The project is over, and the buyer has agreed that the costs were, in fact, $210,000. Because the seller's costs came in higher than the target cost, the seller shares in the added cost: 60 percent to the buyer and 40 percent to the seller. In your Exercise Notebook, calculate the final fee, the final price, and the point of total assumption. Note the ceiling price.

Target cost	$150,000
Target fee	$30,000
Target price	$180,000
Sharing ratio	60/40
Ceiling price	$200,000
Actual cost	$210,000

Answer In this case, the actual cost is higher than the target cost, so the seller receives less fee, or profit. Instead of receiving $30,000 in fee, the seller is due only $6,000. (Note that in the answer table where the final fee is calculated, a common accounting convention is used where negative numbers are indicated with the use of parentheses.) The actual cost plus fee comes to $216,000, but this is higher than the ceiling price (the maximum amount the buyer will pay). The result is that the seller is paid $200,000 when the costs were $210,000. The seller made no profit, and in fact actually lost $10,000.

The point of total assumption (the amount above which the seller bears all the loss of a cost overrun) was $183,333. The seller should have calculated the point of total assumption and used it to manage the work and costs to ensure that their costs did not exceed this amount, since the seller suffers the effects of the inability to control the project and loses money on it.

Final Fee	$150,000 – $210,000 = ($60,000) overage ($60,000) × 40% = ($24,000) $30,000 + ($24,000) = $6,000
Final Price	$210,000 + $6,000 = $216,000 However, this amount is above the ceiling price of $200,000. Therefore, the final price (what the buyer will pay) is $200,000.
Point of Total Assumption	[($200,000 – $180,000)/60%] + $150,000 ($20,000/0.6) + $150,000 $33,333 + $150,000 = $183,333

Imagine that a question on the exam describes a scenario with a fixed price incentive fee contract where actual costs of the work to date are nearing the PTA, and there's still work left to complete. What should the seller do? What would happen if the seller did nothing? The seller's project manager should take the proactive approach of planning and performing cost and schedule management activities on the contract to determine how to address the situation. This should help the project manager anticipate possible problems and find solutions before the seller loses all the profit on the work.

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12.5 Exercise Try this one. For this exercise, you are again the seller in the procurement. In this fixed price incentive fee contract, the target cost is $9,000,000, and the target fee is $850,000. The project is done, and the buyer has agreed that the costs were, in fact, $8,000,000. Because the seller's costs came in lower than the estimated costs, the seller shares in the savings: 70 percent to the buyer and 30 percent to the seller. In your Exercise Notebook, calculate the final fee and final price.

Target cost	$9,000,000
Target fee	$850,000
Target price	$9,850,000
Sharing ratio	70/30
Ceiling price	$12,500,000
Actual cost	$8,000,000

Answer In this case, the actual cost is lower than the target cost, so the seller receives more fee, or profit. Instead of receiving just $850,000 in fee, the seller receives that fee plus an additional $300,000—for a total of $1,150,000. The fee added to the cost totals $9,150,000. Because that is less than the ceiling price, the seller gets paid that amount. Therefore, the seller gains because of their ability to control the project.

Final Fee	$9,000,000 – $8,000,000 = $1,000,000 $1,000,000 × 30% = $300,000 Original fee of $850,000 + $300,000 = $1,150,000
Final Price	$8,000,000 + $1,150,000 fee = $9,150,000

Putting It All Together You should now start to feel like you understand the different types of contracts. The following exercise is challenging but it will help you consolidate this knowledge in your mind for the exam.

We've heard people say they love the exercises in this book, but they always jump straight to the answers. We strongly advise against this. The exercises are designed to increase your knowledge as you do them, so don't skip ahead!

12.6 Exercise Answer the following questions for these contract types: cost-reimbursable, time and material, and fixed-price. Write the answers in your Exercise Notebook. (This is the most challenging exercise in this chapter. The questions are meant to be very difficult in order to further test your knowledge.)

	Question
1.	Generally, what is being bought? (Product or service)
2.	How might the costs to the buyer be stated in the contract?
3.	How might the profit be stated in the contract?
4.	What is the cost risk to the buyer? (High, medium, low, none)

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	Question
5.	How important is a detailed procurement statement of work? (High, medium, low, none)
6.	What industry uses this contract type most frequently?
7.	How much negotiation is usually required to sign the contract after receipt of the seller's price? (High, medium, low, none)
8.	What level of effort and expertise will the buyer need to devote to managing the seller? (High, medium, low, none)
9.	How are costs billed to the buyer?
10.	How much auditing of the seller's costs will the buyer need to do? (High, medium, low, none)

Answer Compare the answers in the following table to your answers.

	Cost- Reimbursable	Time and Material	Fixed-Price
1.	Service (some products may be included)	Service	Product
2.	Costs are variable, but the fee/profit is fixed (as a set amount or a percentage)	Hourly rate or price per unit	As a set currency amount (e.g., $1 million)
3.	Listed separately, and known to the buyer	Included in the hourly rate, and may be unknown to the buyer	Included in the price, and unknown to the buyer
4.	High; increases in costs are reimbursed by the buyer	Medium; although the costs are not fixed, they are known per unit, and this contract type is used for small purchases for a limited time	Low; increases in costs are borne by the seller
5.	Low; the procurement statement of work only needs to describe the performance or functional requirements, since the seller provides the expertise on how to do the work; the buyer pays all costs, so there is less need to finalize the scope	Low; this type traditionally has very little scope, and may only describe skill sets required	High; the procurement statement of work must be complete so the seller knows exactly what work needs to be done in order to come up with an accurate price to complete the work
6.	IT, research and development, and knowledge work; when the work has never been done before (as is often the case in these industries), the seller cannot fix a price; therefore, this is the best form to use	When hiring people for an hourly rate, you are usually hiring services, such as legal, plumbing, or programming	Complete scope of work is most common in the construction industry

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	Cost- Reimbursable	Time and Material	Fixed-Price
7.	High; all estimated costs are looked at to calculate the fee to be paid	Low or none	None
8.	High	Medium	Low
9.	Actual costs as incurred; profit at project completion, or apportioned as allowed in the contract	Hourly or per unit rate (which includes all costs and profit)	Fixed price (which includes profit) according to a payment schedule as work is completed and as allowed in the contract
10.	High; all costs must be audited, and there will be a large number of invoices	None; there may be an audit of work hours completed against those billed, but that will take little effort	Low; since the overall contract costs are fixed, auditing usually focuses on making sure work is completed, not looking at detailed costs and receipts

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PMBOK® Guide
PG: Planning
Process: Plan Procurement Manageemnt

ECO
Domain: I
Task: 8
Domain: II
Task: 11

The Plan Procurement Management process answers these questions: "How will make-or-buy analysis be performed?" "What goods and services do we need to buy for this project?" "How will we purchase them?" "Who are potential sellers to consider?"

Planning involves putting together the bid documents that will be sent to prospective sellers describing the buyer's need, how to respond, and the criteria the buyer will use to select a seller.

Planning the procurement process includes the following:

- Performing make-or-buy analysis[9]
- Creating a procurement management plan
- Creating a procurement strategy for each procurement
- Creating a procurement statement of work for each procurement
- Selecting the appropriate contract type for each procurement
- Creating the bid documents
- Determining the source selection criteria

When planning procurement management, it is important to consider business documents like the benefits management plan and the business case. You also need the project charter; components of the project management plan like the scope and schedule baselines and scope, quality, and resource planning documents; project documents; and any relevant enterprise environmental factors and organizational process assets.

The project charter provides any preapproved financial resources, while project documents provide the following:

- Milestone list
- Project team assignments
- Requirements documentation (including a requirements traceability matrix)
- Resource requirements

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- Risk register
- Stakeholder register
- Procurements already in place

For procurement, enterprise environmental factors include marketplace conditions, the services that are available to be purchased, and the existing culture and structures surrounding the organization's approach to procurements. Relevant organizational process assets can include procurement procedures and documents, standard contract types used by the organization, statement of work templates, lessons learned from past procurements and projects. A preapproved (or prequalified) seller list and master service agreements, if they exist, are also useful.

A preapproved seller list speeds up the process by helping ensure the sellers' qualifications are well researched. The procurement documents are sent only to the preapproved sellers. Master service agreements are contracts between two parties including standard terms that will govern future transactions – a time-saving approach when a buyer frequently works with the same seller because overall terms of working together are already agreed to and signed by both buyer and seller.

Make-or-Buy Analysis During planning, you must decide whether the scope and work of the project will be completed within the organization or if some if it will be outsourced. It's important to ask questions such as, "How are resources currently distributed?" and "What are the capabilities of our resources?" Make-or-buy analysis is done early in the planning phase of the project, and results in a make-or-buy decision.

Logistics and Supply Chain Management An important consideration in make-or-buy analysis is the required lead time for materials and equipment to be purchased. Specialty items, custom products, and items ordered internationally will take more time, which must be built into the project schedule.

Economic Models Economic models similar to those used in project selection and defined in the "Integration" chapter may support make-or-buy decisions. Examples include payback period, ROI, IRR, return, discounted cash flow, and (NPV).

Expect to see questions on the exam that refer to make-or-buy analysis, or even questions that require you to calculate buy-or-lease situations, such as:

Question You are trying to decide whether to lease or buy an item. The daily lease cost is $120. To purchase the item, the investment cost is $1,000; the daily maintenance cost is $20. How long will it take for the lease cost to equal the purchase cost?

Answer Let D equal the number of days when the purchase and lease costs are equal.

$$\$120D = \$1{,}000 + \$20D$$
$$\$120D - \$20D = \$1{,}000$$
$$\$100D = \$1{,}000$$
$$D = 10$$

The calculation says that the costs are the same after 10 days. Therefore, if you are planning to use the item for fewer than 10 days, you should lease. Otherwise it would be cheaper to buy the item.

Source Selection Analysis Project constraints are factors in seller selection. For example, is schedule the most important criteria or is cost the critical factor? You may want to review the project constraints in the "Framework" chapter.

Other source selection criteria[10] are used and, as in project constraints, some are often weighed more heavily over others. If the buyer is purchasing a commodity, such as linear meters of wood, the source selection criteria may just be the lowest price. If the buyer is procuring construction services, the source selection criteria may be price plus experience. If the buyer is purchasing services, the source selection analysis criteria may include:

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- Number of years in business
- Financial stability
- Understanding of need
- Price or life cycle cost
- Technical expertise
- Quality of past performance
- Ability to complete the work on time

If the organization has a preferred seller list, or a master services agreement with an outside source, that information is also considered when analyzing source selection options.

Plan Procurement Outcomes The outcomes of planning for procurement include having a procurement management plan in place. This plan documents or references governance for procurements. It provides guidelines and available tools for make-or-buy and source selection analyses, phase and transition management and tailoring considerations.

Conducting and controlling procurements are supported by planning, so these aspects are also covered in the plan. Rules and guidelines for procurement roles and responsibilities, bidder conferences, and negotiations are included. The control portion of the plan indicates how contract requirements will be managed, and it provides metrics and information on when and how measurements will be taken, guidelines for resolving disputes, the process for accepting deliverables, and the payments to be made.

Make-or-buy decisions are an outcome of the make-or-buy analysis, and another outcome of planning is the procurement strategy. This strategy has three basic elements:

- How goods or services will be delivered to the buyer (for example, will the procurement include subcontractors or an outside service provider)
- Contract selection (for example, will the contract be fixed-price or cost plus; will it include incentives or award fees)
- How the procurement will be carried out for each phase.

Other outcomes of planning include the SOW, source selection criteria, independent cost estimates, and selected types of bid documents. Source selection criteria were discussed earlier in this chapter. For independent cost estimates the buyer prepares an internal estimate often using expert judgment to come up with a benchmark against which to validate the bids received from prospective sellers. The procurement SOW and bid documents were introduced earlier but let's look at them now in further detail.

Procurement Statement of Work (SOW)[11] The complete scope of a procurement is described in a procurement SOW. You use the same skills for the same outcomes you expect to have from the work on your project's scope baseline, since each procurement represents a part of the overall project scope.

Each statement of work must be as clear, complete, and concise as possible, and it must describe all the work and activities the seller is required to complete. This includes all meetings, reports, and communications. It must also detail the acceptance criteria and the process of gaining acceptance. The cost of adding activities later is typically more than the cost of adding them at the beginning of the procurement. Does this make you think about the amount of work required to create a complete procurement statement of work?

Remember that the level of detail required for the SOW will influence the selection of the contract type and the creation of the bid documents. It may include drawings, specifications, and technical and descriptive wording.

What does "complete scope of procurement" mean? It depends on what you are buying. Here are some examples:

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- Expertise (e.g., software design or legal services): Your procurement SOW includes functional and/or performance requirements, a timeline, evaluation criteria, and required meetings, reports, and communications.
- The construction of a building: Specific requirements, outlining things such as the materials to be used, the process that must be followed, and work schedule.
- Augmenting your staff: You will direct these human resources so you will need details of what you want the person to create or achieve.

Note: If the procurement is for services rather than products, the procurement SOW may be referred to as terms of reference (TOR). It includes the work the seller will perform, standards the seller is expected to achieve, and the data and services that will be provided to the buyer.

The procurement statement of work may be revised during contract negotiation, but it should be finalized by the time the contract is signed as it is part of the contract. Both parties to the contract should always be asking, "What does the contract say?" If the procurement SOW is not complete, the seller may frequently need to request clarification or ask for change orders, which can get expensive, and the project manager and/or the procurement manager may find themselves constantly dealing with questions about whether a specific piece of work is included in the original cost or time estimates.

Think about change orders in the context of the procurement strategy and the project plan. In general, contract change orders cost money or cause delay. Bad procurement SOWs can result in overspending and delayed or failed projects.

Although they are not specified in the *PMBOK® Guide*, there are several types of procurement statements of work with which you should be familiar. Your choice will depend on the nature of the work, the industry, and the amount of detail that can be provided about the work. The following are types of procurement statements of work:

- **Performance** This type conveys what the final product should accomplish, rather than how it should be built or what its design characteristics should be. For example, "I want a car that will go from zero to 120 kilometers per hour in 4.2 seconds."
- **Functional** This type conveys the end purpose or result, rather than the specific procedures or approach. Functional procurement statements of work may include a statement of the minimum essential characteristics of the product. For example, "I want a car with 10 cup holders."
- **Design** This type conveys precisely what work is to be done. It includes the materials to be used and an explanation of how the work should be completed. Design procurement statements of work are most commonly used for construction and equipment purchases. For example, "Build a garage exactly as shown in these drawings."

Fixed-Price Work Packages An alternative option within statements of work are fixed-price work packages. Fixed-price work packages are used in conjunction with agile contracts to mitigate the risks of underestimating or overestimating project work by reducing the scope and cost involved in the work being estimated. For example, a statement of work can be divided into individual work packages, each with its own fixed price. Then as project work progresses, a supplier may be able to re-estimate the remaining work packages in the statements of work based on new information and new risks.

Using fixed-price work packages allows the customer to reprioritize the remaining work based on evolving costs. It also gives the supplier the ability to update their costs as new details emerge, removing the need for the supplier to build excess contingency funds into the project cost. The changes are then localized to small components (the work packages). If extra funding is required, it is easy to identify the need and justify it. The figure below illustrates the difference between a traditional SOW and fixed-price work packages.

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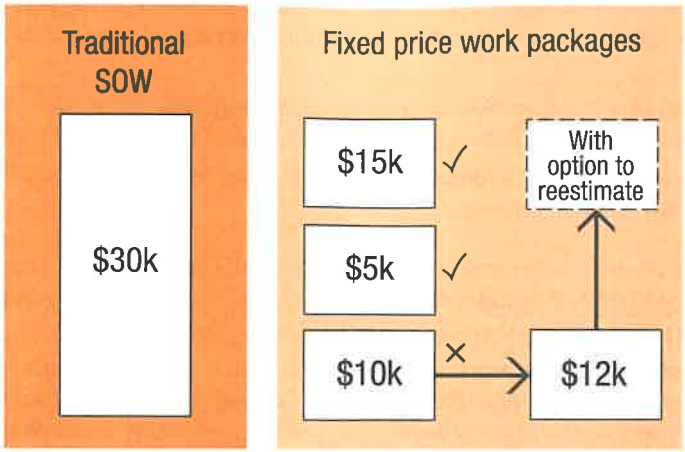

FIGURE 12.2 *Traditional statements of work versus fixed-price work packages*

Bid Documents After the contract type is selected and the procurement statement of work has been created, the buyer can put together the bid document, which describes the buyer's needs to sellers. The following are types of bid documents.

- **Request for proposal (RFP)** An RFP (sometimes called a request for tender) requests a detailed proposal that includes information on price, how the work will be accomplished, who will do it (along with résumés, in some cases), and company experience.
- **Invitation for bid (IFB)** An IFB, sometimes called a request for bid (RFB), usually requests a total price to do all the work. Think of an IFB as a form of RFP where the work described in the procurement statement of work is detailed enough for bidders to determine a total price.
- **Request for quotation (RFQ)** RFQs request a price quote per item, hour, meter, or other unit of measure.
- **Request for information (RFI)** An RFI might be used before bid documents are created. Responses to the RFI help the buyer identify which companies are qualified to handle the procurement. Buyers can also use RFIs to collect information on what work is possible, for later inclusion in RFPs or IFBs. Remember that the purpose of an RFI is to get information, whereas the purpose of an RFP or RFQ is to buy something.

To provide the seller with as clear a picture as possible of what needs to be done to win the work and what the work involves, bid documents may include the following information for sellers:

- Background information about why the buyer wants the work done
- Procedures for trying to win the work (such as whether there will be a bidder conference, when the responses are due, and how the winner will be selected)
- Guidelines for preparing the response (such as maximum length and topics to address in the response)
- The exact format the response should be in (such as which forms must be filled out and whether email submissions are allowed)
- Source selection criteria—the criteria the buyer will use to evaluate responses from the sellers (such as number of years in business, quality of the response, or price)
- Pricing forms (forms to adequately describe the price to the buyer)
- Procurement statement of work
- Proposed terms and conditions of the contract (legal and business)

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Note that the proposed contract is included in the procurement documents. Do you know why? The terms and conditions of the contract are also work that needs to be done, and there are costs associated with that work, including such things as warranties, ownership, indemnification, and insurance requirements. The seller must be aware of all the work that needs to be completed to adequately understand and price the project.

Well-designed bid documents can have the following effects on a project:

- Easier comparison of sellers' responses
- More complete responses
- More accurate pricing
- Decreased number of changes to the project

Sellers may make suggestions for changes to the procurement documents, including the procurement statement of work and the project management requirements included in the documents, before the contract is signed. When approved, these changes are issued by the buyer as addenda to the bid documents and will ultimately become part of the final contract.

Noncompetitive Forms of Procurement Public organizations are generally required by law to follow certain practices regarding competitive procurements and to select a seller in a certain way. Although they might have internal policies to follow, private companies may bypass competitive procurement by using master service agreements or preferred seller lists, in which case they could simply issue a purchase order to obtain goods or services from an approved or preferred seller.

If you do not use a competitive process, you enter one of the following types of noncompetitive procurements:

- **Sole source** In this type of procurement, there is only one seller who can provide the goods or services. They may own a particular patent.
- **Single source** Here, you contract directly with your preferred seller without going through the full procurement process. You may have worked with this company before, and, for various reasons, you do not want to look for another seller. In some cases, there may be a master service agreement in place between an organization and this seller: an established, ongoing contract.

Other reasons for working with a company as a single source are:

- The project is under extreme schedule pressure.
- A seller has unique qualifications.
- Other mechanisms exist to ensure the seller's prices are reasonable.
- The procurement is for a small amount of money.

If you are entering a noncompetitive procurement, you may save time by eliminating part of the process that comes before bidding but you still have to negotiate to finalize the contract.

TRICKS OF THE TRADE® Tricky situational questions on the exam may describe procurement concepts you have not dealt with before, such as negotiating a noncompetitive procurement contract. Do you understand how your efforts during the procurement process are different when there are not multiple companies to go to for the goods or services? Review the following table to get more questions right.

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Single Source (Preferred Seller)	Sole Source (Only One Seller)
Scope More work is needed to include items received without cost in the past since only what is in the contract will be received.	**Risk** A seller owning a patent could go out of business. Then who owns the patent and how will you meet requirements?
Scope There could be a tendency for the buyer to say, "The seller knows us, we know them; we do not have to spend so much time determining requirements and completing a procurement SOW. They know what we want."	**Risk** A seller owning a patent could take on too much work and not complete it on time.
Quality The seller may never be asked to prove they have the experience, cash flow, and manpower to complete the new work. Also, quality may not consistently meet stated requirements because the seller knows they are not competing and becomes complacent.	**Quality** You may have to take what you get rather than being able to request a certain quality level.
Cost Work is needed to compare previous costs to the new costs to ensure it is still appropriate.	**Cost** Multiyear agreements may be required for the purchase of items to prevent a price increase in the future.
Schedule The seller they may not be optimally responsive to schedule requirements.	**Schedule** The seller has little incentive to agree to a schedule.
Customer satisfaction The seller may generally be less responsive to concerns.	**Customer satisfaction** The seller has little incentive to be concerned with the buyer's needs and desires.
Risk Any of the previous issues may weigh risk increasingly toward the buyer.	**Scope** You may have to change the work specified to "take what you can get," rather than "ask for what you want."
	Risk Any of the previous issues may weigh risk increasingly toward the buyer.

Once your make-or-buy analysis and procurement strategy are complete and you have selected the contract type, completed a statement of work and bid documents you are prepared to engage with prospective sellers. You will send the bid documents and supporting documentation, answer the sellers' questions, possibly hold a bidder conference, and evaluate sellers' responses. You will select a seller using your source selection criteria and then negotiate a contract.

Conduct Procurements PAGE 482

PMBOK® Guide
PG: Executing
Process: Conduct Procurements

ECO
Domain: I
Task: 8
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Managing procurements includes carrying out the final strategy for finding a seller and negotiating and finalizing a contract with them. Information from the project management plan including to-date baselines and other planning documentation will assist in this process with prospective sellers and in making a final decision for each procurement. Because the process to finalize procurements is ongoing throughout the project, you and the team may be able to make use of lessons learned from prior procurements on the current project or previous projects, which can provide insight into the organization's experiences with sellers. This information can often streamline the process considerably.

A buyer may use tools and techniques such as advertising to find possible sellers or may send the bid documents to a select list of sellers preapproved by the organization (an organizational process asset). The organization may already have an existing agreement with a particular seller. In this case, they could work

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with that seller to negotiate terms to add new work to the contract. NOTE: The US government and many state and local agencies are required to advertise most of their procurements.

Bidder Conference[12] For a bidder conference the buyer's side carefully controls communications with prospective sellers to ensure legal integrity, fairness, and consistency in the process. All prospective sellers' questions are documented and sent to all prospective bidders – along with subsequent responses – to make sure that everyone has the same information.

Getting answers to questions can be important because many bid documents will include a provision saying that by submitting a bid or proposal, the seller warrants that the bid covers all the work. The bidder conference is also an opportunity for the buyer to discover anything missing in the bid documents.

A bidder conference can be key to making sure the pricing in the seller's response matches the work that needs to be done and is, therefore, the lowest price. Bidder conferences benefit both the buyer and seller. It is a good practice for the project manager to attend the bidder conference. The exam often asks what things the project manager must watch out for in a bidder conference. The answers include:

- Collusion
- Sellers not asking questions in front of the competition
- Making sure all questions and answers are put in writing and issued to all potential sellers by the buyer as addenda to the bid documents (ensuring that all sellers are responding to the same procurement statement of work)

Seller Proposal (or Price Quote or Bid) A proposal is usually the response to a request for proposal (RFP), a quote is usually the response to a request for quote (RFQ), and a bid is usually the response to an invitation for bid (IFB). The proposal (or price quote or bid) represents an official offer from the seller. RFP and RFQ responses describe how the seller will meet the buyer's request. A potential seller's response to an RFI provides information to help the buyer better define their procurement need. Responses to a request for information may trigger the buyer's creation of an RFP or RFQ. Keep in mind that sellers may have many RFPs, RFQs, and IFBs[13] sent to them. They need time to review them and determine which they are interested in responding to. To ensure the best sellers will be interested, the bid documents should be as complete and straightforward as possible.

The buyer's project manager should allow for this time—and the time required for the bidder conference and responses to that as well as the rest of the procurement process—in the project schedule.

Proposal Evaluation A buyer proposals evaluation committee uses the source selection criteria to assess the ability and willingness to provide the requested products or services. This data analysis technique provides a basis to quantitatively evaluate proposals and minimize the influence of personal prejudices.

To select a seller the buyer may:

- Simply select a seller and ask them to sign a standard contract.
- Ask a seller to make a presentation, and then, if all goes well, move on to negotiations.
- Narrow down ("short-list") the list of sellers to a few.
- Ask the short-listed sellers to make presentations, and then ask the selected seller(s) to go on to negotiations.
- Negotiate with more than one seller.
- Use some combination of presentations and negotiations.

The choice of methods depends on the importance of the procurement, the number of interested sellers, and the type of work to be performed. The sellers' proposals are usually reviewed and compared by the evaluation committee using one or a combination of the formal, structured processes discussed next.

Weighting System[14] When the responses from sellers have been received, the buyer's evaluation committee will analyze the responses and select a seller to award the contract to or to negotiate with. If the

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buyer is a public entity and the response is to an invitation to bid, the answer is simple. The work goes to the lowest responsive, responsible bidder. In the case of a proposal, the selection decision is more complicated. The buyer will apply the selection criteria chosen in planning. But which is more important? Price? Competence? Availability? Selection criteria are assigned values based on their relative importance to the procurement. For example, if price is more important, it will be given a higher rating and weight. The buyer's evaluation committee then analyzes seller responses using the weighted source selection criteria.

There are no calculations on the exam regarding weighting systems, but the following example should help you better understand the concept.

Seller A

Criteria	A Weight	B Rating for this category (1 to 100)	C Category score (column A times B)
Number of years in business	5 percent	50	2.5
Understanding of need	25 percent	80	20
Price or life cycle cost (see definition in the "Cost" chapter)	10 percent	90	9
Technical ability	25 percent	40	10
Ability to complete the work on time	20 percent	30	6
Project management ability	15 percent	30	4.5
Total score for this seller			52

Past Performance History The buyer may consider both their history with the prospective sellers and feedback from other organizations who have done business with the sellers when determining which seller to award the procurement to.

Independent Cost Estimates The buyer should compare the seller's proposed cost with an estimate created in-house or with outside assistance during procurement planning efforts. This allows the buyer to discover significant differences between what the buyer and seller intend in the procurement statement of work. The buyer must have their own estimates to check reasonableness and cannot rely solely on the seller's cost estimates. Responses that are significantly different from what is expected may indicate an issue with the sellers' understanding of the procurement statement of work.

Presentations In many cases, some of the sellers will be asked to make presentations of their proposals. This is often a formal meeting of the buyer's and seller's teams. It provides the seller with an opportunity to present their proposal, team, and approach to completing the work. The buyer has an opportunity to see the team they may hire and to ask questions to assess the team's competency. Presentations are used most often for procurements that have cost-reimbursable contracts, but they can be used whenever there is a lot to assess.

Negotiations The exam typically has a question or two related to contract negotiations and the project manager's involvement. You do not have to be an expert negotiator to pass the exam. But, as you have seen in other chapters of this book, the ability to negotiate is an important interpersonal skill for a project manager. Although the procurement manager generally leads negotiations, the exam assumes the project manager is involved. There are often negotiating issues that affect the key objectives of the project or how the project will be managed. Without the project managers' involvement in negotiations, it is common for a contract to be signed that the project managers later discover cannot be completed.

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Objectives of Negotiations It is important for everyone involved in negotiations to understand that the objectives of the negotiations are to:

- Obtain a fair and reasonable price.
- Develop a good relationship between the buyer and the seller.

The second item surprises people because they think of negotiations as win-lose. In a win-win situation, the buyer gets the work completed and the seller makes a reasonable profit. What is wrong with that? Many projects go bad because of the way negotiations were handled, not because of project problems themselves. Negotiation tactics are sometimes represented within situational questions on the exam, (though it is not covered in the *PMBOK® Guide*). Be aware that buyers and sellers may use negotiation tactics such as delaying or withdrawal to get what they want. These are undesirable, of course, and you should have the skills to overcome these tactics.

The main items to address while negotiating a contract can be different depending on what is being purchased. Scope, schedule, and cost are usually negotiated, in that order, although it always depends on project priorities. Other items to be negotiated include risk, risk responsibilities, authority, applicable law (laws from a different state, country, or region should be reflected in the contract), project management process, payment schedule, and quality.

The clearer the scope definition, the easier it will be for the buyer and seller to come to a realistic agreement on the other items.

When negotiations are complete, the contract is awarded to the selected seller. Note that the *PMBOK® Guide* refers to this output using the broader term "agreement," but we'll continue to use the more specific term, "contract," as the most appropriate term for the document describing the legal relationship entered into by the buyer and seller.

What Do You Need in Order to Have a Legal Contract?

- An offer
- Acceptance
- Consideration (a transfer of something of value, but not necessarily money)
- Legal capacity (separate legal parties that are all legally competent)
- Legal purpose (you cannot have a legal, enforceable contract for the sale of illegal goods or services)

A contract, offer, or acceptance may be verbal or written, though written is preferred since verbal agreements are difficult to enforce in a court of law.

The key outputs of the Conduct Procurements process are selected sellers and change requests.

Selected Sellers After all the work of evaluating responses and negotiating with one or more prospective sellers is complete, a seller is chosen for each procurement. This means that the buyer and seller have agreed and signed off on all terms and conditions of the contract, and they will move forward to create the product or service during the Control Procurements process.

Change Requests The procurement management plan is likely to be iterated. Changes to any plan components, baselines, and other project artifacts are possible. Sometimes during project executing, problems that arise related to the procurement process (for example, a seller who isn't performing) or to other areas of the project (such as risk, quality, schedule, or scope management) require reevaluation of the procurement management plan and make-or-buy decisions. So, it may be necessary to revisit the work previously done in planning. Such changes need to be submitted through integrated change control, where they are evaluated against the entire project, and approved, rejected, or deferred.

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It is important enough to state again that contracts may be finalized after other project plans are completed and approved. This could trigger the need for changes to any part of the overall project, potentially including the scope, schedule, or cost baselines (to address availability or cost of procured resources), or any other planning document components such as quality, resources, communications or risk plan components. The preapproved seller list may also be updated based on work done in Conduct Procurements.

Managing Procurements PAGE 492

PMBOK® Guide
PG: Monitoring and Controlling
Process: Control Procurements

ECO
Domain: I
Task: 8
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Managing a procurement once the contract is signed involves managing the legal relationship between the buyer and seller, and ensuring that both parties perform as required by the contract and that each contract is closed when the project is completed or terminated. The *PMBOK® Guide* calls this Control Procurements, but note again that the ECO considers the entire procurement process be included within the Plan and Manage Procurement task. The seller is focused on completing the work while the buyer is focused on measuring the performance of the seller and comparing actual performance to the contract, other procurement documents, and management plans. The exam tends to ask situational questions focusing on what happens after the contract is signed, so this process is an important area on the exam.

You should understand what the project manager should be doing at any point in time, and what problems and issues might affect the management of the project under each contract type. You will need to ensure that all work and legal requirements in the contract are accomplished however small and seemingly unimportant.

The procurement management plan includes the actions you and the team will take to oversee procurements, and you may also review lessons learned to avoid the recurrence of issues experienced in the past. Approved change requests from integrated change control are implemented in this process.

You will use the milestone list and schedule, scope, and cost baselines to confirm that the project is progressing as planned. Requirements documentation describes technical and other requirements the procurement is expected to meet. Quality reports indicate whether the work of the procurement is within the established quality metrics. Work performance data from the Direct and Manage Project Work process (in "Integration") gives the project manager information on costs and the status of project activities, and is used to evaluate seller performance.

You are continually measuring and assessing project progress as compared to the contract and procurement documentation and management plans. The tools and techniques described later in this section include many ways in which this is accomplished. When variances are identified, they are analyzed and may need to be managed using the integrated change control system. Approved changes will be integrated into the management plans or the contract. Contract changes are handled using the organization's contract change control system,[15] which is an enterprise environmental factor. This system includes change procedures, forms, dispute resolution processes, and tracking systems, and is described in the contract. These procedures must be followed, and all changes should be made formally (which means in writing).

TRICKS OF THE TRADE®

Sometimes exam questions ask how project control is different in a procurement environment. These types of questions can be particularly difficult for those with little procurement experience. Getting to a correct answer may include knowing that:

- The seller's and buyer's organizations have different cultures and procedures.
- The seller's objective is to generate revenue while the buyer's objective is to complete the work.
- It is not as easy to see problems on the project when the contracted work is being done in a different location.
- There is a greater reliance on reports to determine if a problem exists.
- There is a greater reliance on the relationship between the buyer's and seller's project managers in terms of resolving issues not covered in the wording of the contract.

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Now let's go into detail with the following exercise. What specific work actions do you think must be done while managing procurements once under contract (Control Procurements in the *PMBOK® Guide*)? (Do not just look at the answers! Do the exercise once, and you will not have to do it again. Only look at the answers, and you will have to spend three times as long to learn this information.)

12.7 Exercise In your Exercise Notebook, describe the specific actions involved in the Control Procurements process.

Answer Be careful while reading over the following list. Do you understand what each of these actions is and how long it might take? Go slowly, and imagine what it would take to handle each one for a multimillion-dollar construction project. (The items in the list are in no particular order.)

Imagine that you are building an office building, and you are the project manager for the building's owner. During this process you may do the following:

- Review invoices. Were they correctly submitted? Do they have all the required supporting information? Are the charges allowable under the contract?
- Evaluate whether a change is needed and is within the approved scope of the project.
- Submit changes through integrated change control as necessary.
- Document and record *everything*. This includes phone calls with the seller, emails, requested changes, and approved changes.
- Manage and integrate approved changes.
- Authorize payments to the seller.
- Interpret what is and what is not in the contract.
- Interpret what the contract means.
- Resolve disputes.
- Make sure only authorized people are communicating with the seller.
- Work with the procurement manager on requested and approved changes and contract compliance.
- Hold procurement performance review meetings with your team and the seller.
- Report on performance—this means your own performance as well as the seller's performance.
- Monitor cost, schedule, and technical performance against the contract, including all of its components, such as terms and conditions and the procurement statement of work.
- Understand the legal implications of actions taken.
- Control quality according to what is required in the contract.
- Issue claims and review claims submitted by the seller.
- Authorize the seller's work to start at the appropriate time, coordinating the seller's work with the work of the project as a whole.
- Communicate with the seller and with others.
- Manage interfaces among all the sellers on the project.
- Send copies of changes to the appropriate parties.
- Accept verified deliverables.
- Validate that the correct scope is being done.
- Validate that changes are giving the intended results.
- Perform inspections and audits.
- Identify risks to the completion of future work.
- Reestimate risks, costs, and schedule.

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- Monitor and control risk.
- Perform contract closure for each contract as it is complete or terminated.
- Analyze the procurement process for lessons learned, and make recommendations to the organization for improvement.
- Accept final deliverables from the seller, and make final payments.

In the contracts section you saw that there are advantages and disadvantages of different contract types. The exam will require you to know that management efforts, issues, and potential trouble spots are different under each type of contract, meaning there will be different things you will need to do depending on the type of contract you have. So with the following exercise, review these concepts and how they affect managing a procurement once the contract is signed.

12.8 Exercise Hopefully, you have built a strong working relationship with the seller. But what if the seller has financial troubles, changes owners, or did not include pieces of the work in their estimate? In your Exercise Notebook, describe specific things you must watch out for and spend your time managing for each of the three main types of contracts.

Answer This is not a complete list! Think of what other actions may be taken.

Fixed-Price	Time and Material	Cost-Reimbursable
The seller cutting scope.	Day-to-day direction to the seller.	Audit every invoice.
The seller cutting quality.	Get concrete deliverables.	Reestimate costs.
Overpriced change orders.	Ensure project length is not extended.	Monitor to confirm the seller's work is progressing efficiently.
Scope misunderstandings.	Confirm the number of hours spent on work is reasonable.	Ensure all costs are applicable and chargeable to your project.
Ensure costs are real, incurred costs (not future or potential costs)—unless there is an agreement stating otherwise.	Watch for the need to switch to a different form of contract (e.g., you determined a design SOW under a T&M contract and switch to a fixed-price contract for completion of the work).	Watch for the seller adding resources that do not add value or perform real work.
		Look for resources being shifted from what was promised.

The tools and techniques that can be used to manage procurements include performance reviews, inspections and audits, earned value analysis, and trend analysis. Performance reviews include analyzing all available data to verify that the seller is performing as they should. Often, the seller is present to review the data and to discuss what the buyer can do to help advance the work. Together they determine if changes are needed to improve the buyer-seller relationship, the processes being used, and how the work is progressing compared to the plan. Any changes must be agreed upon in writing.

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Inspections may involve walkthroughs of the work site or deliverables reviews to verify compliance with the procurement statement of work. Do deliverables meet specifications? Variances or deviations may trigger change requests. An audit is performed by a team that includes representatives of both the buyer and the seller. The audit is to confirm that the seller's activities comply with approved procurement policies and processes. Variances are identified, formal adjustments are made accordingly, and lessons learned are captured. Note that in agreement with what we say in the "Quality" chapter, inspections are related to deliverables while audits are related to processes, policies, and procedures.

Earned value analysis measurements identify scope, schedule, or cost variances from the performance measurement baseline. Variances are analyzed to determine their impact on the project. The results may be used to generate reports, forecast future performance, and predict actual completion dates and costs. Change requests may be made based on these results. Trend analysis determines whether performance is getting better or worse. It can be used to determine if preventive actions can prevent significant variances in the future and to develop forecast estimates and estimate at completion.

Contract Interpretation and Managing Conflict Contract interpretation is never easy and frequently requires a lawyer's assistance. However, the exam may describe a simple situation about a conflict over interpretation of a contract and then ask you to determine the correct answer.

Conflict is an important topic that may be addressed in tricky procurement questions. In many cases the procurement manager (or contract administrator) is the only one with authority to change the contract. We have also said that the contract includes the procurement SOW. The buyer's project manager may want to initiate a change to the scope or sequence of work identified in the procurement SOW (an area seemingly under the project manager's control), but cannot do so without the procurement manager's approval. This adds another layer to the project manager's management activities that you may not have seen if you do not work with procurements. Can you see the potential for conflict between the procurement manager and the project manager?

Conflict can also occur between the buyer and the seller and may result in the seller submitting a claim against the buyer. A claim is an assertion that the buyer did something that has hurt the seller. The seller is now asking for compensation. Another way of looking at this is that a claim is a type of seller-initiated change request. Claims can get contentious. Imagine a seller that is not making as much profit as they had hoped issuing claims for every action taken by the buyer. Imagine the number of claims that can arise if you are working with a fixed-price contract and an incomplete procurement statement of work.

Claims are usually addressed through the contract change control system. The best way to settle them is through negotiation or the use of the dispute-resolution process specified in the contract. Many claims are not resolved until after the work is completed.

TRICKS OF THE TRADE Contract interpretation is based on an analysis of the intent of the parties, as reflected in the language of the contract, along with a few guidelines for interpreting that language. One such guideline is that the contract supersedes any memos, conversations, or discussions that may have occurred prior to the contract signing. Therefore, if a requirement is not in the contract, it does not have to be met, even if it was agreed upon prior to signing the contract. The following is an exercise on intent.

12.9 Exercise In your Exercise Notebook, choose which would "win" in a dispute over contract interpretation: choice A or choice B.

	CHOICE A		CHOICE B
1.	Contract language	*Or*	A memo drafted by one of the parties describing proposed changes after the contract is signed

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	CHOICE A		CHOICE B
2.	Contract language	*Or*	A memo signed by both parties before the contract is signed that describes what was agreed to during negotiations
3.	Contract terms and conditions	*Or*	Procurement statement of work
4.	Common definition	*Or*	The intended meaning (without supplying a definition)
5.	Industry use of the term	*Or*	Common use of the term
6.	Special provisions	*Or*	General provisions
7.	Typed-over wording on the contract	*Or*	A handwritten comment on the contract that is also initialed
8.	Numbers	*Or*	Words
9.	Detailed terms	*Or*	General terms

Answer Check the answers below. Note: The answer to number 3 depends on the Order of Precedence Clause in the contract that describes which terms and conditions take precedence over the others in the event of a conflict between them.

1. A	4. A	7. B
2. A	5. A	8. B
3. A or B	6. A	9. A

The outputs of managing procurements are change requests, procurement document updates, and closed procurements. Change requests to a contract result when the buyer's needs change while the work is underway, the impacts of the contract changes having been negotiated by the two parties. Contract changes may be requested throughout the procurement process and are handled as part of the project's integrated change control efforts, along with all other project changes. Like other project changes, contract changes need to be analyzed for their impacts on all project constraints.

You should be aware of the concept of constructive changes, which do not result from formal change requests. Rather, constructive changes occur when the buyer, through actions or inactions, limits the seller's ability to perform the work according to the contract. This can include over-inspection or failure to hold up their end of the contract (e.g., failing to review documents or inspect deliverables on time). A simple direction to the contractor to perform certain work that may seem minor can result in a constructive change that adds costs if that change is outside the scope of the contract.

Throughout the process of managing an active procurement, data on the contract and contract performance by both the buyer and the seller is gathered and analyzed. Because a contract is a formal, legal document, thorough records must be kept. A records management system may be used to keep procurement documentation complete, organized, and accessible. Record keeping can be critical if procurement-related actions are questioned after the procurement is completed, such as in the case of unresolved claims or legal actions. Records may also be necessary to satisfy insurance requirements. For many projects, every email, every payment, and every written and verbal communication must be recorded and stored. On other projects, information about the weather and the number of people on the buyer's property each day may be recorded. On large or complex projects, a records management system can be quite extensive and can require a person just to update it, including indexing, archiving, and information retrieval systems.

Finally, procurements are closed as they are completed or terminated. All procurements must be closed out, no matter the circumstances under which they stop, are terminated, or are completed. Closure is a way to accumulate some added benefits, such as lessons learned. It provides value to both the buyer and

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the seller and should not be omitted under any circumstances. Closing a procurement consists of tying up all the loose ends, verifying that all work and deliverables are accepted, finalizing open claims, and financial closure. The buyer provides the seller with formal notice that the contract has been completed. There may be some obligations, such as warranties, that will continue after the procurement is closed.

Procurements are closed:

- When a contract is completed
- When a contract is terminated before the work is completed

Many people who are new to procurement do not realize a contract can be terminated before the work is complete. The contract should have provisions for termination, which can be done for cause or for convenience.

When many changes to a procurement are required, it may be best to terminate the contract and start fresh by negotiating a new contract with the existing seller or by finding a new seller. This is a significant step that should be taken only when the existing contract no longer serves the purposes of defining all the work, roles, and responsibilities.

The buyer may terminate a contract for cause if the seller breaches the contract (does not perform according to the contract). This illustrates another reason the contract should clearly identify all the work required by the buyer. The buyer can also terminate the contract before the work is complete if they no longer want the work done (termination for convenience). Sellers need to realize this can happen.

A seller is rarely allowed to terminate a contract, but it could be appropriate on some projects. In any case, termination can result in extensive negotiations on what costs the buyer will pay. This is controlled by the language of the contract. In a termination for convenience, the seller is usually paid for work completed and work in process. If the contract is terminated for cause due to a default, the seller is generally paid for completed work but not for work in process. The seller may also be subject to claims from the buyer for damages. In any case, termination is a serious issue, and one that has lasting effects on the project. Termination negotiations can be drawn out long after the work has stopped—highlighting yet another reason why details of the project must be documented on an ongoing basis.

TRICKS OF THE TRADE® Some people mistakenly think that the process of closing procurements is part of closing a project or phase. This comes up on the exam. Think of project closure as closing out a project or phase and procurement closure as closing only that particular part of scope that you have procured through a third party. Keep the following tricks in mind:

- There may be many procurements in one project, so there can be many procurement closures, but closing a project or phase only happens at the end of the project or phase. Procurements must be closed as part of managing procurements, separate from and before final project closure.
- Upon completion of the contract for each procurement, the project manager performs a process audit on the contract and the seller's performance before closing out the procurement. When the project as a whole is completed later, the project manager performs the final administrative and financial closure along with other processes required to close out the project.
- Read questions carefully. There may be questions that ask about the frequency of project closure or procurement closure. The way the questions are written will help you select the right answer. For projects that are managed in phases, such as a design phase, testing phase, and installation phase, closing the project or phase occurs at the end of each project phase as well as at the end of the project as a whole. In contrast, procurement closure is done at the completion of each contract.
- To protect the legal interests of both parties, procurement closure requires detailed record keeping and must be done more formally than is generally required for project closure.

Now let's think about the real world. What do you think needs to be done at the end of the procurement in order to say the procurement is indeed finished? Wouldn't it be substantially similar to what needs to be done when you close out a project in the Close Project or Phase process?

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12.10 Exercise In your Exercise Notebook, describe what work must be done during procurement closure.

Answer As you read the answer, think about how similar closing procurements is to the Close Project or Phase process. Procurement closure includes all the following:

- **Product validation** This involves you, the buyer, validating and formally accepting (signing off on) the portion of project scope the seller is providing. It includes checking to see if all the work and documentation was completed correctly and satisfactorily.
- **Procurement negotiation** The final settlement of all claims, invoices, and other issues may be handled through negotiations or through the dispute resolution process established in the contract.
- **Financial closure** Financial closure includes final payments and cost records.
- **Procurement process audit** This is a structured review of the procurement process and capturing lessons learned. The resulting documentation becomes part of the organizational process assets. Normally this is done by the procurement manager and project manager, but companies that want to improve their processes may also involve the seller.
- **Updates to records** This involves making sure all records of the procurement are complete and accessible. These records will become part of the procurement file (described later in this discussion).
- **Final contract performance reporting** Think of this as creating a final report reflecting the success and effectiveness of the procurement and the seller.
- **Procurement file** Finalizing the procurement file involves putting all emails, letters, conversation records, payment receipts, reports, and anything else related to the procurement into an organized file. This file will be stored for use as historical records. The project manager, with the help of the procurement manager, decides what documents need to be kept.
- **Other** Procurement closure could also include arranging for storage of procurement records and drawings, creating and delivering legal documents, or returning property used for the procurement to its owner.

Expect questions on the exam that describe a situation and require you to determine whether the procurement is closed. In gaining formal acceptance, the seller is also working to measure customer satisfaction. Note also that the Close Project or Phase process includes confirmation that contract closure has been done satisfactorily.

Test your knowledge by completing the following exercise. Notice the word "actions" within this exercise. For the exam, you need to know what needs to be done during each step as well as what you have when you are done with a process (outputs or outcomes). This is an important exercise for ensuring that you can successfully answer procurement questions on the exam.

12.11 Exercise The Procurement Process Recreate the procurement management process by making a list in your Exercise Notebook of the key actions and of the key outputs for each of the following processes:

- Plan Procurement Management
- Conduct Procurements
- Control Procurements

The answers to this exercise are listed after the next Trick of the Trade. If you have missed many of the answers, do this exercise a second time after reviewing the material.

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TRICKS OF THE TRADE Here is a trick for understanding the process without memorizing the whole thing—know only the outputs! If a question describes some activity and that activity occurs after the procurement documents are created and before the contract is signed, then it must be taking place as part of the Conduct Procurements process. If it is taking place during the time after the contract is signed through when the work is substantially done, it must be occurring during the Control Procurements process.

12.11 Answer The following actions and outputs are the ones you should give the most attention to when preparing for the exam.

Plan Procurement Management	Conduct Procurements	Control Procurements
	Key Actions	
• Perform make-or-buy analysis. • Create a procurement management plan. • Create a procurement strategy for each procurement. • Create a procurement statement of work for each procurement. • Select the appropriate contract type. • Create terms and conditions, including standard and special conditions. • Create bid documents. • Determine source selection criteria. • Gather and analyze data on prospective sellers, the market, and market price. • Estimate time and cost for contract and work.	• Find potential sellers through advertising, a preapproved seller list, or other means. • Send procurement documents. • Hold a bidder conference. • Answer sellers' questions. • Receive the seller responses. • Compare the proposals to the source selection criteria using a weighting or screening system to pick/shortlist the sellers. • Receive presentations from seller(s). • Compare to independent estimates. • Hold negotiations. • Use interpersonal and team skills, such as negotiation. • Allocate risk to sellers when appropriate.	• Understand the legal implications of your actions. • Hold procurement performance reviews. • Request changes. • Administer claims. • Manage interfaces among sellers. • Monitor, analyze, and report on performance against the contract. • Review cost submittals, and make payments. • Perform inspections and audits. • Maintain records of everything. • Manage relationships. • Accept verified deliverables. • Perform procurement audits. • Negotiate settlements. • Create lessons learned. • Complete final contract performance reporting. • Validate the product. • Issue formal acceptance. • Update records. • Create a procurement file. • Perform financial closure.

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Plan Procurement Management	Conduct Procurements	Control Procurements
	Key Outputs	
• Make-or-buy decisions • Procurement management plan • Procurement statements of work • Procurement strategies • Bid documents • Selected contract type • Source selection criteria • Change requests • Independent contract estimates	• Selected sellers • Signed contracts • Resource calendars • Change requests • Project management plan updates • Project documents updates • Recommendations and updates to the processes and procedures for organizational procurement practices • Organizational process assets updates	• Substantial completion of contract requirements and deliverables • Work performance information • Change requests • Project management plan updates • Project documents updates (including updates to procurement documents) • Organizational process assets updates • Formal acceptance • Closed procurements • Lessons learned and records updates

12.12 Exercise Here is another exercise to review what was discussed in this chapter. To pass the exam, you must understand the project manager's role in procurements. After reading this chapter, describe the project manager's role. Write the answer in your Exercise Notebook.

Answer As the project manager, you should:

- Know the procurement process so you integrate all procurements into your project.
- Understand what contract terms and conditions mean so you can read and understand contracts.
- Make sure the contract contains all the scope of work and all the project management requirements, such as attendance at meetings, reports, actions, and communications deemed necessary to minimize problems and miscommunications with the seller(s).
- Identify risks and incorporate mitigation and allocation of risks into the contracts to decrease project risk.
- Help tailor the contract to the unique needs of the project while it is being written.
- Include adequate time in the project schedule to complete the procurement process.
- Be involved during contract negotiations to protect the relationship with the seller.
- Protect the integrity of the project and the ability to get the work done by making sure the procurement process goes as smoothly as possible.
- Help make sure all the work in the contract is done—including reporting, inspections, and legal deliverables, such as the release of liens and ownership of materials—not just the technical scope.

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- Do not ask for something that is not in the contract without making a corresponding change to the contract.
- Work with the procurement manager to manage changes to the contract.

That is the procurement process! Was a lot of this new to you? If you are inexperienced in working with procurements, reread this chapter, and try to visualize how the different topics apply to a large project. Then visualize how it might work on other types of projects. This will help you understand the process better.

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Practice Exam

1. Once signed, a contract is legally binding unless:
   A. One party is unable to perform.
   B. One party is unable to finance its part of the work.
   C. It is in violation of applicable law.
   D. It is declared null and void by either party's legal counsel.

2. You are preparing procurement documents for the building of a community center. There will be government standards, guidelines, and possibly regulations involved. You need to structure the procurement documentation in order to get proposals from qualified prospective sellers interested in doing business on a particular project. All the following statements concerning procurement documents are incorrect except:
   A. Well-designed procurement documents can simplify comparison of responses.
   B. Procurement documents must be rigorous with little flexibility to allow consideration of seller suggestions.
   C. In general, procurement documents should not include selection criteria.
   D. Well-designed procurement documents do not include a procurement statement of work.

3. You are advising another project manager who is starting his first agile project. In addition to the development team, he would like to use subcontractors for some parts of the work, but he isn't sure how to define the acceptance criteria. Which statement would you advise him to include in the contracts?
   A. "The completed deliverables must be fit for business purpose."
   B. "The delivery date may vary as long as all the required scope is completed."
   C. "The completed deliverables must match the original specification."
   D. "The quality of the completed deliverables must pass UI testing."

4. Your organization is transitioning to an agile approach. You have been asked to review the company's existing standard procurement contracts and revise them as needed to reflect the new project approach. What is one of the key adjustments you want to make?
   A. Reduce the time allowance for meetings and planning activities with the team
   B. Add more flexibility for adjusting the iterative delivery deadlines
   C. Increase the customer's involvement in prioritizing and reviewing the deliverables
   D. Improve the standards for providing clear, detailed specifications

5. A project manager for the seller is told by her management that the project team should do whatever possible to be awarded incentive money. The primary objective of incentive clauses in a contract is to:
   A. Reduce costs for the buyer.
   B. Help the seller control costs.
   C. Synchronize objectives.
   D. Reduce risk for the seller by shifting risk to the buyer.

6. All the following statements about change control are incorrect except:
   A. A fixed-price contract will minimize the need for change control.
   B. Changes seldom provide real benefits to the project.
   C. Contracts should include procedures to accommodate changes.
   D. More detailed specifications eliminate the causes of changes.

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7. A routine audit of a cost-reimbursable (CR) contract determines that overcharges are being made. If the contract does not specify corrective action, the buyer should:
   A. Continue to make project payments.
   B. Halt payments until the problem is corrected.
   C. Void the contract and start legal action to recover overpayments.
   D. Change the contract to require more frequent audits.

8. Buyers and sellers have many common goals, but some goals of the buyer will not benefit the seller. Likewise, the seller will sometimes have goals that conflict with those of the buyer. These could negatively affect the project if contracts are not negotiated appropriately. The primary objective of contract negotiations is to:
   A. Get the most from the other side.
   B. Protect the relationship.
   C. Get the highest monetary return.
   D. Define objectives and stick to them.

9. A seller is working on a cost-reimbursable (CR) contract when the buyer decides he would like to expand the scope of services and change to a fixed-price (FP) contract. All the following are the seller's options except:
   A. Completing the original work on a cost-reimbursable basis and then negotiating a fixed price for the additional work
   B. Completing the original work and rejecting the additional work
   C. Negotiating a fixed-price contract that includes all the work
   D. Starting over with a new contract

10. You are working to plan procurements for a project that will develop a prototype cruise ship. The prototype will be tested, perfected, and then used to create a small fleet. In addition to creating a procurement management plan, you must put together bid documents describing the project needs and the criteria that will be used to select a seller. Which of the following will occur during this project's Plan Procurement Management process?
   A. Make-or-buy decisions
   B. Answering sellers' questions about the bid documents
   C. Advertising
   D. Proposal evaluation

11. Which of the following is the best thing for a project manager to do in the Conduct Procurements process?
   A. Evaluate risks
   B. Select a contract type
   C. Perform market research
   D. Answer sellers' questions about the procurement documents

12. The sponsor is worried about the seller deriving extra profit on the cost plus fixed fee (CPFF) contract. Each month he requires the project manager to submit CPI calculations and an analysis of the cost to complete. The project manager explains to the sponsor that extra profits should not be a worry on this project because:
   A. The team is making sure the seller does not cut scope.
   B. All costs invoiced are being audited.
   C. There can only be a maximum 10 percent increase if there is an unexpected cost overrun.
   D. The fee is only received by the seller when the project is completed.

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13. Your CFO has decided to switch to graduated fixed-price contracts for change-driven initiatives. On your projects, you've been working with the same subcontractor for five years under a standard fixed-price contract. The sales rep tells you they are concerned about this contract change and wondering if they can afford to accept any more work from you. How do you explain the change to her?
    A. You will get shorter assignments, but your hourly rate will be higher, making the work more profitable.
    B. Your hourly rate will be higher if you deliver before your deadline, and lower if you deliver after it.
    C. You will have to pay all your own costs now, but your hourly rate will be higher to compensate for that.
    D. Your hourly rate will be lower, but if you get the work done early, you will receive a big bonus fee.

14. You are considering using a fixed-price (FP) contract because you have well-defined requirements for your construction project. With your requirements and your understanding of the seller's competition, you are confident you will be able to establish a complete statement of work. The fee or profit in this type of contract is:
    A. Unknown
    B. Part of the negotiation involved in paying every invoice
    C. Applied as a line item to every invoice
    D. Determined with the other party at the end of the project

15. As part of closing a cost-reimbursable contract on a project, what must the buyer remember to do?
    A. Decrease the risk rating of the project.
    B. Audit seller's cost submittals.
    C. Evaluate the fee she is paying.
    D. Make sure the seller is not adding resources.

16. The sponsor and the project manager are discussing what type of contract the project manager plans to use on the project. The sponsor points out that the performing organization paid a design team a lot of money to come up with the design. The project manager is concerned that the risk for the buyer be as small as possible, and recommends a fixed-price contract. An advantage of a fixed-price contract for the buyer is:
    A. Cost risk is lower.
    B. Cost risk is higher.
    C. There is little risk.
    D. Risk is shared by all parties.

17. As the buyer in an agile contracting environment, what key consideration should you bear in mind when negotiating procurement contracts?
    A. Make sure the seller is satisfied with their compensation, to promote trust and collaboration.
    B. As a servant leader, motivating and encouraging the development team should be your first priority.
    C. Offer a financial bonus to compensate the seller for the higher risk involved in an agile setting.
    D. Provide a clear way to communicate the evolving scope and acceptance criteria to the seller.

18. You are trying to make sure all records from the procurement are documented and indexed. Which of the following do you not have to worry about?
    A. Proposal
    B. Procurement statement of work
    C. Terms and conditions
    D. Negotiation process

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19. A project has a tight budget when you begin negotiating with a seller for a piece of equipment. The seller has told you the equipment price is fixed. Your manager has told you to negotiate the cost with the seller. Your assessment is that the piece of equipment has been offered at inflated pricing. What is your best course of action?
    A. Make a good faith effort to find a way to decrease the cost.
    B. Postpone negotiations until you can convince your manager to change his mind.
    C. Hold the negotiations, but only negotiate other aspects of the project.
    D. Cancel the negotiations.

20. Which of the following is an advantage of centralized contracting?
    A. Increased expertise
    B. Easier access
    C. The project manager doesn't have to be involved
    D. More loyalty to the project

21. Your company has an emergency and needs contracted work done as soon as possible. Under these circumstances, which of the following would be the most helpful to add to the contract?
    A. A clear procurement statement of work
    B. Requirements as to which subcontractors can be used
    C. Incentives
    D. A force majeure clause

22. You are the project manager of a relatively small project to build out improvements to a small shop in a pedestrian mall. The project is using a time and material contract, and you know you must be involved in negotiations. Which of the following is an advantage of a time and material contract?
    A. A time and material contract is less work for the buyer to manage.
    B. The seller has a strong incentive to control costs.
    C. The total price is known.
    D. Negotiations are less extensive.

23. The project team is assessing the responses of prospective sellers who have submitted proposals. One team member argues for a certain seller while another team member wants the project to be awarded to a different seller. What part of the procurement process is the team in?
    A. Plan Procurement Management
    B. Control Procurements
    C. Negotiate Contracts
    D. Conduct Procurements

24. A project manager is in the middle of creating a request for proposal (RFP). What part of the procurement process is he in?
    A. Conduct Procurements
    B. Plan Procurement Management
    C. Administer Procurements
    D. Make-or-Buy Analysis

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25. Your program manager has advised that you need to protect the organization from financial risk. In planning a new project, you realize there is limited scope definition related to the work needed to fulfill the contract. What is the best type of contract to choose?
    A. Fixed-price (FP)
    B. Cost plus percentage of cost (CPPC)
    C. Time and material (T&M)
    D. Cost plus fixed fee (CPFF)

26. Negotiations between two parties are becoming complex, so Party A makes some notes that both parties sign. However, when the work is being done, Party B claims they are not required to provide an item they both agreed to during negotiations, because it was not included in the subsequent contract. In this case, Party B is:
    A. Incorrect, because both parties must comply with what they agreed on
    B. Correct, because there was an offer
    C. Generally correct, because both parties are only required to perform what is in the contract
    D. Generally incorrect, because all agreements must be upheld

27. Your project has just been fast tracked, and you are looking to quickly bring in a subcontractor to complete networking. There is no time to issue a request for proposal (RFP), so you choose to use a company you have used many times before for software development. A primary concern in this situation is:
    A. Collusion between subcontractors
    B. The subcontractor's qualifications
    C. The subcontractor's evaluation criteria
    D. Holding a bidder conference

28. The project manager, the procurement manager, and the project sponsor are discussing the project costs and whether it is better to have their own company do some of the project work or hire another company to do all the work. Generally, it would be better for the organization to do the work internally if:
    A. There is a lot of proprietary data.
    B. You have the expertise, but you do not have the available manpower.
    C. You do not need control over the work.
    D. Your company resources are limited.

29. After much hard work, the procurement statement of work for the project is completed. However, even after gaining agreement that the procurement statement of work is complete, the project manager is unsure of whether it actually addresses all the buyer's needs. The project manager is about to attend the bidder conference. He asks you for advice on what to do during the session. Which of the following is the best advice you can give him?
    A. You do not need to attend this session; the procurement manager will hold it.
    B. Make sure you negotiate project scope.
    C. Make sure you give all the sellers the opportunity to ask questions.
    D. Let the project sponsor handle the meeting so you can be the good guy in the negotiation session.

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30. A seller is awarded a contract to build a pipeline. The contract terms and conditions require a work plan to be issued for the buyer's approval prior to commencing work, but the seller fails to provide one. Which of the following is the best thing for the buyer's project manager to do?
    A. File a letter of intent.
    B. Develop the work plan and issue it to the seller to move things along.
    C. Issue a default letter.
    D. Issue a stop work order to the seller until a work plan is prepared.

31. Procurement closure is different from the Close Project or Phase process in that procurement closure:
    A. Occurs before Close Project or Phase
    B. Is the only one to involve the customer
    C. Includes the return of property
    D. May be done more than once for each contract

32. You have just started work on a procurement when management decides to terminate the contract. What should you do?
    A. Go back to the Plan Procurement Management process.
    B. Go back to the Conduct Procurements process.
    C. Complete the Control Procurements process.
    D. Stop working, and consider the procurement finished.

33. The project team is considering the prospective sellers who have submitted proposals. One team member supports a certain seller while another team member wants the project to be awarded to a different seller. The project manager should remind the team that the best thing to focus on in order to make a selection is the:
    A. Procurement documents
    B. Procurement audits
    C. Source selection criteria
    D. Procurement management plan

34. The $800,000 contract specifies that the seller will bill the buyer at $10,000 per month. However, the seller is able to complete the project work faster than planned. Therefore, they bill the buyer for $15,000 for the work performed in the past month. The buyer should:
    A. Send a breach of contract notice.
    B. Pay the invoice, as they will save on future payments.
    C. Meet with the seller to discuss the overcharge.
    D. Adjust the contract to allow for variations in monthly billings.

35. You are the project manager at a software development company, leading a project to develop an innovative application for a client. The project has followed a strict software engineering process. The requirements have been specified in detail, resulting in extensive functional and technical specification documents. Your project team member delivers an interim project deliverable to the buyer. However, the buyer refuses the deliverable, stating it does not meet the requirement on page 300 of the technical specifications. You review the document and find that you agree. What is the best thing to do?
    A. Explain that the contract is wrong and should be changed.
    B. Issue a change order.
    C. Review the requirements, and meet with the responsible team member to review the WBS dictionary.
    D. Call a meeting of the team to review the requirement on page 300.

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36. Your organization has recently been informed that several of the regulations related to how your products are manufactured will change in six months. In planning for work to change certain design and production processes, you determine you will need to work with several external organizations to do the work. Which type of contract do you not want to use if you do not have enough help to audit invoices?
    A. Cost plus fixed fee (CPFF)
    B. Time & material (T&M)
    C. Fixed-price (FP)
    D. Fixed price incentive fee (FPIF)

37. A new project manager is about to begin creating the procurement statement of work. One stakeholder wants to add many items to the procurement statement of work. Another stakeholder only wants to describe the functional requirements. The project is important for the project manager's company, but a seller will do the work. How would you advise the project manager?
    A. The procurement statement of work should be general, to allow the seller to make their own decisions.
    B. The procurement statement of work should be general, to allow for clarification later.
    C. The procurement statement of work should be detailed, to allow for clarification later.
    D. The procurement statement of work should be as detailed as necessary for the type of project.

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Answers

1. **Answer** C
   Explanation Once signed, a contract is binding to both sides. Contracts typically state that either side can choose to terminate the agreement by negotiating a settlement based on work already performed. Generally, the inability to perform or get financing, or one party's belief that the contract is null and void does not change the fact that the contract is binding. If, however, both sides agree to terminate the contract, the contract can move into closure. An illegal contract is not enforceable.

2. **Answer** A
   Explanation Often, the seller is required to inform the buyer of anything that is missing or unclear in the procurement documents. It is in the buyer's best interest to discover missing items, since it will save the buyer money and trouble to correct the problem early. Procurement documents must include terms and conditions and selection criteria, as well as documentation of all the work that is to be done (which includes the procurement statement of work). This is so the seller can price the project and know what is most important to the buyer. Well-designed procurement documents can simplify comparison of responses. This is an important point and is the best answer.

3. **Answer** A
   Explanation: Agile prioritizes delivering value, but the specific definition of that value is likely to change over the course of a project. So the best option here would be to simply require that the completed deliverables be fit for business purpose. To ensure this, the project manager will need to have ongoing communication and collaboration with the subcontractors. While successful testing might be a requirement, this broader statement would cover that, as well as any other criteria related to quality, scope, or timely delivery. Agile doesn't focus on working to the original specification. In an uncertain project environment, the true requirements aren't known upfront; they emerge as the work is being done. Agile doesn't prioritize scope over schedule, in fact on an agile project usually the opposite is the case—typically, the scope may vary but the deadline is fixed.

4. **Answer** C
   Explanation Of these options, the only global change that would make a plan-driven standard contract "more agile" would be to increase the customer's involvement in prioritizing and reviewing the deliverables. The time allowance for meetings and planning activities shouldn't be reduced until you have more experience with the new approach—if anything, an agile approach will require more planning and collaboration, not less. (Although less planning will be done upfront, more planning will be needed while the work is in progress.) Since agile projects rely on timeboxes with fixed end dates, there shouldn't be any need to adjust the iterative delivery deadlines. Change-driven projects in an uncertain environment evolve the requirements as the work proceeds; they don't rely on detailed specification.

5. **Answer** C
   Explanation Incentives are meant to bring the objectives of the seller in line with those of the buyer, so both are working toward the same objective.

6. **Answer** C
   Explanation There are always good ideas (changes) that can add benefit to the project, regardless of the contract type. Although detailed specifications may reduce the need for changes, they do not eliminate all the causes. Contracts should include procedures to accommodate changes.

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7. **Answer** A
Explanation Halting all payments would be a breach of contract on the buyer's part. Voiding the contract and beginning legal action is too severe and cannot be done unilaterally. Changing the contract to require more frequent audits does not solve the problem presented. A choice that said, "Halt payments on the disputed amount" would probably be the best answer, but it is not offered. The best choice available is to continue to make the payments while working to resolve the issue.

8. **Answer** B
Explanation As a project manager, you want to develop a good relationship during negotiations that will last throughout the project. Negotiations are not about getting the most from the other side (win-lose), as such actions will not create a good relationship. That doesn't mean, however, the buyer sacrifices what is best for the organization.

9. **Answer** D
Explanation The seller can try to negotiate changes or simply continue the original contract and refuse requests to complete additional work, but the seller cannot unilaterally decide to start over with a new contract. Both parties have to agree to this option through negotiations.

10. **Answer** A
Explanation Answering sellers' questions, advertising, and proposal evaluation occur during the Conduct Procurements process. Make-or-buy decisions are made earlier—in the Plan Procurement Management process.

11. **Answer** D
Explanation Risk analysis is done before the Conduct Procurements process begins, as procurement is a risk mitigation and transference tool. Selecting a contract type is part of Plan Procurement Management. Market research is also performed in the Plan Procurement Management process, to enable selection of the appropriate sellers for the needs of the project. During the Conduct Procurements process, the project manager answers questions submitted by prospective sellers.

12. **Answer** B
Explanation Cutting scope decreases profits on this type of contract, so that would not be a way for the seller to generate extra profits. CPFF contracts generally do not limit fee increases. The fee in a CPFF contract is usually paid out on a continuous basis during the life of the project. One of the ways to change the profit in a cost plus fixed fee contract is to invoice for items not chargeable to the project. This would not be ethical by the seller but does not mean that a seller may not try it. Therefore, all invoiced costs should be audited.

13. **Answer** B
Explanation In a graduated fixed-price contract, the hourly rate that the supplier receives depends on how quickly they complete the work. If the supplier delivers early, they get paid for fewer hours but at a higher rate. If they deliver on time, they get paid for the hours worked at their standard rate. If they deliver late, they get paid for more hours, but at a lower rate. The other answer options don't describe this type of contract.

14. **Answer** A
Explanation The fee or profit is known to the seller, but this question is asked from the buyer's perspective. The buyer does not know what profit the seller included in the response to the bid document and, therefore, will not know the profit in the fixed-price contract.

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15. **Answer** B
Explanation Although a reserve might be decreased for the overall project when one of its procurements enters closure, the risk rating of the project is generally not affected. Evaluation of the fee should have been done during the Conduct Procurements process. Making sure the seller does not add resources should not be necessary, as the contracted work has been completed. Auditing the seller's cost submittals is a required aspect of the Control Procurements process.

16. **Answer** A
Explanation If you had trouble with this one, you need to remember that the questions are asked from the buyer's perspective unless otherwise noted. The seller has the most cost risk in a fixed-price contract, and the buyer's risk is lower because the buyer will not pay more if the seller does not control costs. The seller has the risk; if they do not control the costs, they could erode the profit margin and even lose money.

17. **Answer** D
Explanation One of the key challenges for a buyer in an agile contracting environment is finding an effective way to share the evolving scope and acceptance criteria with the seller while the work is being done. From an agile standpoint, it's important to have a win-win relationship, where both parties are satisfied with the agreement. This doesn't necessarily mean paying the seller more, since (as with any contract) it is important to balance the seller's profit and the buyer's cost. In general, the seller shouldn't be subject to higher risk just because the project is change-driven; any contract should have provisions for early termination that are acceptable to the seller. A servant leader will always prioritize motivating and encouraging their development team, but that isn't a big consideration for negotiating procurement contracts.

18. **Answer** D
Explanation The negotiation process is not a document. The proposal, procurement statement of work, and the contract terms and conditions are all records that need to be documented and indexed.

19. **Answer** A
Explanation The best choice is to attempt to find a way to decrease the cost.

20. **Answer** A
Explanation Centralized contracting refers to a situation in which a procurement department exists to oversee procurements across the entire organization. Because there may be many procurements going on simultaneously, it may be difficult to get access to the procurement manager. As their attention is divided between multiple contracts, the procurement manager has less loyalty to any one project. Even with the procurement department leading a procurement, the project manager must participate in the process, so that is not an advantage. Increased expertise of the procurement manager is an advantage of centralized contracting.

21. **Answer** C
Explanation If you follow the proper project management process, you always have good definition of scope (in this case, the procurement statement of work). In this situation, both good scope definition and incentives are required. Along with good scope definition, you need the seller to share your need for speed. Incentives bring the seller's objectives in line with the buyer's and thus would be the most helpful. Good scope definition alone does not ensure speed.

22. **Answer** D
Explanation Negotiation of a time and material contract is generally less extensive than negotiation of other contract types. The other choices are advantages of a fixed-price contract.

23. **Answer** D
Explanation Selected sellers are an output of the Conduct Procurements process.

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24. **Answer** B
Explanation Bid documents are created during the Plan Procurement Management process. The request for proposal is one of those documents, so the project manager is in the Plan Procurement Management process.

25. **Answer** D
Explanation Of the options given, the only contract that limits fees for large projects with limited scope definition is cost plus fixed fee.

26. **Answer** C
Explanation Party B is only required to deliver what is defined in the contract. The subsequent contract would usually have a clause negating all prior agreements or understandings. Even if there was no such provision, even if the notes constituted an agreement it would be considered modified by the subsequent written agreement (contract).

27. **Answer** B
Explanation Although you have used this contractor before, how can you be sure the company is qualified to do the new work, since it is not exactly like the previous work? This is the risk you are taking.

28. **Answer** A
Explanation It is generally better to do the work yourself if using an outside company means you have to lose control or ownership of proprietary data to the other company.

29. **Answer** C
Explanation The project manager should attend the bidder conference, although the procurement manager may lead it. Did you select negotiating scope? Sellers may ask questions about scope during the conference, but negotiations occur after the bidder conference, when the buyer selects one or more sellers with whom to negotiate. Allowing ample opportunity for all the prospective sellers to ask questions is one of the many challenges of a bidder conference. They may not want to ask questions while their competitors are present.

30. **Answer** C
Explanation When a seller does not perform according to the contract terms and conditions, they have defaulted and the project manager must take action. You might prefer a choice to investigate the default by contacting the seller and asking what is going on, but that choice is not available here. You must send the formal written notice as soon as you become aware of the default so that you do not give up any right to receive the work plan in the future. You can contact the seller for a discussion as the second thing you do. Therefore, the best choice is to let the seller know they are in default. The default notification letter will instruct the seller to meet the performance requirement.

31. **Answer** A
Explanation The customer may be involved in lessons learned and procurement audits, and would certainly be involved in formal acceptance. Both procurement closure and the Close Project or Phase process involve the return of property. Procurement closure is done once for each procurement, at the end of the contract. All procurements are closed before the project is closed.

32. **Answer** C
Explanation Even if the contract is terminated before completion, the procurement needs be closed out. The results of the procurement and its documentation are archived as historical records in the Control Procurements process.

33. **Answer** C
Explanation The source selection criteria are the primary tool for evaluating potential sellers and should be used by the team in order to make a selection.

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34. **Answer** A
Explanation By paying the additional amount of this month's invoice, the buyer may waive the right to limit monthly costs to $10,000. The project has allocated $10,000 per month for this seller, and the buyer may not have the capacity to pay more each month. By agreeing to the terms of the contract, the seller is contractually obligated not to exceed that amount. A breach of contract notice from the buyer to the seller is the best way to handle this situation.

35. **Answer** C
Explanation This question is written from the perspective of the seller. The contract could be wrong or the customer could be wrong, but this should have been discovered earlier if proper project management was followed. A seller cannot issue a change order (although they could request one). Did you select calling a meeting of the team? If so, remember that proper project management does not mean making every decision with all the team members. The best choice involves reviewing the requirements documentation and meeting with the appropriate team member. If such a problem has arisen, it could mean something was wrong in the WBS dictionary or in how the team member completed the work.

36. **Answer** A
Explanation If you got this question wrong, reread it. You need to audit invoices in all contract types, so how do you choose? Look for the answer that is best. In this case, it would be the choice that requires the greatest effort. A T&M contract should be used for low dollar and short duration contracts (remember that a T&M contract has no incentive to finish), so it does not have a high level of risk. FP and FPIF contracts cannot be best, because the risk to the buyer is limited. The buyer is still only going to pay the contracted price. In a CPFF contract, the buyer pays all costs. The seller could be charging the buyer for costs that should not be allocated to the buyer. Because of the size and dollar amount of this type of contract, and because the risk to the buyer is great, a CPFF contract requires the most auditing. In this case, you would not want to use a CPFF contract.

37. **Answer** D
Explanation When the seller has more expertise than the buyer, the procurement statement of work should describe performance or function rather than a complete description of work. In any case, the procurement statement of work should be as detailed as possible.

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Stakeholders

THIRTEEN

Some topics on the exam might seem easy to you—so much so that you might be inclined to skip studying them. Does the topic of stakeholders[1] fall into this category for you? Take note of an example of one person who failed the exam because he did not understand proper project management. His method of managing projects was simply to tell people what to do. And because he always worked with the same four people, he didn't think in terms of large projects (those that include hundreds or thousands of stakeholders) and how having so many stakeholders involved would significantly impact a project. In his job, he acted as both a project manager and a subject matter expert, assigning work to a small group of people as well as to himself. During the exam, he thought only in terms of his personal experience, rather than the best practices of project management.

QUICKTEST

- Stakeholder definition
- Stakeholder management process
- Stakeholder involvement
- Stakeholder analysis
- Stakeholder register
- Stakeholder expectations
- Stakeholder engagement
- Stakeholder engagement plan
- Stakeholder engagement assessment matrix
- Stakes
- Personas
- Retrospectives

In reality, the project manager needs to be the expert in project management, while relying on certain stakeholders to serve as experts in what needs to be done and how it should be accomplished. Also note that the project manager does not do all the work activities within a project—that is the job of the project team. The project manager facilitates, motivates, coordinates, and integrates all those work activities into a successful outcome. The person described in the previous paragraph didn't think this way; therefore, he answered questions incorrectly across all knowledge areas on the exam. His failure to understand the importance of planning, managing, and continuously evaluating stakeholder engagement had a huge impact on his understanding of project management.

What about you? Do you properly involve stakeholders on your projects? Have you had any complaints from key stakeholders about your projects? Your projects won't be successful without significant, continuous interactions with stakeholders. Your team can build a great product or service, but if you're not in close contact with the stakeholders who will use it, you may not realize you have missed the mark until it is too late. Likewise, for a shared understanding to take place, you must facilitate the building of highly effective team dynamics.

Let's think about another scenario. Imagine you're assigned as the project manager for a new project. The director of your department provides you with a scope of work and a charter, and tells you to get started. What do you do next? Before you answer that question—and before you take the exam—you need to understand a simple concept: project management requires you to identify all stakeholders, analyze their power, interest, and level of engagement, elicit their requirements and expectations, and then evaluate and incorporate all of that information into the product and project scope as needed. You cannot simply accept a scope of work or project charter without considering the project's stakeholders and their requirements. And stakeholder involvement doesn't end there: Engaging stakeholders should take place

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throughout the life of the project. This means you need to build and maintain positive relationships with stakeholders and make sure they continue to be involved in the project at the level necessary to make it a success.

Did you know that this level of stakeholder engagement may also be influenced heavily by project methodology?

Engaging stakeholders in product development by reviewing portions (demos) of the evolving product is a common adaptive approach that can be used by a project manager. In contrast, projects using traditional approaches have stakeholders review fully developed products. In either scenario, it is the responsibility of the project manager to engage stakeholders and maintain a positive relationship.

Showing interim deliverables comes with risks and rewards. People typically only feel comfortable sharing their work when it's fully developed. However, the opportunity to influence a design declines over time while the cost of change increases.

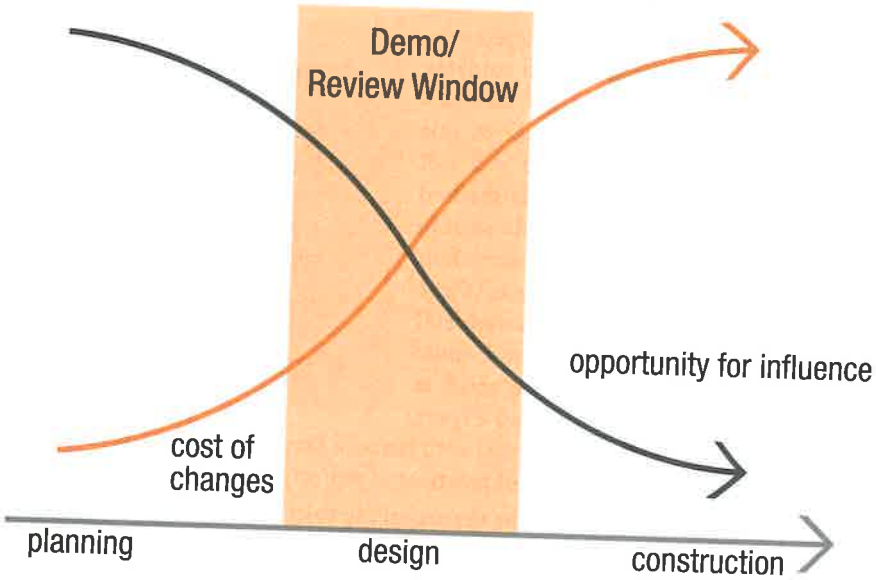

FIGURE 13.1 *The influence of a design*

When using this approach, project managers need to create a safe environment for the team, as feedback will need to be collected from team members without fear of criticism or reprisal for issues. Engaging with stakeholders in this way requires increased levels of trust and collaboration. Also note that this approach may decrease project costs and shorten the project schedule when changes, issues, or new requirements are discovered early in the project.

TRICKS OF THE TRADE If you have access to the *PMBOK® Guide*, review it for the word "stakeholders," and you will see just how many references occur. Think about whether the requisite involvement of stakeholders is different from what happens on your projects, and make note of your gaps.

For the exam, you need to understand the stakeholders process in the *PMBOK® Guide* as well as have a solid understanding of how the associated tasks within the *Examination Content Outline* (ECO) are related to stakeholder engagement.

The following tables should help you understand how stakeholder management fits into the overall project management process.

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PMBOK® Guide Stakeholder Management	Done During
Identify Stakeholders	Initiating process group
Plan Stakeholder Engagement	Planning process group
Manage Stakeholder Engagement	Executing process group
Monitor Stakeholder Engagement	Monitoring and controlling process group

ECO Domain I: People	Domain II: Process
Task 4: Empower Team Members and Stakeholders	Task 4: Engage Stakeholders
Task 9: Collaborate with Stakeholders	
Task 10: Build Shared Understanding	

These tables illustrate that the stakeholder management process from the *PMBOK® Guide* can be mapped to ECO tasks 4, 9, and 10 in domain I. Stakeholder management also maps to ECO task 4 in domain II. Can you see how other domain I tasks in the ECO lend support to these primary tasks? For example, Manage Conflict (task 1) may aid in task 10 (Build Shared Understanding), Engage and Support Virtual Teams (task 11) aids in task 4 (Empower Team Members and Stakeholders), and in fact you will not be able to Engage Stakeholders (domain II, task 4) at all if you haven't mastered the skills needed within domain I.

Stakeholder Involvement in Projects

Let's look at how you should involve stakeholders throughout the life of a project. Some of this discussion includes tasks and processes that fall outside stakeholder management. This demonstrates the important role stakeholders play in all aspects of projects.

So, what should you do with stakeholders throughout a project?

- **Identify all of them.** The first step in working with stakeholders is identifying all of them as early as possible. Stakeholders discovered later in the project will likely request changes, which can impact the project and lead to delays.
- **Determine their requirements.** The project manager must make every effort to obtain as many requirements as possible before work begins. This applies to both plan-driven and change-driven approaches, although the level of detail of the requirements may differ at different stages depending on the project life cycle. Do you try to do this on your real-world projects?

  To understand why this is important, think about the effects of starting a project without all the requirements. Those effects would likely include changes, delays, and possible failure. How would it look if you had to say to your sponsor, "I didn't know about that stakeholder's requirement. Now that I know, I need to extend the schedule to accommodate their needs or cut another stakeholder's needs out of the project." This is just bad project management, and can be avoided with proper stakeholder management.

  There are many ways to make sure you have the requirements—from just asking if you do, to conducting requirements reviews, to explaining to people what the negative consequences to the company and the project will be if a requirement is found later.
- **Determine their expectations.** What are expectations? They are beliefs about (or mental pictures of) the future. These expectations include what stakeholders think will happen to them, their department, and the company as a whole as a result of the project. Expectations tend to be much more ambiguous than stated requirements, or they may be undefined requirements. They may be intentionally or unintentionally hidden. For example, expectations that your project will not interrupt other work, or that your project will produce dramatic improvements could affect project success. Naturally,

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expectations that go unidentified will have major impacts across all constraints. Once captured, expectations are analyzed and may be converted to requirements and become part of the project.

A difference between what a stakeholder thinks will happen and what actually happens might cause conflicts, rework, and changes. Why wait for a change? Why not prevent as many changes as possible by asking stakeholders what they expect and clarifying any expectations that are not accurate or that are poorly defined? This might involve walking stakeholders through what will occur to make sure there are no undiscovered expectations or requirements that could be unrealistic.

- **Determine their interest.** It's important to determine the level of interest each stakeholder has in the project. Does the stakeholder care about the project? Are they likely to be engaged? Once you gather and analyze that information, you can use it to plan out a strategy for maintaining or increasing that stakeholder's interest and level of engagement. You may also find that certain stakeholders are especially interested in working on a particular part of the project—to learn new skills or prove their skills—or that you need attention and support from a key stakeholder for deliverable reviews and acceptance. A great project manager will determine each stakeholder's interests and engagement related to the project, and will structure the work, roles, and responsibilities to maximize engagement.
- **Determine their level of influence.** To some degree, each stakeholder will be able to negatively or positively affect a project. This is their level of influence, and it should be identified and managed.
- **Determine their level of authority.** Each stakeholder's level of authority will impact their effect on the work and outcome of the project.
- **Incorporate their values.** Project priorities should align with stakeholder priorities. Project managers should not plan or initiate work that the stakeholders do not support or value.
- **Plan to engage stakeholders.** Project management focuses on planning before taking action. You need to plan ahead! How will you keep stakeholders involved in the project? How will you engage with them about their interests, influence, and expectations? How will you include them in project decision-making?
- **Plan how you will communicate with them.** Planning communications with your stakeholders is critical and is related to stakeholder engagement. How can you keep stakeholders involved and get them to communicate their thoughts and concerns if you haven't planned out how information will be shared on the project? Remember that poor communications are the most frequent cause of problems on projects, so careful communication planning can help prevent problems.
- **Manage their expectations, influence, and engagement.** Involving stakeholders doesn't end during initiating or planning. You need to work with them and manage relationships throughout the life of the project.
- **Communicate with them.** Stakeholders are included in project presentations and receive project information, including progress reports, updates, changes to the project management plan, and changes to the project documents, when appropriate.
- **Monitor communications and stakeholder engagement.** Good communication and relationships with stakeholders are critical to success, so it's essential to monitor these two areas on the project. You need to determine if and where communication and/or relationships are breaking down, and then adjust your approach as necessary.

TRICKS OF THE TRADE A key to your success as a project manager is how you handle stakeholder relationships. Stakeholders must be involved, and their involvement must be managed by the project manager. That involvement may range from minor to extensive, depending on the needs of the project and the performing organization. In preparing for the exam, use the following list to help you evaluate your understanding of stakeholder involvement and identify any gaps that may impact how you answer questions. In your Exercise Notebook, check off the items you currently do in your project work. If you are unable to check two or more of the following items, you should spend more time studying this topic.

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How the Project Manager Should Involve Stakeholders on the Project

1. List all stakeholders by name; this can include individuals as well as groups.
2. Determine all the stakeholders' requirements.
3. Determine stakeholders' interest in being involved in the project and in the outcomes of the project.
4. Determine stakeholders' level of influence on the project.
5. Determine stakeholders' expectations, and turn them into requirements as appropriate.
6. Determine when stakeholders will be involved in the project and to what extent.
7. Get stakeholders to sign off that the requirements are finalized.
8. Assess stakeholders' knowledge and skills, and make the best use of their expertise.
9. Analyze the project to evaluate whether stakeholders' needs will be met.
10. Let stakeholders know which requirements will be met, which requirements and expectations will not be met, and why.
11. Get and keep stakeholders involved in the project by assigning them project work or responsibilities.
12. Manage and influence the stakeholders' involvement, engagement, and expectations.
13. Communicate to stakeholders what they need to know (when they need to know it).
14. Make sure stakeholders know what they need to communicate to the project manager and other stakeholders.
15. Involve stakeholders, as necessary, in change management and approval.
16. Involve stakeholders in the creation of lessons learned.
17. Negotiate project agreements with stakeholders.
18. Get stakeholders' sign-off and formal acceptance of interim deliverables during the project and at project or phase closing.
19. Reassess stakeholders' involvement, and make changes throughout the project as needed.
20. Engage with stakeholders in demonstrations of increments of product or service built to date.
21. Ensure a shared understanding of the project objectives, goals, deliverables, work, and acceptance criteria.
22. Ask stakeholders to let you know about problems in project communications and relationships.
23. Frequently discuss with stakeholders what "done" looks like.

Stakeholder Analysis PAGE 507

PMBOK® Guide
PG: Initiating
Process: Identify Stakeholders

The first stakeholders are likely those who identify a problem or need. They may be involved in developing business documents for a project to provide a solution. The business case and benefits management plan, created before project initiating, may include lists of stakeholders who will benefit from or be affected by the project. An ongoing, focused effort to identify stakeholders should continue from this point throughout the project.

ECO
Domain: I
Task: 9
Domain: II
Task: 4

Why is it so essential to identify all stakeholders? Any stakeholders who are missed will likely be found later. When they are discovered, they will probably request changes, which may cause delays. Changes made later in the project are much more costly and harder to integrate than those made earlier. Identifying all stakeholders helps to create a project that considers all the interests, influence, and interdependencies of

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stakeholders. That said, changes within a project or organization may introduce new stakeholders, or a project manager may simply miss stakeholders in the initial identification. It's important, therefore, to reassess the list of stakeholders throughout the project to determine whether new ones should be added and, if so, what that will mean for the project.

Many project managers fail to consider the broad range of potential stakeholders. Remember, stakeholders are any people or organizations whose interests may be positively or negatively impacted by the project or its product, as well as anyone who can exert positive or negative influence over the project. This diverse group can include the sponsor, the team, senior management, subject matter experts, end users of the product or service, other departments or groups within the organization, functional or operational managers, sellers, consultants, regulatory agencies, customers, financial institutions, and many more. If the project includes procurements, the parties to the contract(s) are also stakeholders.

Keep in mind that you don't need to do the work of identifying stakeholders alone. The project team should be involved in this process. You can also consult subject matter experts, project managers in the organization who have worked on similar projects, and professional associations. And as new stakeholders are identified, they may be able to suggest other stakeholders to add to the list.

The following tools and techniques can be used during the Identify Stakeholders process (which includes a complete stakeholder analysis).

Questionnaires and Surveys Stakeholders, team members, and subject matter experts may be asked to name other potential stakeholders and to provide input regarding management of particular stakeholders or stakeholder groups.

Brainstorming and Brain Writing[2] Participants may take part in brainstorming sessions to help identify additional stakeholders. Brain writing is an individual effort, while brainstorming involves a group of people interacting and working together.

Stakeholder Analysis There are many factors to consider when analyzing stakeholders. Consider their roles and responsibilities on the project, as well as their level of authority and influence within the organization. Every stakeholder has expectations and attitudes toward the project that must be uncovered. You must also determine how interested they are in the project. What is at stake for them?

Examples of stakes include the following:

- **Ownership** The stakeholder may have to sell property for the new freeway expansion that is proposed.
- **Knowledge** The stakeholder may be the expert who designed a legacy inventory management system that is being replaced.
- **Rights** The stakeholder may be concerned that the new development will endanger the community by destroying the watershed.
- **Rights** A government official may be responsible for ensuring that the safety practices on the construction site comply with state and federal laws.
- **Interest** The community may be concerned that additional traffic will come into their residential neighborhood if the new commuter rail stop does not have adequate parking facilities.
- **Contribution** The resource manager may be concerned that resource team members assigned to the project will not be able to complete their normal operational work with the addition of project work.

Document Analysis Using this technique involves assessing all project documents and reviewing any lessons learned as well as other historical information (organizational process assets) from past projects. This analysis can be used to identify stakeholders and to collect information about the stakeholders and their stakes in the project.

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Stakeholder Mapping In addition to analyzing each stakeholder's potential impact and influence, you need to identify ways to manage them effectively. Stakeholder mapping, which groups stakeholders into categories, is a data representation technique that project managers use to analyze and plan how the project team will build relationships with stakeholders. Creating a stakeholder map with categories and classifications can help you determine how to prioritize your efforts to engage stakeholders on the project.

The following are examples of stakeholder mapping:

- **Power/interest grid**[3] This grid is used to group stakeholders based on their level of power and their interest in the project's outcome. Variations of this tool emphasize other stakeholder attributes, such as power/influence or impact/influence. An example of this grid is shown in figure 13.2.
- **Stakeholder cube**[4] This three-dimensional model is used to represent aspects or dimensions of a stakeholder group. An example is shown in figure 13.3.
- **Salience model**[5] This model is used to group stakeholders based on the appropriateness of their involvement (legitimacy), their authority or ability to influence outcomes (power), and their need for immediate attention (urgency). An example of this model is shown in figure 13.4.

Stakeholders can also be grouped by directions of influence (upward, downward, outward, and sideward).

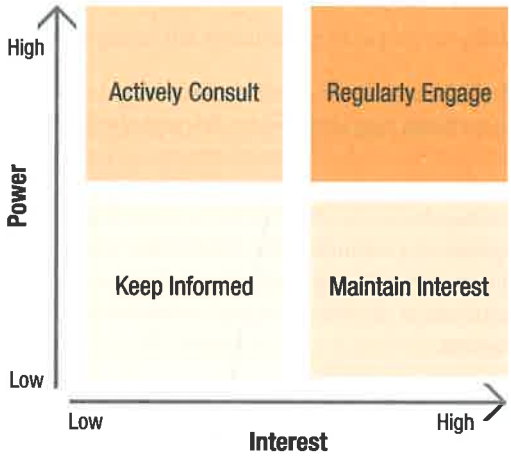

FIGURE 13.2 *Power/interest grid*

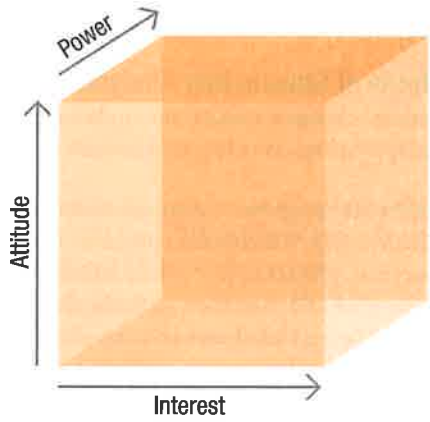

FIGURE 13.3 *Stakeholder cube*

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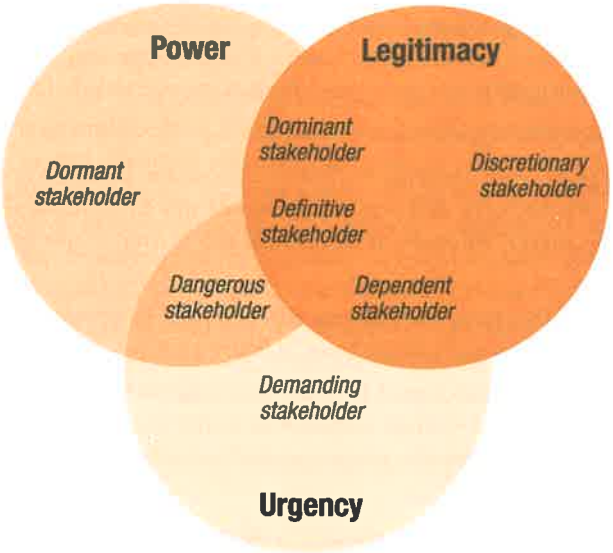

FIGURE 13.4 *Salience model*

Outputs of Stakeholder Analysis The Identify Stakeholders process results in a stakeholder register, personas, change requests, and updates to the project management plan and project documents such as the assumption log, issue log, and the risk register.

Stakeholder Register Information about stakeholders is compiled in the stakeholder register, a key output of the Identify Stakeholders process. The stakeholder register may include each stakeholder's name, title, supervisor, project role, contact information, major requirements and expectations, assessment information, impact and influence, attitude about the project, stakeholder classification, and other relevant information. Figure 13.5 shows an example of a stakeholder register.

Stakeholder Register

Project Title: _____ Project Number: _____

						Assessment Data Results			
ID	Name/Title	Contact Information	Major Requirements	Main Expectations	Roles/ Responsibilities	Influence (1 to 5)	Power (1 to 5)	Interest (1 to 5)	Classifications
1									
2									
3									
4									

FIGURE 13.5 *Sample stakeholder register*

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The stakeholder register is an important input to the Plan Stakeholder Engagement process, as well as to several other planning processes, including Plan Communications Management. Remember that the register will be added to and updated throughout the life of the project.

Personas[6] Personas are quick guides of key stakeholders on the project and their interests. Agile software projects, for example, commonly create personas for the different types of people who will use the system that is being built. Personas may be based on profiles of real people or composites of multiple users. When they are used as a project tool, personas should:

- Provide an archetypal description of users
- Be grounded in reality
- Be goal-oriented, specific, and relevant
- Be tangible and actionable
- Generate focus

Personas help keep stakeholders' values and needs in mind during the project. Agile teams often use personas to focus the project on delivering the features that users will find valuable, which leads to better decision making on the project.

Finally, remember that there are many outputs that are common to many or all knowledge areas, such as change requests and project management plan and document updates. For example, a project management update particular to stakeholders is the stakeholder register, while you of course could also have changes to the stakeholder engagement plan.

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Managing the impact, relationships, and engagement of the stakeholders identified and analyzed during the previous process is essential to project success, but it can take a lot of time. That's why it's so important, as is the case with much of project management, to think and plan ahead before taking action.

Stakeholders can be an asset or a problem on the project, depending on how well the project is planned. To effectively manage relationships with this many people, you need to develop a stakeholder engagement plan. You need to think ahead about how the project will impact stakeholders, how you and the project team will interact with stakeholders, how you will involve stakeholders in making decisions, how you will manage their expectations, and how you can keep them satisfied—to ensure they are an asset on the project.

Planning stakeholder engagement requires you to strategize about your approach to stakeholder involvement, and develop actionable plans. This means you should schedule time to get to know your stakeholders and to check in with them throughout the project. If you know your stakeholders well, you'll have more success engaging them and will be better able to predict what engagement will look like throughout the project. Only through ongoing stakeholder engagement can the project manager and team be confident they will deliver the expected end result.

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Take a look at what can happen on a project without proper stakeholder engagement:

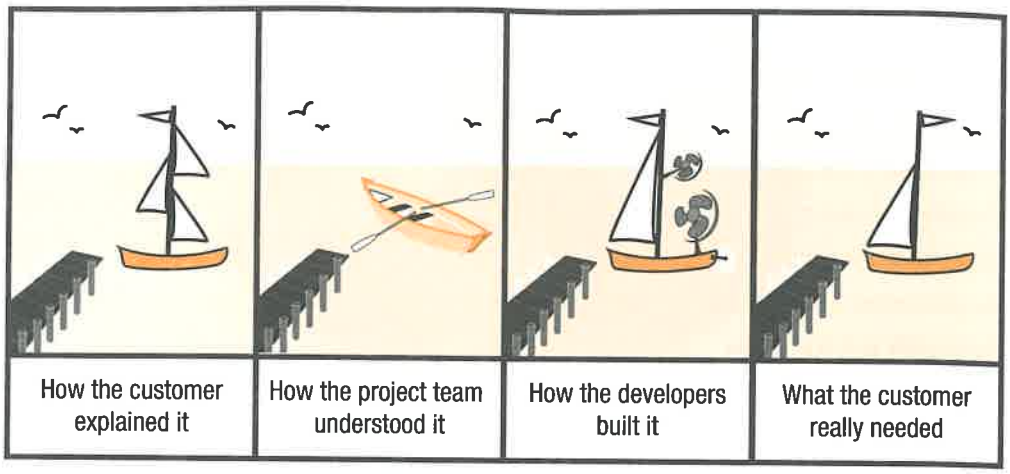

FIGURE 13.6 *Gulf of Evaluation*

The gulf of evaluation[7] (as shown in figure 13.6) is so common because it is easy for mismatches to arise between what one person envisions and tries to describe and how another person hears and interprets that description. If the mismatch is left unchecked for too long, costly rework or project failure can (and often does) result.

Now you may be thinking, "I have hundreds of stakeholders on my project, located all over the world. How can I possibly build and maintain relationships with them?" This is exactly why you need a plan. You may not be able to have a close relationship with every stakeholder, but you can't afford not to have relationships with key stakeholders and as many project team members as you are able. It's also important for you to plan ways in which you and your team members can develop relationships with stakeholders who are not a part of the project team.

Keep in mind, the closer you are to stakeholders, the more comfortable they will be to come to you with problems and concerns, and the easier it will be for you to pick up on verbal and nonverbal cues that can tell you when something might be wrong. This can be an early warning system for problems on your project. How do you build positive and powerful relationships with your stakeholders? The same way you have built them with your friends and family: by spending time getting to know them and allowing them to get to know you. The more time you spend with someone, the better you'll be able to ascertain their impressions and concerns.

What are the characteristics that define a good relationship? Take a few minutes to think about this. Draw on your experience with your family, friends, coworkers, and others. You may come up with different or additional qualities, but here are a few potential characteristics of a good relationship:

- Trust
- Honesty
- Interest
- Sincerity
- Respect
- Concern
- Empathy
- Good communication

As you plan how you will get to know your stakeholders, remember that these are the qualities you want to nurture in your relationships with them.

During planning, you need to determine which stakeholders will require most of your time and effort. These decisions require you to think about the role of each stakeholder, the environment within which they operate, and the specific needs of your project. If there are any procurements in place, you will need to

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coordinate with the procurement department to plan stakeholder engagement efforts related to parties of the contract.

To plan stakeholder engagement, you will need the details of what has already been planned and documented in plans including resource and communications management, information from the stakeholder register, and any relevant information from past, similar projects.

Let's consider an example. Imagine you are managing a project to replace the online application process for open positions in your company. Your sponsor is the human resources director, who wants to streamline the process and encourage candidates with advanced technical experience to apply for jobs. Even though your stakeholders include anyone who is a potential job candidate (possibly millions of people), there are a few key stakeholders with whom you will plan to spend most of your time: your sponsor and the managers in the company who evaluate candidates. As the project team is designing and building the new website to satisfy stakeholder requirements, you will want to receive frequent feedback from your key stakeholders about how the design meets their expectations. You might also identify a few newly hired employees who could help the team understand problems with the existing application process. Your stakeholder engagement plan might include formal review meetings where you discuss progress and get feedback on the progress of the website development.

Your experience on other projects and historical records of similar projects can help you anticipate and plan to meet stakeholder needs on the project. However, you should make use of the expertise of others as well. If you'll be working with a stakeholder for the first time, talk to another project manager or team member who knows this person. Meet with professional organizations, consultants, and subject matter experts to hear valuable insight on working with various stakeholders and stakeholder groups. Ask questions about how best to work with the stakeholders, and then meet with them as soon as possible to initiate these important relationships. Make sure the stakeholders themselves understand how important it is for you to meet their needs, and encourage them to communicate frequently as the planning and project work proceed. These preliminary meetings and conversations are critical for you to get an impression of how best to work with each stakeholder.

Not every stakeholder will be as engaged in the project as you might like, and some might be more engaged than you would wish. Stakeholder engagement can range from unaware of or resistant to the project to neutral to supportive or even interested in taking a leading role on the project. Think about each stakeholder's attitude and interest in the project as this will help you determine the level of engagement required to make the project successful. You should also consider how much engagement you require from stakeholders during each phase of the project. You may require some stakeholders to be more involved during planning, for example, while others will take on a more prominent role during executing. Identify and analyze variances between the current and desired level of engagement, and work with the team to identify ways to achieve the right engagement level.

The project manager will need to choose tools and techniques to plan stakeholder engagement that are appropriate for the project.

Stakeholder Engagement Assessment Matrix[8] A stakeholder engagement assessment matrix is a data representation tool used to compare stakeholders' current and desired level of engagement (see figure 13.7). The stakeholder engagement plan documents how adjustments to stakeholders' level of engagement will be achieved. This matrix is revisited as the project progresses, to evaluate ongoing stakeholder engagement. Analysis of updates to this matrix may indicate the need to further plan or alter the stakeholder engagement strategy.

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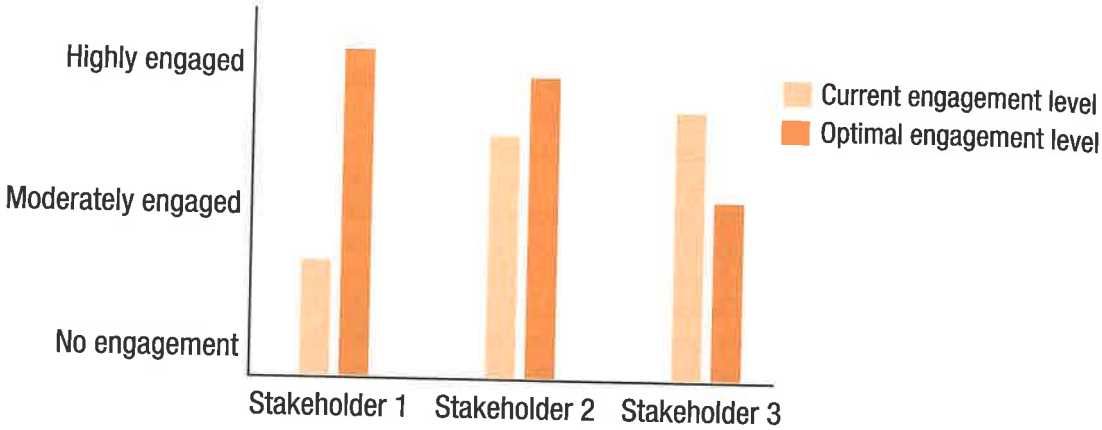

FIGURE 13.7 *Stakeholder engagement assessment matrix*

Assumption and Constraint Analysis and Root Cause Analysis Evaluating assumptions about stakeholders' attitudes toward the project enables the team to determine actions necessary to adjust stakeholders' levels of engagement to benefit the project. Analysis of project constraints can provide insight into determining strategies to adjust stakeholders' levels of engagement.

Root cause analysis is a way for the project manager and team to analyze the cause of the current level of stakeholder support and engagement. Doing so will help them determine how best to facilitate a change to bring the stakeholders' engagement level to what is desired.

13.1 Exercise If you've never planned stakeholder involvement on a project before, it can be difficult to imagine how you would go about doing this on an individual level. Think about the various stakeholders involved on a large project. The following table lists a stakeholder description. In your Exercise Notebook, write down how would you plan to manage the involvement of the stakeholders listed here.

Stakeholder Description
1. High interest in the project, low influence, highly knowledgeable expert on high-risk areas
2. Low interest, the source of major requirements on the project (high influence), not easy to work with
3. High interest, high influence, not a supporter of the project
4. High interest, high influence, a supporter of the project
5. Moderate interest, high influence, completing many activities on the project, a supporter of the project
6. Moderate interest, high influence because the stakeholder has identified a large number of potential risks for the project, a supporter of the project
7. Moderate interest, nervous about completing assigned activities

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Answer Listed here are some suggestions for how you might plan to manage the involvement of these stakeholders according to the descriptions in the previous table. Check these against what you came up with in your Exercise Notebook. These are generalized descriptions and answers, but if you do not work on large projects in your real world, reviewing the following information will help you better understand the work that needs to be done for large projects.

Options for Managing Stakeholder Involvement
1. Invite the stakeholder to participate in analyzing the risks on the project.
2. a. Determine why the interest is low. Ask the stakeholder about their engagement preferences and how they would like to be involved with the project. b. Identify ways to elicit requirements as efficiently as possible. c. Make sure requirements are clearly captured and approved by the stakeholder as accurate. d. Send reports.
3. Ask why the stakeholder is not a supporter. Use your understanding to base your plan for engaging this stakeholder on dealing with those reasons.
4. Ask the stakeholder what is most important to them, involve the stakeholder in team meetings, report project performance to this person, and include information as the stakeholder requests.
5. Invite the stakeholder to officially join the project management team. Identify the stakeholder's preferred level of involvement; use this information to continue to get their support throughout the life of the project.
6. Plan to meet with the stakeholder periodically throughout the project to potentially identify any other risks. Keep the stakeholder informed about the effectiveness of risk efforts, and involve the stakeholder in risk reviews and audits.
7. Plan to find and forward relevant literature to help the stakeholder, and arrange for training if necessary.

Project Elevator Statement[9] Elevator statements are short descriptions of the project goals, benefits, and decision attributes that quickly explain the project or product. Stakeholder involvement may include the development of a project elevator statement as a way to help them analyze and understand the project. The following is a popular format for elevator statements:

For:	Target customers
Who:	Need (opportunity or problem)
The:	Product/service name
Is a:	Product category
That:	Key benefits/reason to buy
Unlike:	Primary competitive alternative(s)
We:	Primary differentiation

EXAMPLE:

For people **who** want to stream video content **the** Viking Ultimate service **is a** streaming service **that** is faster, cheaper, and better, **unlike** ABC services **we** have no lengthy contacts.

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Stakeholder Engagement Plan The result, or output, of planning stakeholder engagement is a stakeholder engagement plan. The plan documents the existing and desired levels of engagement for all stakeholders, including plans to achieve the desired levels. It also provides details about ways in which stakeholders will be involved in the project, and it includes guidelines and metrics for monitoring and evaluating how well the plan is meeting the needs of stakeholders and the project.

TRICKS OF THE TRADE Stakeholder engagement plans generally have a component that addresses how communication will be used on the project to help manage stakeholder engagement and expectations. This means that the stakeholder engagement plan and the communications management plan can be repositories of some similar information about stakeholder communication requirements and who needs to receive what information on a project. But the two plans each have a different focus. The communications management plan emphasizes the details about the technology, methods, and models of communication—the what, when, and how of communication. The stakeholder engagement plan, on the other hand, explains the why of communications—why stakeholders need to receive certain information, and how the sharing of that information will help in managing stakeholder engagement and expectations. As you might expect, portions of these two plans are often created together.

Keep in mind that the stakeholder engagement plan will likely require adjustment throughout the project. We've already discussed how you'll need to reevaluate your list of stakeholders during the project. The discovery of new stakeholders may require changes to the plan, and there may be changes on the project that require less or more involvement from various stakeholders.

Be careful with information about stakeholders! Think carefully before you share the stakeholder engagement plan, your stakeholder register, or other verbal and written communication about stakeholders. Consider all the potentially sensitive information you might be documenting about stakeholders' attitudes and personalities, or obstacles or challenges related to working with a stakeholder. Given how important it is to maintain good relationships with stakeholders, consider how damaging it would be to your project for someone to find a list of stakeholders along with negative comments about some (particularly if the person looking at the list is on that list). As the project manager, you always want to maintain a positive attitude toward your stakeholders, even those who are resistant or difficult to work with. A good leader is encouraging and supportive of everyone involved with the project. This means that when you discover an obstacle or challenge associated with a stakeholder, you may decide not to share it with others and not to write it down: so, small portions of your stakeholder engagement plan may reside only in your mind.

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To meet stakeholder needs, resolve their issues, and make sure they remain interested and active in the project, it's essential to encourage stakeholder engagement and manage their expectations. Although this is an executing process, managing stakeholder engagement is ongoing throughout the life of the project. When was the last time you did something like the following scenario?

> *A project manager knows a particular stakeholder is dissatisfied because one of his requests was not included in the scope of the project. The rest of the stakeholders agreed upon the scope, but the project manager anticipates this person will continue pressing to add his request. The project manager schedules a meeting with the stakeholder to talk about why this request was not a high priority for the other stakeholders and to suggest this stakeholder build a business case for it being included in another project.*

How about this situation?

> *During requirements gathering, a stakeholder expressed concern about how much the project would impact her department's other work. The project manager contacts her to say, "I have kept your concern in mind while planning the project. You know there is little probability we could do this project without impacting your department, but because of your concerns, I have put together a report telling you when we*

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will impact your department's regular work." As the project moves forward, the project manager continues to check in with the stakeholder to discuss any unforeseen impacts.

Or this one?

A project manager notices that a stakeholder who used to provide helpful input regularly has become less involved in the project lately. The project manager touches base with the stakeholder to say, "I've really missed getting your feedback on the status reports. I've always appreciated your comments. Is there a reason you've been holding back lately? Is there anything I can do to get you more involved again?"

Why bother doing such work? Such actions are proactive, and let the stakeholders know that their input is important and that their needs and concerns are being considered, even if they are not agreed to. These efforts are much more likely to encourage stakeholder support of the project, and also serve the valuable role of keeping open communication channels with the stakeholders so they can inform the project manager of potential changes, newly discovered risks, and other information.

Do you think you don't have time in your real world to do these things? As with many other areas of project management, such efforts can actually help you be more efficient by reducing the amount of time you are forced to spend dealing with problems. When taking the exam, assume, unless stated otherwise, that the project manager has followed the best practices of project management. Therefore, the project manager has time to continuously encourage stakeholder engagement and manage expectations.

The project manager reviews the stakeholder engagement plan, other management plans, and project documents, such as the stakeholder register, issue log, and change log, to find and address any issues that could be impacting stakeholder engagement. This review may identify sources of confusion or misunderstanding. For example, a deferred or rejected change request could decrease the engagement level of stakeholders who supported the change.

Given how important good communication is to stakeholder management, it's also critical to follow the communications management plan. How can you keep people involved and informed if you're not communicating with them? Managing stakeholder engagement also requires attention to stakeholders' needs while work is being done. And it's essential for the project manager to maintain trust, help resolve conflicts, prevent problems, foster agreement among stakeholders to meet the needs of the project, and generally encourage stakeholder support of the project and the outcome of the project. This requires the use of interpersonal and team skills such as political and cultural awareness, negotiating, and conflict management.

It's important to note a key difference between predictive and adaptive approaches as it relates to problem solving, conflict management, and stakeholder engagement. Traditional project management tends to rely on the project manager for problem solving and correction, while agile project management treats this as a whole-team activity. When attempting to resolve threats and issues, organizations often overlook a great source of potential solutions—the project team.

Involving the team in solving problems has many benefits. One of the most important advantages is that you gain the team's buy-in from the start; you don't have to sell your solution to the team. Engaging the team in problem solving also accesses a broader knowledge base. Team members are often closer to the details of the project and may bring additional insights unknown to the project manager. Of course, it's important to only involve the team when necessary to solve critical problems. Otherwise, you risk getting in the way of project work.

Managing stakeholder engagement can result in requested changes to the project or product scope as well as updates to the stakeholder engagement plan and communications management plan. It can also lead to updates to project documents, such as the change log and stakeholder register. The issue log may need to be updated to document stakeholders' concerns and their final resolution. Lastly, lessons learned may be documented to reflect the results of efforts to engage stakeholders.

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Monitor Stakeholder Engagement PAGE 530

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Maintaining stakeholder relationships and monitoring stakeholder engagement are ongoing responsibilities of the project manager. Monitoring stakeholder engagement will help you understand stakeholder perceptions of project progress. This will allow you to make minor adjustments to ensure continuous stakeholder engagement and support. In addition to evaluating stakeholder engagement and improving and refining strategies for engagement, this process also involves reassessing the stakeholder register, updating stakeholder information, adding stakeholders as appropriate, and noting when a particular stakeholder's involvement is no longer necessary.

Components of the project management plan that are inputs to this process include the resource management plan (remember that all team members are also stakeholders), the communications management plan, and the stakeholder engagement plan. In addition to these plans, the issue log tracks any concerns, disagreements, confusion, or unresolved questions that arise during the project. This log can provide direct or indirect information about stakeholder engagement. Other project documents include the lessons learned register and the risk register. Note the inclusion of the risk register as an input here. It is important to realize that a lack of stakeholder engagement adds risk to the successful completion of the project. Such risks must be identified and managed.

Utilizing Data It is important to know that monitoring stakeholder engagement requires you to collect and analyze data. For example, work performance data from the Direct and Manage Project Work process includes measurements of project performance and the engagement levels of specific stakeholders. That data is then used to compare actual engagement efforts against the project management plan to look for variances. Any variances may indicate a potential problem with stakeholder engagement. The stakeholder engagement plan specifies how this work of analysis and evaluation will be accomplished, who should be involved, how the results should be documented and presented, and how changes will be handled.

How do you analyze the work performance data related to relationships? You should have established in your stakeholder engagement plan some measurable performance metrics regarding stakeholder engagement. You might, for example, use a data analysis technique, such as root cause or alternatives analysis, to assess stakeholder engagement. You could also use the stakeholder engagement assessment matrix to further analyze stakeholder engagement levels. These types of tools will help you figure out if adjustments or changes need to be made to maintain stakeholder engagement.

Work performance data and metrics are useful for analyzing the quality of relationships, but keep in mind that some of your assessment will also be subjective. For example, if an activity is behind schedule because a stakeholder hasn't provided needed data the percent complete data will reflect the delay. This might point to a lack of stakeholder engagement or a problem with a relationship on the project. These indicators require the project manager to clarify and analyze the problem, and then work to correct or improve the situation. If the stakeholder in this example is not returning phone calls, the project manager will want to find out why. If the stakeholder is engaged, but having difficulty providing the information or getting the work done, the project manager may need to revise the strategy for engaging this stakeholder and reevaluate the work assignment or the time estimate. This type of assessment can be immensely helpful in monitoring stakeholder engagement.

Communication plays a large part in helping you discover and correct relationship problems. To maintain strong relationships, you need to spend time talking with the stakeholders and develop ways to listen and gather information on their ongoing (and evolving) feelings about the project and other stakeholders. To get feedback, you can of course ask direct questions like, "How do you think things are going?" But assessing success and the strength of relationships often requires a more complex and subtle form of communication. This is when interpersonal skills can really make a difference. To further understand how stakeholders feel, use techniques such as active listening, perception of body language, leadership, facilitation, and emotional intelligence. These skills will help identify issues or concerns that need your attention.

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To experience this for yourself, spend a day or two really paying attention to the responses you get to the question, "How are you?" Ask the cashier at your local coffee shop, a virtual team member, the person sitting next to you at work, your sponsor, and people on your project team. Most of the time, people will probably give you a positive response: "I'm doing fine, thanks." Then, try asking follow-up questions such as, "How are sales this week?" or "Are you keeping busy?" You may hear a less positive, but more honest answer: "Well, things are a little tough this week," or "I am so overwhelmed with work I don't think I'll ever get a day off." To get a more detailed (and, often, more accurate) answer, you'll need to spend more time, ask a series of questions, and pay attention to nonverbal cues where possible. This is where all the effort you have put into building stakeholder relationships will come into play: the better your relationship, the more likely the person will tell you the truth. Even so, you may have to probe to get honest status updates and learn what people really think about the project. Sometimes people are reluctant to share bad or difficult news, especially if it is bad news about the project you are managing. It will help if you make it clear to everyone on the project that you want them to come to you with their concerns.

As you learn about problems or issues from individual stakeholders, consolidate the information, look for patterns, and make adjustments as necessary. Your conversations may also reveal the need for a change request. These changes could be recommendations for solving a problem, risk mitigation suggestions to prevent future potential problems, or ways to improve engagement of various stakeholders.

Monitoring stakeholder engagement results in work performance information (an analysis of the work performance and validating data gathered through your stakeholder engagement efforts) and possibly updates to the project management plan and project documents, such as the issue log and the stakeholder, risk, and lessons learned registers.

This brings us to the end of the Stakeholders chapter. For the exam, keep in mind that stakeholders are important throughout the life of the project. You need to identify all of them as early as possible, and periodically reevaluate the stakeholder list. You also need to plan how to manage their expectations, engagement, and influence, and then follow that plan and adapt it throughout the life of the project.

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Practice Exam

1. The project has been going well, except for the number of changes being made. The product of the project is being installed into seven different departments within the company and will greatly improve departmental performance when operational. The team has selected the appropriate processes for use on the project. The project manager is a technical expert and has been trained in communications and managing people. Which of the following is the most likely cause of the project changes?
   A. The project manager was not trained in understanding the company environment.
   B. The project should have more management oversight since it will result in such great benefits to the company.
   C. The project should have used more of the project management processes.
   D. Some stakeholders were not identified.

2. You have been tentatively assigned to a project that has not yet received final approval. Several stakeholders who will likely be involved or impacted by the project have already been identified. Stakeholders can be identified during which project management process groups?
   A. Initiating, planning, executing, and monitoring and controlling
   B. Initiating and planning
   C. Planning and monitoring and controlling
   D. Monitoring and controlling and closing

3. Which of the following statements best describes how stakeholders are involved on a project?
   A. They help to determine the project schedule, deliverables, and requirements.
   B. They help to determine the project constraints and product deliverables.
   C. They help to determine the resource needs and resource constraints on the project.
   D. They approve the project charter, help provide assumptions, and create the management plans.

4. You know that some groups within your organization are going to provide input to requirements that may impact your ability to develop a realistic schedule. Managing stakeholder expectations is always important, but achieving stakeholder satisfaction will be more critical with some groups than with others. All the following are parts of the team's stakeholder management effort except:
   A. Determining stakeholders' needs
   B. Identifying stakeholders
   C. Giving stakeholders added value
   D. Managing stakeholders' expectations

5. You are working on a project that requires the use of a stakeholder engagement assessment matrix. This tool can be used to identify:
   A. Additional stakeholders
   B. Variances from anticipated stakeholder involvement
   C. Key relationships between stakeholders
   D. Skill levels of stakeholders

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6. You are managing a project to develop an organization's new website. The site will be highly complex and interactive, and neither your project team nor the client has much experience with this type of website development.

   The timeline is extremely aggressive. Any delay will be costly for both your firm and the client. You and the project sponsor have achieved agreement and sign-off on both the project charter and the project management plan. Client personnel have been kept fully informed of the project's progress through status reports and regular meetings. The project is on schedule and within budget, and a final perfunctory review has been scheduled.

   Suddenly you hear that the entire effort may be cancelled because the product being developed is totally unacceptable. What is the most likely cause of this situation?

   A. A key stakeholder was not adequately engaged in the project.
   B. The project charter and project management plan were not thoroughly explained to or adequately reviewed by the client.
   C. Communications arrangements were inadequate and did not provide the required information to interested parties.
   D. The project sponsor failed to provide adequate support for the project.

7. In managing a change-driven project, which aspect of stakeholder management is most important?

   A. Making sure the team members are fully occupied at all times
   B. Planning the team members' interactions with other stakeholders
   C. Leaving the team alone to solve their own problems
   D. Ensuring a shared understanding of the project goals

8. A primary goal of your project is to decrease the amount of time it takes for service technicians to help customers resolve issues via an online chat function. The current process includes correctly verifying client authentication information, assessing the problem, and then solving it. The team thinks a technical fix is needed to improve the chat functionality to support the goal of decreasing the time required to resolve customer problems. The customer service representatives think the process is at fault. A few team members have also expressed concern that the customer service representatives are interfering with their work by trying to take on a larger role than is appropriate for the project. The tension among stakeholders is escalating, and leadership is concerned. There has been discussion about who should assign roles for the project. The role of each stakeholder is determined by:

   A. The stakeholder and the sponsor
   B. The project manager and the sponsor
   C. The team and the project manager
   D. The project manager and the stakeholder

9. You are managing a project to update an existing payroll application. You have identified and analyzed your stakeholders and taken measures to ensure positive stakeholder engagement and to ensure that requirements will meet project objectives. The stakeholder register has been an important part of much of this effort. What is a stakeholder register?

   A. A process of systematically gathering and analyzing quantitative and qualitative information to determine whose interests must be taken into account throughout the project
   B. A project document containing assessment and classification information regarding identified stakeholders
   C. An approach to increase the support and minimize negative impacts of stakeholders
   D. A table that links requirements to project objectives

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10. The team is working on the development of a new product that is designed to appeal to individuals of all ages throughout the world. Because of the diversity of the stakeholder base, the team has decided to group stakeholders by category in order to plan effective stakeholder engagement strategies. Which of the following tools will be most beneficial in this effort?
    A. Resource breakdown structure, prioritization, multicriteria decision analysis
    B. Salience model, traceability matrix, prioritization
    C. Power/interest grid, stakeholder cube, salience model
    D. Benefits management plan, focus group, power/interest grid

11. You've managed to get the key stakeholders for your upcoming agile project together for a visioning session to reach agreement on what the project needs to accomplish. The participants might not have another chance to meet in person. How will you recommend they spend this time?
    A. Write an elevator statement
    B. Develop personas for the key user groups
    C. Explain their requirements and needs
    D. Decide who will make the key decisions for the project

12. The project manager is trying to recall a stakeholder's preferred communication method. Where can she find that information?
    A. RACI chart
    B. Stakeholder engagement assessment matrix
    C. Stakeholder engagement plan
    D. Resource management plan

13. You are planning a project to develop a website for a large medical center. The site will be used by patients, medical professionals, support staff, and insurance company representatives. Which tools will best help you determine the current attitudes of stakeholders toward the project and the level of engagement you will need from each of these groups?
    A. Stakeholder register and stakeholder engagement assessment matrix
    B. Trend analysis and requirements traceability matrix
    C. Data analysis and resource management plan
    D. Assumption and constraint analysis

14. When would it be worthwhile for your agile team to take the time to develop a set of personas for the project?
    A. When they need to document a complex web of requirements
    B. When they want to stay focused on what the users really need
    C. When delivering maximum business value is their top priority
    D. When the priorities of external stakeholders conflict with those of internal stakeholders

15. The key objective of stakeholder management is:
    A. Communication
    B. Coordination
    C. Satisfaction
    D. Relationships

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16. As project manager, you are unable to allocate as much time as you would like to interact with your stakeholders. Which of the following stakeholders will you make it a priority to get to know?
    A. The stakeholder who is an expert on the product of the project, but is not interested in implementing it in his department
    B. The manager of the department that will use the product of the project, who is known to be resistant to change
    C. The project sponsor, with whom you have successfully worked on many projects
    D. The department employee who is unfamiliar with the product of the project, but open to the positive impacts he believes the product will have on his work environment

17. A stakeholder's belief about or mental picture of the future is a(n):
    A. Requirement
    B. Heuristic
    C. Expectation
    D. Constraint

18. The degree to which a particular stakeholder may be able to positively or negatively affect a project is their:
    A. Level of engagement
    B. Level of interest
    C. Level of commitment
    D. Level of influence

19. As project manager, you overhear three of your agile team members debating the best way to design the acceptance test for a user story. They have reached a stalemate and can't decide how to proceed. What should you do?
    A. Join the conversation and explain the requirements needed for the test
    B. Gather the rest of the team to discuss the issue and come up with a collective solution
    C. Since this has become an impediment to progress, evaluate the options and identify the best design
    D. Tell the team you will meet with the customer and let them know the answer

20. In an effort to identify stakeholders who may be affected by your project, you're looking over the organizational structure of your client's company. As you identify stakeholders on the organizational chart, you request meetings with each stakeholder. You'll document the information you learn about each stakeholder in the stakeholder register. This register can then be used as an input to which of the following processes?
    A. Plan Risk Management and Collect Requirements
    B. Perform Integrated Change Control and Plan Communications Management
    C. Plan Quality Management and Manage Quality
    D. Identify Risks and Develop Project Charter

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Answers

1. **Answer** D
   Explanation It is important to look for the choice that would solve the real problem. The most likely root cause is that stakeholders were missed and, as a result, their requirements were not identified. Those stakeholders are now requesting changes to accommodate their needs. There is no reason to think that training, management oversight, or a need for more processes are factors contributing to the number of changes.

2. **Answer** A
   Explanation Stakeholders can be identified throughout the project. However, the earlier stakeholders are identified, the better for the project. If all the stakeholders' needs and requirements are taken into account before plans are finalized and project work is begun, fewer changes will be needed later in the project, when they will be more costly.

3. **Answer** B
   Explanation The project manager determines the project schedule through schedule development. The team and other stakeholders provide the inputs. Since it is also the project manager's role to determine resource needs and create management plans, the choices including those roles cannot be best. The project sponsor approves the project charter, not the stakeholders. Stakeholders do, however, help determine project constraints and product deliverables. Notice how tricky questions can be if you do not read them correctly! Watch for this in other questions, and pay close attention to the wording.

4. **Answer** C
   Explanation Identifying all the stakeholders, determining their needs, and managing their expectations are all parts of good stakeholder management. Giving stakeholders added value (including extras not documented in the requirements) is known as gold plating. This is not effective stakeholder or quality management.

5. **Answer** B
   Explanation The stakeholder engagement assessment matrix can be used to compare the actual engagement levels (involvement) of individual stakeholders versus the desired levels of engagement needed to optimize the plan. Any discrepancies can be analyzed, and efforts to adjust the engagement levels can be implemented.

6. **Answer** A
   Explanation Communications were good and there is no evidence that the sponsor didn't support the project. The client approved the charter and plan. However, a single unsatisfied high-level stakeholder can threaten project success even if they have, by choice, been only tangentially involved. It is critical to ensure that all decisions makers are identified and engaged to ensure their concerns are addressed.

7. **Answer** D
   Explanation A shared understanding of the project's vision and goals is essential for a change-driven team to successfully deliver value. The project manager should watch out for the gulf of evaluation and make sure that the team isn't misinterpreting the desired outcome or going off in a different direction based on their own assumptions. Since agile teams are self-organizing and self-directing, the project manager shouldn't need to manage the team's interactions with other stakeholders or make sure they are busy all the time. While change-driven team members are empowered to solve their own problems, that doesn't mean that the project manager should ignore them.

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8. **Answer** D
Explanation The role of each stakeholder is determined by the project manager and the stakeholder. It is important that stakeholders have input into what they will be contributing to the project. The role of the project manager is not to tell people what to do!

9. **Answer** B
Explanation Gathering and analyzing information to determine whose interests must be considered is part of stakeholder identification and analysis. Increasing support and minimizing negative impacts of stakeholders is part of stakeholder management. Linking requirements to project objectives is included in a requirement traceability matrix. A stakeholder register is a document that includes assessment and classification information related to identified stakeholders.

10. **Answer** C
Explanation The power/interest grid, stakeholder cube, and salience model are ways of representing data about stakeholder groups, enabling the team to plan how to engage and manage all the stakeholders effectively.

11. **Answer** A
Explanation An elevator statement is a short description of a project's goals, benefits, and key attributes. Such statements may be used as agile project charters, and they are a quick way to help stakeholders analyze and understand the project. Writing an elevator statement would be the best use of the stakeholders' time since this will provide clear direction for the project and the team. None of the other activities mentioned will lead to actionable results. Also, deciding "who will make the key decisions for the project" implies a top-down, directive approach that doesn't reflect agile's collective, team-based values.

12. **Answer** C
Explanation Stakeholders' individual communication requirements are documented in the stakeholder engagement plan.

13. **Answer** A
Explanation The stakeholder register contains information including the stakeholders' requirements and expectations, as well as their levels of interest and influence. The stakeholder engagement assessment matrix graphically illustrates the current and desired levels of stakeholder engagement. This information can be used to determine actions required to close gaps between those levels.

14. **Answer** B
Explanation Personas are quick guides or reminders of the key groups of people who will use the solution, including what they need and value—so they can help the team gain insight into the users and stay focused on their needs. The other options are incorrect. Agile teams use a user story backlog to document requirements. Creating personas might be somewhat helpful for evaluating conflicting priorities, but on an agile project setting priorities isn't up to the team (and in any case that isn't the primary purpose of writing personas). Finally, "delivering maximum business value" isn't a specific scenario; it is the overarching goal of all agile projects.

15. **Answer** C
Explanation While communication, coordination, and development of relationships are parts of stakeholder management, collectively they contribute to the main objective of this process—stakeholder satisfaction.

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16. **Answer** B
Explanation As the department manager, this person is a key stakeholder, and wields a lot of influence over other stakeholders in her department. The fact that she is resistant to change indicates she will need some personal reassurance from the project manager, or she may exert her influence to derail the project.

17. **Answer** C
Explanation Expectations are not as direct or straightforward as requirements. Nonetheless, they are important to recognize and address to ensure stakeholder satisfaction with the project. Therefore, the project manager must do additional work to uncover the expectations of stakeholders.

18. **Answer** D
Explanation This question is referring to levels of influence. Each stakeholder's level of influence may be based on status within the organization, seniority, or other factors. The level of influence of each stakeholder should be identified and managed throughout the project.

19. **Answer** B
Explanation This scenario is an example of team problem solving in an adaptive setting. While traditional project management tends to rely on the project manager for problem solving, agile treats this as a whole-team activity. Therefore the best answer is to gather the team so they can all discuss the issue and come up with a collective solution. As the manager of an agile project, you should allow the team members to make their own technical decisions, rather than decide for them. Even if they make mistakes, it's important to let them own their local decisions and learn from them.

20. **Answer** A
Explanation The stakeholder register is an input to Collect Requirements, Plan Quality Management, Plan Communications Management, Plan Risk Management, and Identify Risks. So answer A is the best answer. Be sure you understand why the stakeholder register is important in each of these processes.

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Tips for Passing the PMP Exam the First Time

FOURTEEN

This chapter serves as a review of some of the key things you need to understand as you prepare for the exam. Now that you've studied each topic individually, let's put your knowledge and understanding all together. Rita's Process Chart™ is one way to connect the concepts in this book. If you worked through the exercises in the "Processes and Domains" chapter, you should understand the overall project management process, including all the efforts involved in it. If you skimmed over these exercises, go back and spend time on them. You should also know the commonly occurring terms and concepts covered in the "Framework" chapter. Understanding these terms and concepts will help you understand how each of these things relate to the overall project management process.

As you work through this chapter, take this as an opportunity to find any remaining gaps in your knowledge so you are prepared to pass the exam on your first try.

Putting It All Together

Over the next several pages, we review some of the frequently occurring terms and concepts you need to understand for the exam.

Organizational Process Assets How many times have you seen the term "organizational process assets" in this book? Do you understand what it really means? Organizational process assets are an organization's existing processes, procedures, and historical data that influence the way a project is managed. With this definition in mind, can you see why organizational process assets are inputs to many of the individual project management processes from initiating to closing?

Enterprise Environmental Factors Enterprise environmental factors are also frequent inputs to project management processes. Think of enterprise environmental factors as a company's culture and existing systems that the project will have to deal with or can make use of. Enterprise environmental factors are outside the control of the team and may originate from within the organization or from external sources. Enterprise environmental factors could include the culture, mission, and values of the organization, as well as governance factors external to the organization.

Management Plans (for Each Knowledge Area) Planning is a key step in addressing the knowledge areas of scope, schedule, cost, quality, resource, communications, risk, procurement, and stakeholders, as well as plans for configuration management, change management, and requirements management. It is a crucial part of a project manager's job. These plans are vital tools that empower team members to take responsibility for their actions, work, and participation. It's important to note that these areas of planning may occur within agile and hybrid environments as well but may be less formal. These plans address the majority of questions and concerns that might come up throughout the life of a project, and they allow the

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project manager and team to spend more of their time completing the work of the project and less time dealing with problems.

Project Management Plan The project management plan is described in the "Integration" chapter and discussed throughout this book. This plan contains the blueprint for the project. It is an input to many planning, executing, and monitoring and controlling processes, as well as the Close Project or Phase process. Work is compared against the plan to ensure that the correct work is being accomplished. Because the plan is the blueprint for the project, it is maintained throughout the project, and it is updated when there are changes. Therefore, project management plan updates are an output of most of the executing and monitoring and controlling processes, as well as some planning processes. (See the "Project Management Plan Updates and Project Documents Updates" section in this chapter for more on this topic).

Baselines The scope, schedule, and cost baselines help the project manager control the project. They combine to create the performance measurement baseline for the project. How well the project is performing in terms of scope, schedule, and cost is determined by comparing performance measurements against these baselines. Change requests that affect the baselines must be approved in the Perform Integrated Change Control process before the baselines can be changed.

Work Performance Data, Information, and Reports The terms work performance data, work performance information, and work performance reports differentiate the various stages of project data and information. Work performance data is made up of the initial measurements and details gathered during project work (executing). When work performance data has been analyzed for conformance to the project management plan during the controlling processes, it becomes work performance information. This information can then be organized into work performance reports, which are distributed to stakeholders.

Expert Judgment Expert judgment, a frequently used tool of project management, refers to the knowledge and experience of someone who has done the types of things necessary to complete the work for the project. Although it is not often discussed in this book, expert judgment is used throughout the project in every process, including every aspect of integration management. Expert judgment is particularly valuable in planning a project and is a tool and technique for most of the individual planning processes.

Project Management Plan Updates and Project Documents Updates Updates to project artifacts are frequent outputs of the project management processes across planning, executing, and monitoring and controlling. Updates to the project management plan may include updates to any of the plan's components. Project documentation is updated to reflect adjustments, actions, and changes. In planning, updates include iterations of the plan and knowledge gained as planning processes are followed. In executing and monitoring and controlling, project documents are updated with work performance data and information. These updates ensure everyone has a common understanding of the project as it progresses. They also allow the project manager to reliably use documentation to measure and control the project.

Change Requests Change requests include recommended corrective and preventive actions and defect repair. They are outputs of some planning processes, most of the executing processes, and all the monitoring and controlling processes except Perform Integrated Change Control. Change requests are inputs to Perform Integrated Change Control, where they are reviewed. The approved change requests (outputs of Perform Integrated Change Control) are inputs to Direct and Manage Project Work and Control Procurements, where the changes are implemented. In Control Quality, the approved changes are verified to make sure that they return the intended results.

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14.1 Exercise Here is a way to get more familiar with the project management processes. In your Exercise Notebook draw a chart with a header as shown here. For each process listed, fill in the appropriate information in each column.

Project Management Process	Knowledge Area	Process Group	What Does It Include?	What Knowledge Area Process Comes Before?	What Knowledge Area Process Comes After?
Define Activities					
Plan Procurement Management					
Monitor and Control Project Work					
Sequence Activities					
Collect Requirements					
Direct and Manage Project Work					
Develop Project Management Plan					
Develop Schedule					
Validate Scope					
Perform Qualitative Risk Analysis					
Identify Stakeholders					
Conduct Procurements					
Define Scope					
Perform Integrated Change Control					

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Answer The answers to this exercise provide a description and the associated actions to the given process. These descriptions align with the required interpersonal skills as well as the project management and technical activity needed.

Project Management Process	Knowledge Area	Process Group	What Does It Include?	What Knowledge Area Process Comes Before?	What Knowledge Area Process Comes After?
Define Activities	Schedule management	Planning	Creating an activity list from each work package	Plan Schedule Management	Sequence Activities
Plan Procurement Management	Procurement management	Planning	Creating the procurement statements of work, bid documents, and the procurement management plan	None	Conduct Procurements
Monitor and Control Project Work	Integration management	Monitoring and controlling	Measuring and analyzing performance against the project management plan and baselines	Manage Project Knowledge	Perform Integrated Change Control
Sequence Activities	Schedule management	Planning	Creating a network diagram	Define Activities	Estimate Activity Durations
Collect Requirements	Scope management	Planning	Documenting detailed requirements and creating the requirements traceability matrix	Plan Scope Management	Define Scope
Direct and Manage Project Work	Integration management	Executing	Facilitating and producing work according to the project management plan	Develop Project Management Plan	Manage Project Knowledge
Develop Project Management Plan	Integration management	Planning	Integrating all the individual management plans and baselines, and creating a project management plan that is bought into, approved, realistic, and formal	Develop Project Charter	Direct and Manage Project Work

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Project Management Process	Knowledge Area	Process Group	What Does It Include?	What Knowledge Area Process Comes Before?	What Knowledge Area Process Comes After?
Develop Schedule	Schedule management	Planning	Creating a bought into, approved, realistic, and formal schedule and schedule baseline	Estimate Activity Durations	Control Schedule
Validate Scope	Scope management	Monitoring and controlling	Meeting with the customer to gain formal acceptance of interim deliverables	Create WBS	Control Scope
Perform Qualitative Risk Analysis	Risk management	Planning	Analyzing the probability and impact of potential risks to determine which risks might warrant a response or further analysis	Identify Risks	Perform Quantitative Risk Analysis (don't forget, however, that some projects, or individual project risks, may skip this process and go straight to Plan Risk Responses)
Identify Stakeholders	Stakeholder management	Initiating	Identifying, documenting, and analyzing information about stakeholders on the project	None	Plan Stakeholder Engagement
Conduct Procurements	Procurement management	Executing	Selecting a seller and obtaining a signed contract	Plan Procurement Management	Control Procurements
Define Scope	Scope management	Planning	Creating the project scope statement	Collect Requirements	Create WBS
Perform Integrated Change Control	Integration management	Monitoring and controlling	Evaluating the impact of requested changes to the project and approving or rejecting change requests	Monitor and Control Project Work	Close Project or Phase

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If you found this exercise helpful, you may want to continue to test yourself on other processes not listed here, and review your answers against the process descriptions in this book.

14.2 Exercise Use this exercise to practice recognizing processes at work. Read each description and write down in your Exercise Notebook the process name being described by the scenario.

Scenario
1. When meeting with the customer to obtain acceptance of interim deliverables
2. When measuring project performance against the performance measurement baseline
3. When making sure people are using the correct processes
4. When evaluating whether performance reports are meeting stakeholders' needs
5. When working with the project team
6. When assessing stakeholder relationships
7. When you notice that there are many unidentified risks occurring
8. When evaluating a seller's performance
9. When evaluating team members' performance
10. When making sure deliverables meet quality standards
11. When communicating with stakeholders to resolve issues and manage their perceptions about the project

Answer

Process Being Described	
1. Validate Scope	7. Monitor Risks
2. Control Scope, Control Schedule, Control Costs	8. Control Procurements
3. Manage Quality	9. Manage Team
4. Monitor Communications	10. Control Quality
5. Manage Team	11. Manage Stakeholder Engagement
6. Monitor Stakeholder Engagement	

Understanding Inputs and Outputs

What about other inputs and outputs? Many people who have not had good project management training stress over memorizing the inputs and outputs.

First, let's review the definitions of inputs and outputs.

An input means:

"What do I need before I can . . ."

An output means:

"What will I have when I am done with . . ."

Or,

"What am I trying to achieve when I am doing . . ."

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Do you realize how many inputs and outputs there are, and how much time you could spend focusing on memorization? Since the exam will test your ability to apply knowledge, such memorization would waste your valuable time, and it will not benefit you in the real world. If you understand project management and the actions that occur in each of the processes, you can use logic to identify most of the key inputs and outputs that appear on the exam, rather than relying on memorization. For example, if you know what a WBS is, you should understand that you need information about scope and requirements to create the WBS. Therefore, the project scope statement and requirements documentation are key inputs. If you understand the integrated change control process, you should know that it results in changes to project documents and components of the project management plan affected by approved changes.

The following exercises will give you some additional help with inputs and outputs.

14.3 Exercise The following are some of the project management processes for which you should know the inputs and outputs. Use logic and your understanding of the process to complete the following exercise. In your Exercise Notebook, list the key inputs and the key outputs for each process. Keep in mind that this may include any real-world inputs and outputs that you can think of that are not in the *PMBOK® Guide*. When you are finished, check your answers with the *PMBOK® Guide* and the rest of this book.

List the Key Inputs andd Outputs for these Processes	
1. Close Project or Phase	9. Define Scope
2. Sequence Activities	10. Identify Stakeholders
3. Develop Project Management Plan	11. Develop Schedule
4. Plan Procurement Management	12. Validate Scope
5. Collect Requirements	13. Monitor Risks
6. Define Activities	14. Manage Stakeholder Engagement
7. Estimate Activity Resources	15. Conduct Procurements
8. Direct and Manage Project Work	

If you found this exercise helpful, you may want to continue to test yourself on other processes not listed here.

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Formulas to Know for the Exam

Although we do not suggest you memorize a lot of information to prepare for the exam, the following formulas are ones you do need to memorize, as well as understand. The exam will not include a lot of questions involving formulas, but knowing these formulas will enable you to apply them at a moment's notice. If you are not comfortable with math, you will be happy to hear that you can know none of these formulas and still pass the exam! The most important formulas are those relating to earned value because earned value is a key component of monitoring and controlling.

Formulas to Know for the Exam

Name	Formula	*PMP® Exam Prep* Chapter Reference
Present value (PV)	$\frac{FV}{(1+r)^n}$	Integration
Expected activity duration (triangular distribution)*	$\frac{P+M+O}{3}$	Schedule
Expected activity duration (beta distribution)*	$\frac{P+4M+O}{6}$	Schedule
Total float	LS – ES or LF – EF	Schedule
Cost variance (CV)	EV – AC	Cost
Schedule variance (SV)	EV – PV	Cost
Cost performance index (CPI)	$\frac{EV}{AC}$	Cost
Schedule performance index (SPI)	$\frac{EV}{PV}$	Cost
Estimate at completion (EAC)	AC + Bottom-up ETC	Cost
Estimate at completion (EAC)	$\frac{BAC}{CPI^C}$	Cost
Estimate at completion (EAC)	AC + (BAC – EV)	Cost
Estimate at completion (EAC)	$AC + \frac{(BAC - EV)}{(CPI^C \times SPI^C)}$	Cost
To-complete performance index (TCPI)	$\frac{(BAC - EV)}{(BAC - AC)}$	Cost
Estimate to complete (ETC)	EAC – AC	Cost
Variance at completion (VAC)	BAC – EAC	Cost
Communication channels	$\frac{n(n-1)}{2}$	Communications
Expected monetary value (EMV—Cost)	P × I	Risk
Expected value (EV—Schedule)	P × I	Risk

**Remember that these formulas can be used for costs as well as activity durations.*

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TRICKS OF THE TRADE In the "Cost" chapter, we also highlighted some reverse formulas to help you calculate earned value (EV). With so many other formulas listed here, you may not want to memorize these (particularly if you understand the process for reversing the formulas), but they can be useful. They are EV = CV + AC, EV = SV + PV, EV = CPI × AC, and EV = SPI × PV.

TRICKS OF THE TRADE Before You Take the Exam

Many people fail the exam because they did not properly prepare. You can avoid that mistake. Read the following tips slowly, and honestly assess how each item applies to you:

- Know the material thoroughly, but do not approach the exam assuming it simply tests facts that you must memorize. The exam tests knowledge, application, and analysis. You must understand how to use all concepts and processes in the real world, including how they work in combination with each other in the context of a large project.
- Have real-world experience using major project management tools and techniques. If you do not have this experience now, try to get it. If you cannot get this experience before you take the exam, make sure you can visualize how tools and processes would be used on real projects. This visualization will help you understand the benefits of using project management tools and techniques in the real world, and help you prepare for situational questions on the exam.
- Think in terms of large, plan-driven projects when studying for and taking the actual exam. This will help you remember the importance of processes, tools, and techniques that you may not be using in your real-world project management. At the same time, be open to the ideas of tailoring, and agile and hybrid approaches, as questions or situations may call for one of these approaches.
- Understand the areas that PMI emphasizes (PMI-isms, explained in chapter 1 and in the "Quality" chapter).
- Be familiar with the types of questions you can expect on the exam, but do not be alarmed if you see new types of questions when you take the exam.
- Be prepared to see situations on the exam that may be ambiguous and wordy. Practice interpreting these types of questions using the practice exams or PM FASTrack® if you have it.
- If you have PM FASTrack®, practice using analysis to select the best answer from what appears to be two or more "right" answers. (See the next section for more information.)
- Decide in advance what notes you will write down at the beginning of your exam. This may include formulas or gaps in your project management knowledge. Practice creating this "download sheet" before taking the exam. (See the next section for more information.)
- Deal with stress before you take the exam. If you are a nervous test taker, using PM FASTrack® can give you an opportunity to practice stress control.
- Plan and use a strategy for taking the exam. This may mean you will take a mental break after every 50 questions, or that you will answer all exam questions as quickly as possible and then take a break before you review, and potentially adjust, your answers.
- Expect that there will be questions you cannot answer or even understand. This happens to everyone. Be prepared so you do not get anxious or doubt your abilities during the exam.
- Do not expect your exam site to be quiet. If you have PM FASTrack®, practice answering questions in an environment that is not 100 percent quiet.
- Do not overstudy. Getting completely comfortable with all the material in this book is just not possible. It is not worth studying for hundreds of hours. It is a waste of time and will not guarantee you'll pass the exam.

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- Do not study the night before you're scheduled to take the exam. Instead, do something relaxing and get extra sleep. You want to be fresh and well rested.

TRICKS OF THE TRADE® Tricks for Taking and Passing the PMP Exam

This book has presented what you should do and know before you take the exam. Now, let's prepare you for the big day. The following are some tips for taking—and passing—the exam (at a testing center).

1. You must bring your authorization (email or letter) from PMI to the test site, as well as two forms of ID with exactly the same name you entered on the exam application.
2. Make sure you are comfortable during the exam. Wear layered clothing so you can remove outer layers if you become too warm. (Note, however, that you may encounter specific requirements regarding removed clothing while taking the exam.)
3. Have something to eat and drink available in case you need either during the exam. You will not be able to access these items while taking the exam but you will be able to take a break, and you may be thirsty or hungry and you'll want to get rid of that distraction.
4. You will be given something on which to make notes during the exam. It's important to note that this may be something physical, such as paper and a pencil or a small white board, or it may be electronic.
5. After you start your exam, consider taking no more than five to seven minutes of your test time to create your "download sheet," which is where you write down anything you have trouble remembering. It will free up your mind to handle exam questions once the information you are most concerned about is written down.
6. It's important to know that you may have one or two technology and/or computer tutorials (general testing tutorial and PMP test-specific) to complete prior to the start of the exam. This will help you become familiar with the computer-based test functionality. You need to start and complete those tutorials within their allotted time. Then you can start your four-hour exam.
7. You will have access to a calculator during the exam. The computer will have a calculator function and the tutorial will show you how to use it.
8. The exam does not adapt to your answers. This means 200 questions are selected when your exam starts, and those 200 questions will not change.
9. Use deep-breathing techniques to help you relax and focus. This is particularly helpful if you are very nervous before or during the exam and when you notice yourself reading the same question two or three times. Breathing techniques can be as simple as breathing deeply five times, to provide more oxygen to your brain.
10. Smile when taking the exam. This may sound hard to do when you are stressed and taking an exam for four hours, but studies show that smiling relieves stress and makes you feel more confident.
11. Use all the exam time. Do not submit your exam early unless you have reviewed every question you skipped or marked for review.
12. Everyone has their own unique test-taking quirks and style. If you have PM FASTrack®, pay attention to your quirks while you work through the exam simulations. You may have to create a plan to ensure your style will not negatively impact you while taking the exam.
13. Control the exam; do not let it control you. How would you feel if you read the first question and didn't know the answer? And then the same thing happened after you read the second and third questions as well? This can happen because you are just not ready to answer questions and your level

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of stress is not allowing you to think. So what do you do? If you do not immediately know the answer to a question, leave it blank, or use the Mark for Review function and come back to it later.

14. Control frustration, and maintain focus on each question. You might dislike or disagree with some of the questions on this exam. You might also be surprised at how many questions you mark for review. Make sure you stay focused on the current question. If you are still thinking about question 20 when you reach question 120, there will have been 100 questions that you have not looked at closely enough.

15. Answer each question using your knowledge of project management good practices. Be prepared to separate your experience from PMI's perspective. Many people who failed the exam tried to answer questions from their real-world experience. If an answer doesn't come to you by applying good practices of project management from PMI's perspective, then rely on your training. If this still does not help you answer the question, only then should you rely on your real-world experience.

16. First, identify the actual question in the words provided (it is often the last sentence), and then read the rest of the text. Note the topics discussed in the question and in the descriptors. This should help you understand what the question is asking and reduce the need to reread questions.

17. Carefully consider each answer choice listed and choose the best one of the choices given. Don't read into the answers.

18. One common reason people answer questions incorrectly is they do not read all four answer choices. Do not make this mistake. Make sure you read the question and all four choices. This will help you select the best answer. If you find yourself forgetting to read all answer options, start reading the choices backwards (choice D first, then C, etc.).

19. There may be more than one "correct" answer to each question but only one "best" answer. Make sure you are looking for the best answer.

20. There will be answer choices that are meant to distract you from the correct answer. These are plausible choices that less knowledgeable people will pick. Such choices make it appear as though some questions have two or more right answers. To many people, it seems as though there are only shades of difference between the choices. As noted earlier, make sure you look for the best answer for such questions, and think about the situation in terms of project management good practices.

21. Be aware that questions may also include irrelevant information.

22. Look for words and phrases such as "still," "yet," "first", "last," "next," "except," "not," "most likely," "less likely," "primary," "initial," and "most." Make certain you clearly read the question, and take note of these words so you will answer the question correctly.

23. Watch for choices that are true statements but do not answer the question.

24. Watch for choices that contain common project management errors. They are intentionally there to determine if you really know project management. You can combat this by looking for errors in your knowledge and correcting those errors as you go through this book. (See the "Common Project Management Errors and Pitfalls" section in this chapter.)

25. Options that represent broad, sweeping generalizations tend to be incorrect, so be alert for words such as "always," "never," "must," "completely," "all," and so forth. Alternatively, choices that represent carefully qualified statements tend to be correct, so be alert for words such as "often," "sometimes," "perhaps," "may," and "generally."

26. You may see some poorly worded or grammatically incorrect questions or answer choices on the exam; don't let this distract you.

27. Look for answers that support the value of project management with underlying messages such as, "Hooray for project management!"; "The project manager is so important"; or "The WBS is so useful." They are generally the correct choice.

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The exam will not be scored until you indicate you are ready, or after four hours have passed. You will also be asked if you are certain you want to score your exam after you submit it. You will receive a summary of your test results. If you do not pass, PMI will send you information on retaking the exam. You will have to pay an additional fee to retake the exam.

TRICKS OF THE TRADE

Are you ready for some very important tricks to keep in mind when you take the exam? Pay careful attention:

- Recognize that "rules" (what we think should be best) are meant to be broken. Rules, such as what to do when there is a conflict, can change depending on the situation. This drives some people crazy—especially those who expect the exam to just test facts. You need to be able to read and understand the situations on the exam and then be able to figure out the best thing to do in that situation.
- Unless stated otherwise, assume proper project management was done. If you answer a question thinking about real-world projects that do not use proper project management, you might miss the correct answer. If the question makes it clear that proper project management has not been done, you'll likely need to think about what is missing, how to solve the root cause of the problem, and how to make sure proper project management is carried out going forward on the project.
- For each question notice which part of the project the scenario is occurring in. If the situation described is taking place in planning, your answer may be different than if it was occurring during executing.
- Be prepared for questions with multiple problems. A question may describe a situation with various problems and ask you to determine which one to address first. Here is an example:

  Two stakeholders are disagreeing via a series of emails as to whether a deliverable meets the acceptance criteria. The cost-benefit analysis done in planning did not support delivering a higher level of performance, and the stakeholders agreed. A team member has just informed you that a problem with his work has occurred. The deliverable he is working on must be shipped today or there will be a project breach. One of the stakeholders having the email disagreement comes to you to complain about the other. What should you do?

The following tips will help you focus on the most important problem in order to select the best answer. It is important to note that all these tips will not apply all the time, and they do not have an order of importance.

- Determine the immediate problem to address.
- Deal with the root cause first.
- Deal with the problem with the greatest negative impact first.
- Solve the problem that occurred the earliest.
- Look for a proactive solution.

TRICKS OF THE TRADE Common Project Management Errors and Pitfalls

As mentioned at other points in this book, the exam often includes common errors in project management as possible answers. Read the following summary of some of the major errors even highly experienced project managers make, and make sure you understand why these are errors.

Common project management errors include the following:

- Focusing primarily on asking for percent complete

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- Holding "go around the room" status meetings
- Spending most of your time micromanaging team members by constantly checking on them
- Asking team members to cut 10 percent off their estimates
- Thinking a bar (Gantt) chart from scheduling software is a project management plan
- Not attempting to obtain finalized requirements
- Not getting real resource commitments
- Not having a rewards and recognition system
- Not focusing on quality
- Not having a change control system
- Not having management plans
- Not measuring against the project management plan
- Not creating metrics to measure and evaluate performance
- Not spending time finding and eliminating root causes of problems or deviations
- Not implementing corrective actions to keep the project in line with the project management plan
- Not reevaluating the effectiveness of the project management plan
- Not reevaluating the accuracy or completeness of scope, schedule, or cost
- Not keeping the project management plan and project documents updated to reflect changes and revised information about the project
- Ignoring resource managers' responsibilities to manage ongoing business operations in addition to responding to project needs (team and physical resources)
- Not realizing the project can affect the reputation of team members
- Not realizing the project manager has resource responsibilities; these can include responsibilities to the project team (such as creating project job descriptions, evaluating individual and team performance on the project, and adding letters of recommendation to team members' human resource files) as well as responsibilities related to physical resources
- Blaming unrealistic schedules on management instead of realizing that developing a realistic schedule is the project manager's responsibility

A Day-in-the-Life

The following exercise provides one last opportunity to test yourself to see if you really understand what a project manager does.

14.4 Exercise Many people do not practice the breadth of project management practices described in the *PMBOK® Guide* on their real-world projects. This may be because they have not received the training needed or because they do not understand the project management process or its value. A lack of experience in using these practices to properly manage large projects can have a significant impact on how you perform on the exam. This exercise is designed to help you uncover what you might be doing incorrectly on your projects so differences between your real-world experience and the world of project management good practices do not get in your way on the exam. In your Exercise Notebook, list which activities a project manager should spend the most, average, and least amount of time on during a typical day after planning is complete and the team has begun working on the project.

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Answer There are a number of correct answers to this question. Let's first review what should not be on your "Most" list, and then we will look at what efforts a project manager should focus on during the course of a day. Think through the items listed here, and identify whether you have any misconceptions about what you should be doing as a project manager. If you do, you need to clarify and fix these misconceptions before you take the exam.

Items that should not be on your "Most" list:

- Dealing with problems and unexpected changes (rather than preventing them)
- Schedule and other items related to schedule management
- Meetings
- Micromanaging
- Completing work activities

The following items should have been included in your "Most" list:

- Using project management tools, such as a charter, WBS, and project management plan
- Measuring
- Recommending and taking corrective and preventive actions
- Doing risk management and implementing risk responses
- Coaching, mentoring, and team building
- Communicating and using active listening
- Managing by exception to the plan
- Interacting with stakeholders to maintain and improve stakeholder engagement
- Looking for possible changes

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Conclusion

You have reached the end of this book! Congratulations!

As noted in chapter 1, we recommend that you review the information in this book several times to really retain what you learned. So read through this book again, focusing on the areas where you have identified gaps in your knowledge. In a second pass through this book you will find that you understand some topics differently than you did the first time, and other concepts will stand out to you that you previously missed. In particular, make sure you review the PMI-isms in chapter 1, the most commonly used tools and techniques in chapter 2, and Rita's Process Chart™ and the project management process exercises in chapter 3. Having a solid understanding of the project management process and the material presented in this book will not only help you pass the exam (you can use logic instead of having to memorize information), it will also enable you to apply what you have learned to your real-world projects.

Thank you for taking this journey with us. We hope you will come back to RMC Learning Solutions after you have earned your PMP. We can help you continue your training and earn PDUs to maintain your certification through our advanced instructor-led and eLearning courses and products. So good luck, and we look forward to seeing you after you pass the exam!

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Endnotes

The following notes provide the historical background of many of the terms in this book. You do not need to know this information for the exam. It is simply provided for your interest and reference.

CHAPTER TWO

1. **Stakeholder** The first use of the word "stakeholder" in management literature was in 1963 in an international memorandum at the Stanford Research Institute. [Robert Y. Cavana and Arun A. Elias, "Stakeholder Analysis for Systems Thinking and Modelling." Paper presented at ORSNZ, Wellington, New Zealand, December 2000.]

2. **Organizational project management** The concept of organizational project management began in the information technology sector in the 1980s; within a decade it had become widely popular throughout management science. [British Standards Institution, *Use of Network Techniques in Project Management: Guide to the Use of Graphical and Estimating Techniques* (London: British Standards Institution, 1984), 1.]

3. **Project management office** The development of departments within organizations to manage projects dates back to the beginning of project management as a discipline. [Frank Parth, Cynthia Snyder, and Cynthia Stackpole, *Introduction to IT Project Management* (Vienna, VA: Management Concepts, 2007), 22.]

4. **Business case** This term has been in wide use for decades; business cases were being written and studied in the 1920s as part of the scientific management movement. They became popular in the 1950s after the Harvard Business School began using them as a teaching method. [Michael Davis, *Ethics and the University* (New York: Routledge, 1999), 145.

5. **Benefits management plan** The benefits management plan was introduced in the 1990s in the United Kingdom. The concept spread to the United States in the early 2000s. [Roland Munro and Jan Mouritsen, *Accountability: Power, Ethos and the Technologies of Managing* (Stamford, CT: International Thomson Business Press, 1996), 133.]

6. **Matrix** These categories were defined in 1971 by Jay R. Galbraith to help organizations improve their management efficiency. [Jay R. Galbraith, "Matrix Organization Designs: How to Combine Functional and Project Forms," *Business Horizons* 14, no. 1 (1971): 29–40.]

7. **Organizational knowledge repository** The concept of the organizational knowledge repository was created by J. M. An and fellow researchers in 1992, as they began work on early search engines. The idea was quickly adopted and was common in knowledge management research by the end of the decade. [J.M. An, R.G. Hung, and G.L. Sanders, "The Role of Domain Coverage and Consensus in a Network of Learning and Problem Solving Systems," in *Proceedings of the Twenty-Fifth Hawaii International Conference on System Sciences* (Los Alamitos, CA: IEEE Computer Society Press, 1992), 443.]

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8. **Lessons learned repository** The organization of formal systems to integrate experience into corporate management is a fairly recent development. J. G. March and J. P. Olsen published a paper in 1975 that became the basis for "organizational learning." The concept of the lessons learned repository was developed by the US military to build on this as part of its 1985 overhaul of contracting standards; it was disseminated into wider management practice in the 1990s. [Department of Defense, *Military Standard Specification Practices* (Washington, DC: U.S. Department of Defense, 1985).]

9. **Assumption log** The assumption log is a new practice in project management. [John Murdoch et al, "Measuring Safety: Applying PSM to the System Safety Domain," *Proceedings of the 8th Australian Workshop on Safety Critical Systems* 33 (2003): 50.]

10. **Constraints** Dr. Martin Barnes was the first to describe what he called the "iron triangle" of time, cost, and output in his course "Time and Money in Contract Control" in 1969, laying the foundations for what has become known as the "triple constraint" (schedule, cost, and scope constraints). [Patrick Weaver, "The Origins of Modern Project Management" (lecture, Fourth Annual PMI College of Scheduling Conference, Vancouver, Canada, April 15–17, 2007).]

11. **Present value, net present value, internal rate of return, payback period, cost-benefit analysis, opportunity cost, sunk costs, depreciation** These key terms are borrowed from accounting and economics. The investment of time and money in a project should be reviewed as carefully as the investment of time or money in any business venture. [Colin Haslam and Alan Neale, *Economics in a Business Context* (London: Thomson, 2000).]

12. **Economic value added (EVA)** This term was coined by Thomas B. McMullen in 1997 as a new label for earlier work by Eliyahu M. Goldratt. [Thomas B. McMullen, *Introduction to the Theory of Constraints (ToC) Management System* (Boca Raton, FL: CRC Press, 1998).]

13. **Law of diminishing returns** This is one of the fundamental principles of modern economics, developed by David Ricardo and Thomas Malthus in 1815. It has been applied to many fields of social science in the two centuries since its discovery. [Mark Skousen, *The Making of Modern Economics: The Lives and Ideas of the Great Thinkers* (Armonk, NY: M.E. Sharpe, 2001), 100.

CHAPTER THREE

1. **Project life cycle** Dr. Russell Archibald, a founder of PMI, was one of the theorists who refined the concept of the project life cycle. [R. Max Wideman, *The Role of the Project Life Cycle (Life Span) in Project Management* (Vancouver: AEW Services, 2004), 2.]

2. **Development life cycle** The concept of the development life cycle originated in US military contracting during the Vietnam War, influenced by the lessons learned by NASA during the space race of the 1950s and 1960s. It spread quickly into IT and general management in the 1970s. [Gerald R. Holsclaw, "Integrated Logistic Support—The Life-Cycle Task of Support Management," *Defense Industry Bulletin* 4, no. 2 (June 1968): 11.]

3. **Phase gate** The phase gate concept is derived from the "stage gate" system developed by Robert G. Cooper in the late 1980s, which underlies most modern waterfall deployment models. [Robert G. Cooper, "Stage-Gate Systems: A New Tool for Managing New Products," *Business Horizons* 33, no. 3 (May–June 1990): 44.]

4. **Progressive elaboration** The term "progressive elaboration" has been present in medical science since the nineteenth century, and was widely popularized during the twentieth century in a variety of contexts. Its use in management science dates to the 1980s, when it evolved from the iterative nature of computer science. [D.K. Hitchins, "Managing System Creation," *IEE Proceedings-A* 133, no. 6 (September 1986): 343.]

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5. **Rolling wave planning** This process was refined by Gregory Githens and J. Rodney Turner in the 1990s to improve the balance of flexibility and structured process in project management. [J. Rodney Turner, *The Handbook of Project-Based Management*, 3rd ed. (New York: McGraw-Hill, 2008), 56.]

CHAPTER FOUR

1. **Integration management** The concept of "systems integration management" arose from the highly technical management requirements of post–World War II engineering projects. By the end of the 1960s, integration management was a common term in project management. [Society of Automotive Engineers, "Jet Plane Costs Need Not Skyrocket with Performance," *SAE Journal*, August 1953: 66.]
2. **Project charter** While the concept of the project charter is very old, it was refined as part of the Six Sigma methodology. [Penelope Przekop, *Six Sigma for Business Excellence* (New York: McGraw-Hill, 2003), 61.]
3. **Project management plan** The integration of various project management techniques into a formal process began in the 1950s with projects coordinated for the US Department of Defense by the RAND Corporation and Booz Allen Hamilton. [Lauren Keller Johnson, Richard Luecke, and Robert Daniel Austin, *The Essentials of Project Management* (Boston: Harvard Business School, 2006), xv.]
4. **Baseline** The use of the baseline as a statistical tool dates to the nineteenth century. The word has been redefined in the context of management science, although it still generally refers to measurement using numerical or statistical methods. [Harold Kerzner, *Project Management: A Systems Approach to Planning, Scheduling and Controlling* (Hoboken, NJ: Wiley, 2001), 1014.]
5. **Configuration management system** Configuration management was first developed in the 1950s by NASA. The technique was then borrowed by the US Department of Defense, before it was refined by private corporations in the 1960s. It was originally intended to manage large, complex projects, such as the design and launch of rockets. [Frank B. Watts, *Engineering Documentation Control Handbook* (Norwich, NY: William Andrew, 2000), 10.]
6. **Work authorization system** The concept of a refined work authorization system evolved from the PERT methodology of the 1960s and quickly spread from the US federal government to private corporations. [Gregory A. Garrett and Rene G. Rendon, *U.S. Military Program Management: Lessons Learned and Best Practices* (Vienna, VA: Management Concepts, 2007), 133.]
7. **Defect repair** Defect repair has been a management term for decades. [Barbara M. Bouldin, *Agents of Change: Managing the Introduction of Automated Tools* (Old Tappan, NJ: Pearson Education, 1988).]
8. **Integrated change control processes** The concept of integrated change control was refined at NASA, where an Integrated Change Control Board was organized in the late 1970s. [Gale Research Company, *Acronyms, Initialisms and Abbreviations Dictionary* (Farmington Hills, MI: Gale Research Company, 1980), 1512.]
9. **Change control board** The change control board was an important part of the change control process from its earliest days in the 1970s. [John A. Burgess, *Design Assurance for Engineers and Managers* (Boca Raton, FL: CRC Press, 1984), 96.]

CHAPTER FIVE

1. **Requirements elicitation** This term became widely popular in the field of information science during the 1980s and quickly assumed an important role in project management. [Rudy A. Hirschheim, *Information Systems Development as Social Action: Theory and Practice* (Oxford: Oxford Institute of Information Management, 1987), 2.]

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2. **Work breakdown structure (WBS)** The work breakdown structure was developed as part of the PERT methodology, although it was not mentioned by name in the 1959 paper that introduced PERT. The term was in widespread use by 1961. [Gregory T. Haugan, *The Work Breakdown Structure in Government Contracting* (Vienna, VA: Management Concepts, 2003), 8.]

3. **Product backlog** The concept of the product backlog predates IT, and was common in industry from the 1920s on. Editors, "Car and Rail Buying Active," *The Iron Trade Review*, vol. LXX, no. 2, p. 121 (Jan. 12, 1922).

4. **Product roadmap** This term spread from Motorola into general IT usage in the late 1980s. Michael Killen, *Saa and Unix: IBM's Open Systems Strategy*. (Whitby, Ont.: McGraw-Hill Ryerson, 1992), p. 64.

5. **Multicriteria decision analysis** This was popularized as a management concept in the 1980s. [Milan Zeleny, *MCDM: Past Decade and Future Trends: A Source Book of Multiple Criteria Decision Making* (Greenwich, CT: JAI Press, 1984).]

6. **Affinity diagrams** Affinity diagrams were devised as part of the total quality management method in the 1970s. [Shigeru Mizuno, *Management for Quality Improvement: The Seven New QC Tools* (New York: Productivity Press, 1988).]

7. **Mind maps** While similar techniques have been used for centuries, the modern mind-mapping technique was developed by British consultant Tony Buzan. Buzan first conceived of the mind map in the 1970s and has continually refined the technique. [Tony Buzan, *How to Mind Map* (New York: Thorsons, 2002).]

8. **Nominal group technique** This technique was invented by researchers Andre Delbecq and Andrew Van de Ven in 1971 to overcome the hesitation some participants might feel in a face-to-face meeting. [Charles M. Judd and Harry T. Reis, *Handbook of Research Methods in Social and Personality Psychology* (Cambridge, MA: Cambridge University Press, 2000), 181.]

9. **Context diagrams** Context diagrams began as a tool for structured analysis management in the 1970s. [Tom DeMarco, *Structured Analysis and System Specification* (New York: Yourdon, 1978).]

10. **Requirements traceability matrix** The requirements traceability matrix was developed in the software industry and was adopted as standard procedure by the US Department of Defense in 1988. [Deborah A. Cerino, Judith A. Clapp, and Wendy W. Peng, *Software Quality Control, Error Analysis, and Testing* (Park Ridge, NJ: Noyes Data Corporation, 1995), 45.]

11. **Timeboxing** The timeboxing concept was widespread in IT by the 1990s, and heavily influenced the development of Scrum and XP (extreme programming). [Steve McConnell, *Rapid Development: Taming Wild Software Schedules* (Redmond, Wash.: Microsoft Press, 1996), 575.]

12. **Project scope statement** The concept of the project scope statement is very old, but the term itself originated in IT projects of the 1970s. [Maurice Blackman, *The Design of Real Time Applications* (Hoboken, NJ: Wiley, 1975), 236.]

13. **Control account** This concept was developed as part of the work breakdown structure; it has been part of the PERT methodology since 1959. [Gregory T. Haugan, *The Work Breakdown Structure in Government Contracting* (Vienna, VA: Management Concepts, 2003).]

14. **Scope creep** This term was coined by the military during the Vietnam War, but it did not become widely popular until the 1990s. [U.S. House of Representatives, *Military Construction Appropriations for 1973* (Washington, D.C.: U.S. Government Printing Office, 1973), 315.]

15. **Decomposition, deconstruction** These terms were developed as part of the work breakdown structure; they have been part of the PERT methodology since 1959. [Gregory T. Haugan, *The Work Breakdown Structure in Government Contracting* (Vienna, VA: Management Concepts, 2003).]

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CHAPTER SIX

1. **Rolling wave planning** See note 5 for chapter 3.
2. **Network diagrams** The network diagram was developed in the 1950s as part of the PERT methodology. [Robert T. Futrell, Donald F. Shafer, and Linda Shafer, *Quality Software Project Management* (Upper Saddle River, NJ: Prentice Hall PTR, 2002), 501.]
3. **Precedence diagramming method** The precedence diagramming method was developed in 1961 by Dr. John Fondahl as an alternative to the critical path method. [Patrick Weaver, "The Origins of Modern Project Management" (lecture, Fourth Annual PMI College of Scheduling Conference, Vancouver, Canada, April 15–17, 2007).]
4. **Mandatory, discretionary, external dependency** The use of these terms in project management dates to the 1980s, when they were popularized as part of the Six Sigma methodology. [Mathematical Sciences Education Board and National Research Council, *Reshaping School Mathematics: A Philosophy and Framework for Curriculum* (Washington, DC: National Academies Press, 1990), 34.]
5. **Lessons learned register** While the general concept of "lessons learned" is centuries old, the lessons learned register is a recent innovation that did not begin appearing regularly in management literature until the first decade of the twenty-first century. [Jonathan Paul Scopes, "London 2012: A New Approach to CDM Coordination," *Proceedings of the Institution of Civil Engineering* 162, no. 2 (May 2009).]
6. **Resource breakdown structure** This concept is related to the work breakdown structure; like that concept, it was also developed as part of the PERT methodology. [Gregory T. Haugan, *The Work Breakdown Structure in Government Contracting* (Vienna, VA: Management Concepts, 2003), 8.]
7. **Story point** The story point concept originated with Ron Jeffries in the 1990s XP (extreme programming) methodology. Kent Beck and Martin Fowler, *Planning Extreme Programming*, (Boston: Addison-Wesley, 2001), p. 61
8. **Analogous estimating** This type of top-down estimation is ancient. The term itself derives from mathematical theory, and its use in project management dates to the 1990s. [American Mathematical Society, *20 Lectures Delivered at the International Congress of Mathematicians* (Providence, RI: American Mathematical Society, 1974), 111.]
9. **Regression analysis** Regression analysis was first developed by the British scientist Sir Francis Galton as part of his research into human heredity in 1886. [Michael Patrick Allen, *Understanding Regression Analysis* (New York: Plenum Press, 1997), 2.]
10. **Heuristics** Heuristics are as old as human language. Modern computer-assisted heuristics can be traced to the work of information theorist Claude Shannon in the 1950s. [Bruce Abramson, *Digital Phoenix: Why the Information Economy Collapsed and How It Will Rise Again* (Cambridge, MA: MIT Press, 2005), 86.]
11. **Three-point estimating** Three-point estimating is part of the PERT methodology. [Christopher D. McKenna, *The World's Newest Profession: Management Consulting in the Twentieth Century* (New York: Cambridge University Press, 2006), 294.]
12. **Beta distribution** This is a statistical term associated with the PERT process. [Rodney D. Stewart, Richard M. Wyskida, and James D. Johannes, *Cost Estimator's Reference Manual* (New York: Wiley, 1995).]
13. **PERT** The concept of PERT was developed in 1957 by a team from the US Navy Special Projects Office, Bureau of Ordinance, and the consulting firm Booz Allen Hamilton. [Patrick Weaver, "A Brief History of Scheduling: Back to the Future" (lecture, myPrimavera06, Canberra, Australia, April 4–6, 2006).]

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14. **Standard deviation (SD)** The term "standard deviation" was invented in 1893 by the mathematician Karl Pearson, although the technique had been used by earlier mathematicians, such as Gauss. [Theodore M. Porter, *Karl Pearson: The Scientific Life in a Statistical Age* (Princeton, NJ: Princeton University Press, 2004), 237.]

15. **Bottom-up estimating** This is an old practice, but time-consuming. Parametric estimating was developed to solve some of the difficulties with bottom-up estimating. [John C. Goodpasture, *Quantitative Methods in Project Management* (Boca Raton, FL: J. Ross, 2004), 89.]

16. **T-shirt sizing** This method spread throughout software development in the late 1990s. Kevin McDonald, Andreas Wilmsmeier, David C. Dixon, and W. H. Inmon, *Mastering the SAP Business Information Warehouse* (New York: Wiley, 2002), p. 458.

17. **Planning Poker** James Grenning devised the planning poker method in 2002. James Grenning, *Planning Poker, or How to avoid analysis paralysis while release planning* (self-published, www.grenning.net, 2002).

18. **Contingency reserve and management reserve** These concepts have been part of financial planning for decades; Samuel Paul suggested integrating reserve analysis techniques into project management in 1982. [Peter W. G. Morris, *The Management of Projects* (London: Telford, 1994), 18.]

19. **Schedule model** This concept was developed by the RAND Corporation in the 1960s and popularized in management theory over the next few years. [William J. Abernathy et al., *A Three-Stage Manpower Planning and Schedule Model* (Stanford, CA: Stanford University Press, 1972).]

20. **Critical path method** The critical path method was developed in 1956 when E. I. du Pont de Nemours was trying to find a use for its UNIVAC computer. James E. Kelley and Morgan Walker presented the critical path method to the public at a conference in 1959. [Patrick Weaver, "A Brief History of Scheduling: Back to the Future" (lecture, myPrimavera06, Canberra, Australia, April 4–6, 2006).]

21. **Near-critical path** This concept was developed as part of the critical path method. [Patrick Weaver, "A Brief History of Scheduling: Back to the Future" (lecture, myPrimavera06, Canberra, Australia, April 4–6, 2006).]

22. **Float** The concept of float is part of the critical path methodology. [Rocco Martino, *Project Management* (Springfield, MO: Management Development Institute, 1968), xiii.]

23. **Schedule compression** Schedule compression and the terms "fast tracking" and "crashing" are part of the critical path methodology. [Charles Heath and James L. Riggs, *Guide to Cost Reduction Through Critical Path Scheduling* (Englewood Cliffs, NJ: Prentice Hall, 1966), 118.]

24. **Crashing** This informal engineering term was popularized in management theory in the 1980s. [American Society of Civil Engineers, *Proceedings of the Second Conference on Computing in Civil Engineering* (Reston, VA: American Society of Civil Engineers), 1980.]

25. **Monte Carlo analysis** The Monte Carlo method was first used in 1930 by Enrico Fermi to calculate the properties of the neutron. It was also used by scientists working on the Manhattan Project during World War II; the development of the electronic computer allowed the Monte Carlo method to be refined in the 1950s. [Jeffrey Seth Rosenthal, *Struck By Lightning: The Curious World of Probabilities* (Washington, DC: Joseph Henry Press, 2006), 186.]

26. **Resource optimization** This is an engineering term that entered management theory in the early twentieth century. [Frank K. Schenck, *Application of Time Study to Foundry Operations* (Flemington, NJ: Foran Foundry, 1955).]

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27. **Resource leveling** This concept was first used in the construction industry; it rapidly spread to other areas of management science in the 1980s. [Thomas J. Driscoll, Stephen B. Hurlbut, and Jon M. Wickwire, *Construction Scheduling: Preparation, Liabilities, and Claims* (New York: Aspen Publishers, 2003), 423.]

28. **Resource smoothing** This concept is taken from the critical path management method. [Paul Barnetson, *Critical Path Planning: Present and Future Techniques* (London: Newnes Books, 1968).]

29. **Velocity** Velocity entered Agile methodology via Scrum, which began using the term in the 1990s. Jeffrey Victor Sutherland, "Business Object Design and Implementation" in OOPSLA '95 Workshop Proceedings (Austin: OOPSLA, 1995), p. 130.

30. **Cumulative flow diagrams** First devised in the early twentieth century, the cumulative flow diagram was introduced into information theory in the 1940s and from there into lean product development and Agile. Donald G. Reinertsen, *Managing the Design Factory* (New York: Free Press, 1997), p. 49.

31. **Milestone charts** Milestone charts were developed in the 1940s. [Patrick Weaver, "The Origins of Modern Project Management" (lecture, Fourth Annual PMI College of Scheduling Conference, Vancouver, Canada, April 15–17, 2007).]

32. **Bar charts** The bar chart was first developed by Karol Adamiecki in 1896; it was popularized and refined during the 1910s by management consultant Henry Gantt. [Peter W. G. Morris, *The Management of Projects* (London: Telford, 1994), 18.]

CHAPTER SEVEN

1. **Rough order of magnitude (ROM) estimate** This type of estimating has been around for a long time, although the title is fairly new. The RAND Corporation developed parametric estimating to refine their ROM estimates. [RAND Corporation, *The Rand Paper Series* (Santa Monica, CA: RAND Corporation, 1988), 17.]

2. **Funding limit reconciliation** This term was recently invented. However, the process it describes—checking costs against the project's budget—has been part of project management since its beginning. [U.S. Department of Defense, *Financial Management in the Department of Defense* (Washington, DC: U.S. Department of Defense, 1954), 21.]

3. **Earned value measurement** The earned value technique was developed by the US Department of Defense in the 1960s as an alternative to the PERT methodology. It began to spread into the corporate world in the 1980s. [Wayne F. Abba, "Earned Value Management: Reconciling Government and Commercial Practices," *PM Magazine*, January/February 1997, 58–63.]

4. **Cost performance index (CPI)** This is a standard accounting term. Its use in project management is derived from US Department of Defense contracts of the 1950s. [Cecil Hamilton Chilton, ed., *Cost Engineering in the Process Industries* (New York: McGraw-Hill, 1960), 337.]

CHAPTER EIGHT

1. **Gold plating** This term is commonplace in contracting; it was already the subject of criticism in a 1962 paper analyzing US defense contracts. [Peter W. G. Morris, *The Management of Projects* (London: Thomas Telford, 1997), 58.]

2. **Kaizen** Masaaki Imai made the term *kaizen* famous in his 1986 book, *Kaizen: The Key to Japan's Competitive Success*. [Masaaki Imai, *Kaizen: The Key to Japan's Competitive Success* (New York: McGraw-Hill, 1986).]

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3. **Total quality management (TQM)** Ways to implement total quality management can be traced to quality gurus such as Philip B. Crosby, W. Edwards Deming, Armand V. Feigenbaum, Kaoru Ishikawa, and Joseph M. Juran. ["Total quality management (TQM)," ASQ Quality Glossary, s.v., accessed October 14, 2008, http://www.asq.org/glossary/t.html.]

4. **Six Sigma** In the late 1980s, Mikel Harry, an engineer at Motorola, developed the concept of Six Sigma, which became a key method for doing business at Motorola. [George Eckes, *The Six Sigma Revolution: How General Electric and Others Turned Process Into Profits* (New York: Wiley, 2001), 5.]

5. **Just in time (JIT)** JIT systems were refined by Japanese corporations during the 1980s, although the process may have originated from the observations of Taiicho Ohno, who studied the stocking systems of US supermarkets during the 1950s. [Ian Inkster, *The Japanese Industrial Economy: Late Development and Cultural Causation* (New York: Routledge, 2001), 106.]

6. **ISO 9000** The ISO (International Organization for Standardization) introduced the ISO 9000 standards in 1987, just as the European Union (EU) was being formed. The adoption of ISO 9000 standards by the EU led to their widespread adoption throughout the world. [Paul A. Nee, *ISO 9000 in Construction* (Hoboken, NJ: Wiley, 1996), 5.]

7. **CISG** This acronym stands for the United Nations Convention on Contracts for the International Sale of Goods, which is a treaty governing international trade. The CISG is in constant change, and the courts of many nations interpret it in different ways. Periodically, conventions have met to reconcile the differing interpretations. [Joseph M. Lookovsky, *Understanding the CISG in the USA.* (The Hague, Netherlands: Kluwer Law International, 2004), 34.]

8. **Benchmarking** The modern benchmarking process originated at Xerox in the 1980s. Dr. Robert Camp was instrumental in developing and popularizing the benchmarking process. [James L. Heskett, W. Earl Sasser, and Leonard A. Schlesinger, *The Value Profit Chain: Treat Employees Like Customers and Customers Like Employees* (New York: Free Press, 2003), 103.]

9. **Cost-benefit analysis** Cost-benefit analysis was fully developed as a technique by the US Army Corps of Engineers in the 1930s. The technique spread throughout the US federal government, and was integrated into corporate planning after World War II. [Michael Power, *Accounting and Science: Natural Inquiry and Commercial Reason* (Cambridge, MA: Cambridge University Press, 1996), 41.]

10. **Cost of quality (COQ)** This concept was developed and refined in the 1980s as part of the Six Sigma methodology. [William Truscott, *Six Sigma: Continual Improvement for Businesses: A Practical Guide* (Boston, MA: Butterworth-Heinemann, 2003), 26.]

11. **Costs of conformance and noncomformance** These concepts—like other concepts in this chapter, such as the cost of quality—were refined in the 1980s as part of the Six Sigma methodology. [William Truscott, *Six Sigma: Continual Improvement for Businesses: A Practical Guide* (Boston, MA: Butterworth-Heinemann, 2003), 26.]

12. **Marginal analysis** Marginal analysis was used by early economists, such as David Ricardo, and revived as a theory in 1934 by economist Joan Robinson. [Kenneth Ewart Boulding and W. Allen Spivey, *Linear Programming and the Theory of the Firm* (New York: Macmillan, 1960), 2.]

13. **Matrix diagram** This tool was popularized in the 1980s after decades of use. [Jack Stone, "Long-Range Planning: One Formula for Success," *Computerworld*, Oct. 20, 1980, 35.]

14. **Cause-and-effect diagram (fishbone diagram, Ishikawa diagram)** The cause-and-effect diagram is sometimes referred to as the "Ishikawa diagram" because it was developed by Kaoru Ishikawa. ["Cause and Effect Diagram," ASQ Quality Glossary, s.v., accessed October 14, 2008, http://www.asq.org/glossary/c.html.]

15. **Histogram** Although the word "histogram" was first coined in 1892, the earliest known histogram appeared in 1786. These tools were well-known and used throughout the nineteenth century. [Yannis Ioannidis, The *History of Histograms (abridged)* (Athens, Greece: University of Athens, 2003), 1.]

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16. **Scatter diagram** The scatter diagram, or scatter plot, was invented by Sir Francis Galton in 1908 as part of his research on human heredity. [A. Reza Hoshmand, *Design of Experiments for Agriculture and the Natural Sciences* (Boca Raton, FL: CRC Press, 2006), 269.]

17. **Design of experiments (DOE)** Experimental design has been a central concern of scientists for centuries. The application of scientific methods to management problems was an important part of the revolution in management science after World War II. [Jiju Antony, *Design of Experiments for Engineers and Scientists* (Oxford: Butterworth-Heinemann, 2003), 29.]

18. **Process analysis** While process analysis is an old concept, it has been refined as part of the Six Sigma methodology. [George Eckes, *Six Sigma for Everyone* (Hoboken, NJ: Wiley, 2003), 49.]

19. **Flowchart** The flowchart was first invented by Frank Gilbreth in 1921 to better document processes and was quickly adopted throughout the management industry. It was refined during the 1940s by researchers at Procter & Gamble, as well as by Princeton's John von Neumann. [Mark R. Lehto and James R. Buck, *Introduction to Human Factors and Ergonomics for Engineers* (New York: Lawrence Erlbaum, 2008), 100.]

20. **Control chart** Walter Shewhart came up with the idea of a production control chart in 1924. [Stuart Crainer, *The Management Century: A Critical Review of 20th Century Thought and Practice* (San Francisco: Jossey-Bass, 2000), 82.]

21. **Control limits** Control limits are part of the control chart, invented by Walter Shewhart at Bell Labs in the 1920s. [W. Edwards Deming, *Out of the Crisis: Quality, Productivity, and Competitive Position* (Cambridge, MA: Cambridge University Press, 1986).]

22. **Specification limits** Specification limits have been a standard statistical term for decades. [Society of Quality Control Engineers, *Industrial Quality Control*, vol. 17 (Buffalo, NY: Society of Quality Control Engineers, 1960).]

23. **Rule of seven** This is a statistical rule of thumb—if seven runs of data produce results on the same side of the target value, then the mean is assumed to have changed. [Christopher Chatfield, *Statistics for Technology: A Course in Applied Statistics* (New York: Chapman and Hall, 1983), 301.]

24. **Assignable cause/special cause variation** This concept was first developed in 1924 by the researcher Walter Shewhart. It was later refined in total quality management and Six Sigma. [William C. Johnson and Richard J. Chvala, *Total Quality in Marketing* (Delray Beach, FL: St. Lucie Press, 1996), 43.]

25. **Pareto chart** The Pareto chart or diagram was defined in 1950 by Joseph M. Juran. It is based on the Pareto principle, which was named after the nineteenth-century economist Vilfredo Pareto. ["Pareto Chart," ASQ Quality Glossary, s.v., accessed October 14, 2008, http://www.asq.org/glossary/p.html.]

26. **Daily stand-up** The idea of a brief and focused "standup meeting" originated in the U.S. military and has been widely used in business for decades. *U.S. House of Representatives, Hearings, Reports and Prints of the House Committee on Science and Astronautics, vol. 2* (Washington, D.C.: U.S. House of Representatives, 1970), p. 1706.

27. **Throughput** The concept was firmly established in IT management by the time the Agile Manifesto emerged. Steven L. Goldman, Roger N. Nagel, and Kenneth Preiss, *Agile Competitors and Virtual Organizations: Strategies for Enriching the Customer* (Hoboken: Wiley, 1994), p. 306.

CHAPTER NINE

1. **Responsibility assignment matrix (RAM)** The RAM was first developed by IT project managers in the 1970s; it spread into wider use over the next decade. [M. D. Wadsworth, *Electronic Data Processing Project Management Controls* (New York: Prentice Hall, 1972), 43.]

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2. **RACI chart** The RACI chart was invented and popularized in the 1990s. [Jeff R. Greenberg and J. R. Lakeland, *A Methodology for Developing and Deploying Internet and Intranet Solutions* (Upper Saddle River, NJ: Prentice Hall, 1998).]

3. **Organizational breakdown structure** After the work breakdown structure became a common tool in industry during the 1980s, the organizational breakdown structure also became widespread. [Peter W. G. Morris, *The Management of Projects* (London: Telford, 1994), 264.]

4. **Resource breakdown structure** See note 6 for chapter 6.

5. **Recognition and reward systems** This term derives from the total quality management method. [Michael B. Weinstein, *Total Quality Safety Management and Auditing* (West Hartford, CT: CRC Press, 1997).]

6. **Halo effect** This effect was first demonstrated with objective data in 1920 by Edward Thorndike, who was studying the ratings of officers in the US Army. Thorndike's findings were quickly applied to business. [Neil J. Salkind and Kristin Rasmussen, *Encyclopedia of Educational Psychology* (Thousand Oaks, CA: Sage, 2008), 458–59.]

7. **Motivation theory** Modern motivation theory has its roots in the work of pioneering economists such as Adam Smith, who asserted that money was the root of all motivation. Twentieth-century psychologists began developing new concepts as part of modern management theory. [Patrick J. Montana and Bruce H. Charnov, *Management* (Happauge, NY: Barron's, 2000), 238.]

8. **McGregor's theory of X and Y** Douglas McGregor introduced this theory in 1960. He hoped to persuade managers to trust their employees, and, therefore, to act according to Theory Y. [Donald Clark, "A Time Capsule of Training and Learning," accessed October 14, 2008, http://www.skagit-watershed.org/~donclark/hrd/history/xy.html.]

9. **Maslow's hierarchy of needs** Abraham Maslow introduced this theory in his 1943 article "A Theory of Human Motivation." While later researchers have questioned Maslow's results, the hierarchy of needs has become accepted wisdom. [Christopher D. Green, "Classics in the History of Psychology," accessed April 16, 2013, http://psychclassics.yorku.ca/Maslow/motivation.htm.]

10. **McClelland's theory of needs** David McClelland first developed this theory at Harvard in the 1960s as part of his research into political power and motivation theory. [Ellen Weisbord, Bruce H. Charnov, and Jonathan Lindsey, *Managing People in Today's Law Firm* (Westport, CT: Quorum Books, 1995), 35.]

11. **Herzberg's two-factor theory of motivation** Frederick Herzberg refined this theory in a series of papers between 1959 and 1968. He hoped to help create a new kind of workplace based on employee satisfaction. [Robert B. Denhardt, Janet Vinzant Denhardt, and Maria Pilar Aristgueta, *Managing Human Behavior in Public and Nonprofit Organizations* (Thousand Oaks, CA: Sage, 2001), 150.]

12. **Forming, storming, norming, performing** Psychologist Bruce Tuckman described the phases of team development as forming, storming, norming, and performing in 1965. He later added a final stage of adjourning, also referred to as mourning. ["Forming, Storming, Norming, and Performing: Helping New Teams Perform Effectively, Quickly," accessed April 16, 2013, http://www.mindtools.com/pages/article/newLDR_86.htm.]

13. **Shu-ha-ri model** The shu-ha-ri model of mastery developed out of Japanese artistic tradition: The Noh playwright Zeami applied the principles of drama to the growth of students, and this spread into martial arts and other fields. Yoshirō Tamura, *Japanese Buddhism: A Cultural History* (Tokyo: Kosei Publishing, 2000), p. 118.

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14. **Dreyfus Model of Adult Skill Aquisition** The researchers Stuart E. Dreyfus and Hubert L. Dreyfus proposed this model while researching training and education for the U.S. military in 1980. Stuart E. Dreyfus and Hubert L. Dreyfus, *A Five-Stage Model of the Mental Activities Involved in Directed Skill Acquisition* (Berkeley, Cal.: Operations Research Center, 1980), 15.

15. **Colocation** In this context, the term dates from the 1990s and the rise of telecommuting. [Donald Reinertsen, *Managing the Design Factory* (New York: Simon & Schuster, 1997).]

16. **Conflict resolution framework** Speed B. Leas developed this theory in 1985 for church leaders. This theory was adapted by agile coaches in the early 2000s. [Speed B. Leas, *Moving Your Church through Conflict* (Herndon, VA: Alban Institute, 1985).]

17. **Expectancy theory** Expectancy theory was developed in 1964 by Victor Vroom of the Yale School of Management to explain the motivations of employees. [Ronald R. Sims, *Managing Organizational Behavior* (Westport, CT: Greenwood Press, 2002), 62.]

18. **Fringe benefits** In 1942, the US War Labor Board approved employee benefits such as health insurance to allow employers to attract new employees. The term "fringe benefit," first used around this time, took several years to gain wide acceptance. [Nelson Lichtenstein, *Labor's War at Home: The CIO in World War II* (Cambridge, MA: Cambridge University Press, 1982), 240.]

CHAPTER TEN

1. **Communication blockers** The term "communication blocker" first appeared in the 1990s in the therapeutic community. It was introduced to project management theory in the early 2000s. [Cornell Cooperative Extension, *Parent-Caregiver Partnerships: Communication Workshops for Parents and Child Care Providers.* (Ithaca, NY: Cornell University, 1992).]

2. Alistair Cockburn, *Agile Software Development: The Cooperative Game*, 2nd ed. (Upper Saddle River, NJ: Addison-Wesley, 2007), 125.

3. **Interactive, push, pull communication** These categories have been used in communication theory for decades. More recently they have been popularized by the explosion of the internet and the replacement of early "pull" technologies, such as websites, with "push" technologies, such as RSS feeds and email updates. [National Association of Women Deans, Administrators and Counselors, *Journal of the National Association of Women Deans, Administrators and Counselors* (1958): 61.]

4. **Communication channels** The literal meaning of this term quickly gave rise to a metaphorical use in psychological theory. By the end of the 1960s, this new usage was widespread. [Wiener, Morton, and Mehrabian, Albert. *Language Within Language: Immediacy, a Channel in Verbal Communication.* (New York: Appleton-Century-Crofts, 1968).]

5. **Trend report** The concept of the trend report arose in the scientific management movement of the 1920s; it gained wide popularity in the 1930s because of the planning documents of the New Deal. [National Opinion Research Center, *Do Americans Support Gasoline Rationing? Trend Report Based on Eight Nation-wide Surveys.* (Denver, CO: University of Denver, 1943).]

6. **Forecasting report** The concept of forecasting arose in the nineteenth century in the field of meteorology. It was applied to management by the scientific management movement of the 1920s. [*The Problems of Business Forecasting*,William Persons, ed. (Boston: Houghton Mifflin, 1924).]

7. **Variance report** This is an accounting term; its use in project management dates to the 1970s. [Harold Kerzner, *Project Management: A Systems Approach to Planning, Scheduling, and Controlling* (New York: Van Nostrand Reinhold, 1979), 447.]

8. **Earned value report** Earned value management techniques were first developed and used by the US government in the 1960s. [David I. Cleland and Lewis R. Ireland, *Project Manager's Portable Handbook* (New York: McGraw-Hill, 2004), 389.]

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9. **Information radiators** Alistair Cockburn coined this term in 2000 while working to develop the principles of Agile software development, introducing it widely in his 2001 work, *Agile Software Development.* [Alistair Cockburn, *Agile Software Development: The Cooperative Game,* 2nd ed. (Upper Saddle River, NJ: Addison-Wesley, 2007), 504.]

CHAPTER ELEVEN

1. **Risk management** The concept of risk management exploded out of the insurance industry to become nearly universal in management theory during the 1960s. [U.S. Department of Agriculture, *Farmers' Bulletin No. 2137: Insurance Facts for Farmers* (Washington, D.C.: U.S. Government Printing Office, 1967), 3.]
2. **Spike** The concept of spikes originated with Kent Beck, a leading figure in the 1990s Extreme Programming movement. Agile Learning Labs, "Spike" (http://agiledictionary.com/209/spike/: Retrieved on April 13, 2020), 2010.
3. **Fast failure** This idea originated in a quote from Tom Peters: "Test fast, fail fast, adjust fast." Tom Peters, *Thriving on Chaos: Handbook for a Management Revolution* (New York: HarperPerennial, 1987), p. 479
4. **Risk response** This idea came into widespread use as the discipline of risk management moved from insurance to general management. [Lindon J. Robison and Garth Carman. "Aggregate Risk Response Models and Market Equilibrium," in *Risk Management in Agriculture: Behavioral, Managerial and Policy Issues* (Champaign, Ill.: University of Illinois Press, 1979), 139.]
5. **Root cause analysis** Root cause analysis was first developed in the 1950s by the US Department of Energy to investigate industrial (and specifically nuclear) accidents. The methodology was refined by the healthcare field, and became popular in management science in the 1980s. [B. S. Dhillon, *Reliability Technology, Human Error, and Quality in Health Care* (Boca Raton, FL: CRC Press, 2008), 45.]
6. **Strengths, weaknesses, opportunities, and threats (SWOT) analysis** SWOT analysis was developed by Albert Humphrey of Stanford University to improve long-range planning techniques. Humphrey and his colleagues introduced SWOT in 1964, and the first prototype project using SWOT was completed in 1973. [Regina Fazio Maruca, *The Way We Work: An Encyclopedia of Business Culture* (Westport, CT: Greenwood Press, 2008), 244.]
7. **Project pre-mortem** This technique was developed by psychologist Gary Klein in the 1990s; it became widely popular a decade later. Gary Klein, "Performing a Project Premortem," *The Harvard Business Review*, vol. 85, no. 9, pp. 18-19 (September 2007).
8. **Risk register** The concept of the risk register began in the United Kingdom as a medical tool in the 1960s; it was later adopted as a project management tool. [Fred Grundy, *The New Public Health: An Introduction to Personal Health and the Welfare Services for Health Visitors, Social Workers and Midwives* (London: H. K. Lewis, 1968), 63.]
9. **Qualitative risk analysis** In its simplest form—thinking carefully about the risks of any project—qualitative risk analysis is as old as civilization. In its modern sense, qualitative risk analysis and the related terms in this chapter have been developed over the last few decades; the term itself first appeared in the 1970s. [Tom Kendrick, *Identifying and Managing Project Risk: Essential Tools for Failure-Proofing Your Project* (New York: AMACOM, 2003), 165.]
10. **Probability and impact matrix** This tool was devised by researcher D. C. Hague in 1984. [Sui Pheng Low, *Marketing Research in the Global Construction Industry* (Singapore: Singapore University Press, 1993).]

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11. **Quantitative risk analysis** As the concept of risk management moved from insurance to general management, the idea of quantitative risk management moved with it. [Mohammed Gahin, *A Theory of Pure Risk Management in the Business Firm*. (Madison, WI: University of Wisconsin Press, 1966), 214.]

12. **Sensitivity analysis** Originally an engineering term, sensitivity analysis entered management theory in the 1960s. [Rajko Tomovic, *Sensitivity Analysis of Dynamic Systems* (New York: McGraw-Hill, 1963).]

13. **Tornado diagram** Introduced in the 1980s, the tornado diagram became a popular management tool in the 1990s. [Robert M. Oliver and J. Q. Smith, *Influence Diagrams, Belief Nets, and Decision Analysis* (New York: Wiley, 1990).]

14. **Decision tree** This concept is very old—an excellent early example is the system invented by Carl Linnaeus in the 1730s to classify species by kingdom, phylum, and class. [Michael J. A. Berry and Gordon Linoff, *Data Mining Techniques for Marketing, Sales, and Customer Relationship Management*, 2nd ed. (Indianapolis, IN: Wiley, 2004), 166.]

15. **Pure (insurable) risk** This term was invented in Britain in the nineteenth century, as the first modern insurance companies were taking shape. [J. M. Ross, ed., *The Globe Encyclopaedia of Universal Information* (Edinburgh, UK: Grange, 1877), 507.]

16. **Residual risks** Residual risk was defined as a business term during the scientific management movement after World War I. By 1922, it was familiar to many managers and business owners. [Fred Emerson Clark, *Principles of Marketing* (New York: Macmillan, 1922), 361.]

17. **Risk trigger** This term was in general use by 1980. [United States House of Representatives, *Oversight Hearing on the Child Labor Provisions of the Fair Labor Standards Act* (Washington, DC: US General Printing Office, 1980).]

18. **Reserves (contingency)** The concept of contingency reserve has been used in creating business and government budgets for over a century. It was popularized during the scientific management movement of the 1920s. [Actuarial Society of America, *Transactions* (New York: Actuarial Society of America, 1907), 109.]

19. **Risk backlog** The concept of a dedicated risk backlog arose in economics in the 1970s. Simon Rottenberg, *The Economics of Medical Malpractice* (Washington, DC: American Enterprise Institute for Public Policy Research, 1978), p. 237

20. **Risk thresholds** The concept of a risk threshold became widely popular as a business term in the 1960s. It originated as a medical term and spread into business through engineering. [Max H. O'Connell, *Aircraft Noise* (Brooks City, TX: US Air Force School of Aerospace Medicine, 1960), 2.]

21. **Risk audits** This concept was first used for managing serious problems such as epidemics and disasters. The concept spread in the 1990s to apply to project management. [Alan E. Boyle, *Environmental Regulation and Economic Growth* (Oxford: Oxford University Press, 1994), 42.]

22. **Risk burndown chart** The application of the burndown chart methodology to risk was created in 2004 by John Brothers and became widely popular about a decade ago. David Hillson, *Managing Risk in Projects* (Aldershot, UK: Gower, 2009), p. 122

CHAPTER TWELVE

1. **Procurement management** Procurement management as a discipline dates to the 1930s, when the federal government massively increased spending and began organizing a number of large, long-term projects. [Michael C. Loulakis, ed., *Design-Build for the Public Sector* (New York: Aspen, 2003), 61.]

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2. **Bid and procurement documents** These terms have been in general use since the 1930s, having originated in federal government contracts. The massive expansion of the federal government in the 1930s due to the Great Depression and the outbreak of World War II required the creation of new terms and processes to manage large contracts. [U.S. Interior Department, *Interior Department Appropriation Bill for 1940* (Washington, D.C.: U.S. Government Printing Office, 1940), 125.]

3. **Fixed-price, time and material, cost-reimbursable contracts** Contract law has distinguished between these types of contracts for a long time—the term "fixed-price contract" appears in legal documents from 1845. These contract types were defined by the US government in the late nineteenth century to streamline military procurement. [US Office of the Federal Register, *Code of Federal Regulations* (Washington, DC: US National Archives, 1901), 15.]

4. **Fixed-price with economic price adjustment (FPEPA)** Introduced in government contracting in the late 1980s, this term quickly entered use in private procurement in the 1990s. [John J. Marciniak, *Encyclopedia of Software Engineering*, vol. 1, *Acquisitions–Outsourcing* (New York: Wiley, 1994).]

5. **Target price, sharing ratio, ceiling price** The use of these standard terms was popularized by the RFPs issued by the US government after World War II. [A. Michael Agapos, *Government-Industry and Defense: Economics and Administration* (Tuscaloosa, AL: University of Alabama Press, 1975), 164.]

6. **Sharing ratio** See note 5.

7. **Ceiling price** See note 5.

8. **Point of total assumption (PTA)** The term "total assumption" has a long history, having been used in government contracts and debates since the nineteenth century. "Point of total assumption" is a newer term that was introduced by the US government. [John W. Langford, *Logistics: Principles and Applications* (New York: McGraw-Hill, 2007), 207.]

9. **Make-or-buy analysis** This process relies heavily on the research of consultant Michael Porter, who introduced analytical tools for make-or-buy analysis in the 1980s. [Chris Argyris, Derek F. Channon, and Cary L. Cooper, *The Concise Blackwell Encyclopedia of Management* (Malden, MA: Blackwell Business, 1998), 681.]

10. **Source selection criteria** This term entered government contracts in the 1960s and spread into private sector procurement in the 1970s. [Frederick M. Scherer, *The Weapons Acquisition Process: Economic Incentives* (Boston: Harvard University Press, 1964).]

11. **Statement of work** The first clearly defined statement of work in the modern sense was published in 1908 by the US government, which issued requirements for an airplane prototype to be purchased by the US Army. [Michael G. Martin, *Delivering Product Excellence with the Statement of Work* (Vienna, VA: Management Concepts, 2003), 4.]

12. **Bidder conferences** These conferences became common after the concept was introduced at the 1959 conference of the American Society for Quality Control. [American Society for Quality Control, *National Convention Transactions, 1959* (Milwaukee, WI: American Society for Quality Control, 1959), 438.]

13. **RFP, IFB, RFQ** These terms were first used in the nineteenth century. The US government pioneered procurement law, with the first such law in 1795. Corporations adopted many later refinements of procurement by the US federal government. [Margaret M. Worthington, Louis P. Goldsman, and Frank M. Alston, *Contracting with the Federal Government* (New York: Wiley, 1998), 1.]

14. **Weighting system** The concept of a weighting system has a long history in economics. The application of this term to project management, and specifically to contracting, is fairly recent. [Michael Greer, *The Project Manager's Partner: A Step-by-Step Guide to Project Management* (Amherst, MA: Human Resource Development Press, 2001), 108.]

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15. **Contract change control system** When the concept of change control was introduced in the 1970s, it was quickly adapted for use with contracts, since many of the companies that used change control for IT projects were also government contractors. [Philip A. Metzger, *Managing a Programming Project* (New York: Prentice-Hall, 1973), 84.]

CHAPTER THIRTEEN

1. **Stakeholders** The concept of stakeholders became central to management in 1984, when R. Edward Freeman published his book *Strategic Management: A Stakeholder Approach.* [Robert Y. Cavana and Arun A. Elias, "Stakeholder Analysis for Systems Thinking and Modelling." Paper presented at ORSNZ, Wellington, New Zealand, December 2000.]
2. **Brainstorming/brain writing** The term "brainstorm" was coined in the nineteenth century and first used as a verb in the 1920s. An ad agency in the 1930s was the first to hold a "brainstorming session," and the idea became a standard part of business management in the mid-1950s. [Metcalf, Allan and Barnhart, David K., *America in So Many Words: Words That Have Shaped America* (New York: Houghton Mifflin Harcourt, 1997), 221.]
3. **Power/interest grid** Researchers Kevan Scholes and Gerry Johnson created the power/interest grid to help managers assess the engagement and strength of project stakeholders. [Gerry Johnson and Kevan Scholes, *Exploring Corporate Strategy*, 3rd ed. (New York: Prentice Hall, 1993), 184.]
4. **Stakeholder cube** The concept of the power/interest grid quickly took hold in the 1990s and was expanded into the stakeholder cube to take into account a third variable, attitude. [*GIS Applications in Natural Resources 2* (New York: GIS World Books, 1996), 52.]
5. **Salience model** Although the salience model has been used in the social sciences since the 1970s, the application of this model to project stakeholders was developed in 1997 by Mitchell, Agle, and Wood. [Ronald K. Mitchell, Bradley R. Agle and Donna J. Woo, "Toward a Theory of Stakeholder Identification and Salience: Defining the Principle of Who and What Really Counts," *The Academy of Management Review* 22, no. 4 (Oct. 1997): 853–86.]
6. **Personas** The concept of the stakeholder persona originated in organizational behavior studies in the 1990s. [Janet W. Wohlberg and Scott Weighart, *OB in Action: Cases and Exercises* (Boston: Houghton Mifflin, 1992), p. 5.]
7. **Gulf of evaluation** Donald Norman coined this term in his 1988 book The Design of Everyday Things. [Donald Norman, *The Design of Everyday Things* (New York: Basic Books, 1988) p. 51.]
8. **Stakeholder engagement assessment matrix** The stakeholder engagement matrix was developed in 1991 by a team of researchers at the Academy of Management. [Grant T. Savage, Timothy W. Nix, Carlton J. Whitehead, and John D. Blair, "Strategies for Assessing and Managing Organizational Stakeholders," *The Executive* 5, no. 2 (May 1991): 61–75.]
9. **Elevator statement** There are several possible origin stories, but the idea of the "elevator pitch" has been circulating broadly for decades. [Gerald J. Hahn, "Statistics-aided manufacturing: A look into the future," in *The American Statistician*, vol. 43, no. 2, pp. 74-79 (May 1989).]

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