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Eighth Edition

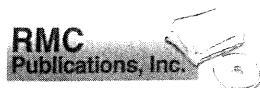
Aligned with the PMBOK® Guide, Fifth Edition

Rita Mulcahy, PMP, et al.

PMP® Exam Prep

Accelerated Learning to Pass PMI®'s PMP Exam

By Rita Mulcahy, PMP, et. al



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By Rita Mulcahy, PMP, et al.

Printed in the United States of America

First Printing

ISBN 978-1-932735-65-9

Library of Congress Control Number: 2013909006

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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.

Acknowledgments

The following people made invaluable contributions to this book:

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Introduction to PMP® Exam Prep, Eighth Edition

Welcome to the eighth edition of *PMP® Exam Prep*. It's hard to believe we're at the eighth edition already. It seems like only yesterday Rita was publishing the first edition of the book.

Looking back, we've come so far since the publication of that original edition in 1998. RMC has come a long way, as has the entire project management profession. Back when the first edition was published, project management, while not in its infancy, was still a young profession. That first edition of *PMP® Exam Prep* was only 170 pages long.

Over the years the profession has grown. The practice of project management has gotten more complex. Indeed, back when *PMP® Exam Prep* was first published, the vast majority of certified project managers practiced within the United States. This is no longer the case. Now there are more PMPs outside the United States than within. Indeed, this growing complexity is further demonstrated by recent changes in the exam necessitating the publication of the eighth edition.

First, there is a new emphasis on working with and engaging stakeholders throughout the project management process: the *PMBOK® Guide* has moved its coverage of stakeholders from the communications management knowledge area into its own, expanded knowledge area. We expect this new emphasis to be an important part of the PMP exam going forward. To reflect this change we have significantly updated our Communications Management chapter and have added a new Stakeholder Management chapter, largely written by Barbara Carkenord. Just so you know, Barbara is a rock star in business analysis as well as a PMP. She was a cofounder of B2T Training and has written several books in the field of business analysis, including the International Institute of Business Analysis™ (IIBA®) exam preparation materials published by RMC. We're thrilled to have her as part of our team, and she's made a great contribution to *PMP® Exam Prep* through her work on the Stakeholder Management chapter.

Another big change is the creation of several new planning processes in the *PMBOK® Guide*, including Plan Scope Management, Plan Schedule Management, and Plan Cost Management. And the *PMBOK® Guide* has added countless other updates throughout the knowledge areas. These changes required the creation of the new edition of the book. Great as it was, the seventh edition can no longer be relied upon as a study tool to pass the PMP exam.

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

Another thing that has remained the same is our continued commitment to helping our students, not only to pass the exam but to become better project managers. At the end of the day, 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 solely to spit them back on an exam and 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. Once 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 in this book is to get you to pass the exam on the first try.

Finally, I couldn't allow this book to go out the door without acknowledging the efforts of the RMC staff in making this happen. In particular, I'd like to thank Deborah Kaufman, Lead Development Editor here at RMC, and Sonja Almlie, Senior Instructor, for all their dedication and hard work. Without their efforts this book would not have been possible.

So enjoy the book, learn, and have fun.

What are you waiting for? Go get 'em.

Tim Mulcahy
President and CEO
RMC Project Management and RMC Publications

History of This Book

The first edition of Rita Mulcahy's *PMP® Exam Prep* was published in 1998, and at the time 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* in less than a week. Since then, the popularity of the book has grown immensely through eight wildly successful editions, and today the book is by far the best-selling PMP exam preparation guide in the world. By the end of 2012, there were hundreds of thousands of copies in circulation worldwide in three different languages, with several more translations to come.

In September of 2005, Rita was diagnosed with Stage 4 Inflammatory Breast Cancer (IBC), just days before back-to-back speaking appearances at PMI Global Congress in Toronto, Ontario. Given only months to live, Rita spent the next five years privately fighting her disease with a continuous regimen of both Western and holistic treatments. During that time she continued to work, authoring five more best-selling books, including *Risk Management; Tricks of the Trade® for Project Managers*, which won PMI's Professional Development Product of the Year award; and *PM Crash Course™ for IT Professionals*, co-published with Fortune 100 leader Cisco Systems. Rita also continued to deliver classes and keynote speeches across the globe and spent a great deal of time growing her business, watching RMC expand its training and product distribution to nearly 50 regions worldwide. For five years after her diagnosis, Rita worked feverishly to build RMC into one of the fastest-growing training organizations in the industry.

Tragically, Rita passed away on May 15, 2010. RMC continues her mission today with the eighth 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. Available in English, Brazilian Portuguese, and Spanish, *PMP® Exam Prep* and its related products are used as stand-alone study tools by hundreds of thousands of project managers across the globe, and in hundreds of classroom-based prep classes at universities, training companies, and corporations large and small.

Free Updates 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 www.rmcproject.com/extras. Have this book with you when you go to the website.

We Need You to Help Us Stop Copyright Infringement As the publisher of the best-selling PMP exam prep book on the market, RMC is also, unfortunately, the most illegally copied. It is true that many people use our materials legally and with our permission to teach PMP exam preparation. However, from time to time, we are made aware of others who copy our exam questions, Tricks of the Trade*, and other content illegally and use them for their own financial gain.

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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 e-mail at pmp@rmcproject.com.

Tricks of the Trade® for Studying for This Exam

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Why Take the PMP Exam?

Preparing to take the PMP exam is a journey. If you let it, this journey can help you expand yourself and your abilities. In preparing for the exam, you have an opportunity to become a better project manager, not just pass the exam. 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 retain it just long enough to get through the four-hour testing period. Instead, you need to take your knowledge to the next level. You need to truly understand the process of project management and what value that process can bring to your daily work on projects. The PMP exam is an international exam designed to prove your knowledge and experience in applying the art and science of project management. The exam focuses on situations you might encounter in the real world, rather than just asking you to repeat data you have learned. Achieving the PMP certification is a way to set yourself apart.

In addition to the opportunity to improve yourself and your abilities, there can be financial incentives for passing the exam. A salary survey by the Project Management Institute (PMI®) has found that PMP-certified project managers in the United States are paid on average 16 percent more than those without this certification. RMC has had students who received a bonus and a raise when they passed the exam. Others have said they got a job over 200 others because they were PMP certified. In this economic climate, 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 this exam, you must meet the requirements outlined by PMI. The current requirements are described in the following table.

Category	General Education	Project Management Education	Project Management Experience		Number of Questions
One	Bachelor's degree	35 contact hours	4,500 hours	Three years	200
Two	High school graduate	35 contact hours	7,500 hours	Five years	

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RMC offers CAPM exam prep courses (classroom or online training) and a CAPM Exam Prep System of products to use in preparing for the CAPM exam. Visit www.rmcproject.com for more information about this series of products.

Remember, just because you qualify on paper to take the exam does not mean you will be able to pass it! You must know project management and have experience applying it. Consider taking PMI's CAPM® exam if you do not meet the requirements in the previous table. You can find the requirements for the CAPM exam at www.pmi.org. At the time this book was published, CAPM test takers were required to document 1,500 hours of experience working on projects or 23 hours of project management education to qualify for this exam.

Are You Ready for the PMP Exam?

In RMC's experience, 50 percent 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*. The *PMBOK® Guide* helps you improve your knowledge, but it does not teach you project management. And while this exam prep book will explain the project management process and help you understand it from PMI's perspective, if you find that many of the concepts and terms presented in this book are new to you, you probably need additional project management training before continuing to study.

Another large percentage of the people who fail this exam do not have real-world experience. They may be managing a help desk or small projects or might not even work as a project manager. This exam is designed to identify those who have not had project management training and who do not have experience. It is not an exam for a beginning project manager or for one who hopes to become a project manager. The more experience you have had working on large projects, the better prepared you will be for the exam: you're more likely to have worked with the tools and techniques and have created the outputs as described in the *PMBOK® Guide* on a large project. It's therefore helpful to answer questions on the exam from the perspective of managing large projects.

The following are examples of large projects:

- Designing a new call center (vs. handling small call center projects)
- Designing a new manufacturing process (vs. manufacturing a standard product for a customer)
- Installing commercial software across the company (vs. installing a PC desktop operating system and associated software updates)
- Designing and constructing a new building (vs. getting an existing building repainted)

What level are you at in your knowledge of project management? Review the following list. 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
- People on the team are unsure of 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 concepts on the exam. Do you understand these concepts and currently apply them to your real-world projects?

- The step-by-step process for managing projects, and why each step is necessary
- Roles of the project manager, sponsor, team, and stakeholders
- The use of historical information from previous projects
- The use of lessons learned from previous projects
- The creation of lessons learned on your project
- Project charter
- What a work breakdown structure is (not a list or a bar chart) and how to create it
- How to manually create a network diagram
- Critical path—how to find it and what benefits it provides the project manager
- Three-point estimating
- Monte Carlo analysis
- Earned value measurement
- Schedule compression (crashing and fast tracking)
- Managing float
- A realistic schedule
- Managing the quality of both the project and the resulting product
- Developing relationships with stakeholders, and keeping them interested and involved in the project
- The risk management process (risk management is not just using a checklist)
- Expected monetary value
- Calculating reserves and their relationship to risk management
- A realistic and approved project management plan that you are willing to be held accountable to achieving
- Controlling the project to the project management plan
- Managing the change request process
- Controlling change
- The professional and social responsibility of the project manager

If you don't know (or don't do) many of the items on this list, we suggest you take our 3-day PM Tricks of the Trade® in-person class or the Live Online version. Either course will assist you in dealing with situational questions on the exam, and will also give you over half of the contact hours required to sit for the PMP exam. Please visit [www.rmcproject.com](http://rmcproject.com) or call (952) 846-4484 for more information.

Keep in mind that on large projects, the project manager does not have time to do the wrong project management activities. The project can easily get out of control if the project manager spends too much time on efforts like solving problems rather than preventing them or babysitting people instead of making sure they know what they need to do before the project starts. When preparing for this exam, think about the concepts presented in this book and in 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 this exam. Applications may be submitted by mail or online. Submit online if at all possible, since PMI's response time is faster for electronic submissions. In addition, the online application process makes it easier for you to document your project management hours and experience while adhering to the application guidelines. (There are numerous non-PMI-created spreadsheets available online for documenting your project management experience, but using them often means you'll end up duplicating your application efforts.) You will receive a notice authorizing you to make an appointment to take the exam. You may be subject to an audit of your application before it is approved. Be aware that an audit will delay your authorization to take the exam.

The exam is usually offered on a computer at designated testing sites, but it might be different depending on the country you are in. Your authorization notice will give you specific instructions. PMI is quickly moving to offer computerized testing around the world in many languages.

Tricks of the Trade® for Studying for This Exam

ONE

ONCE YOU RECEIVE YOUR AUTHORIZATION NOTICE, 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.) In some instances, testing centers may not have openings for several weeks.

How to Use This Book

Be Sure You Have Current Materials for the Exam Before you begin using this book, you should 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. To confirm that you are using the correct edition, visit www.rmcproject.com.

How This Book Is Organized Most chapters are organized the same way: an introductory discussion, a list of Quicktest topics (generally listed in order of importance), Rita's Process Chart, review materials, and a practice exam. All page references in this book refer to the *PMBOK® Guide, Fifth Edition*, unless otherwise stated. The *PMP® Exam Prep* book can be used alone, but it is also designed to be part of an exam prep system with RMC's *PM FASTrack®* exam simulation software and *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.

Quicktest

The list at the beginning of each chapter indicates the topics covered in the chapter and our impression as to their general order of importance. Refer back to this list when you are finished with each chapter, to test your knowledge of the chapter contents and to review what is most important.

Rita's Process Chart

Created in 1998 for the first edition of this book, this chart has been greatly expanded to help you understand the process of managing a project. The chart is a key trick for passing the exam with less study. You will first see this chart in chapter 3, Project Management Processes. It then appears in most of the remaining chapters in the book, with the relevant processes highlighted for each chapter. Use the repeated chart at the beginning of each chapter 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 many exercises. 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 jump 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. They will help you pass the exam.

The answers are listed immediately following the exercises. Although some readers wish the answers were shown later in the book, we have found that it is more effective to place them right after the exercises. If you want to keep yourself from seeing the answers, here is a trick: keep a blank piece of paper handy to cover the answers until you have completed each exercise and are ready to review them.

The questions in this book are tests on the chapter content. They do not simulate the complete range and depth of the PMP exam questions. You can find such a simulation in RMC's *PM FASTrack®* exam simulation software.

ON THE TRICKS OF THE TRADE® Tricks of the Trade® for Studying for This Exam



Also included in the review material are tricks to passing the exam called Tricks of the Trade® (a registered trademark of RMC). The tricks are designated by this image and will give you some extra insight on what you need to know about project management. Many of the Tricks of the Trade® first described or presented in this book have since become industry standards.



Our method of helping you prepare for the exam does NOT focus on rote memorization. The few things you should memorize are designated by this "memory finger" image.

Practice Exam

The practice exam at the end of each chapter allows you to review the material and test your understanding. On the following pages, you will find a score sheet to use as you take the practice exams. Make a copy of it for each practice exam.

NOTE: You cannot simply practice answering questions to prepare for this exam. The questions in this book and in *PM FASTrack®* are provided to help you assess your knowledge and to get you familiar with the types of questions that are on the exam. Make sure you focus your study efforts on reading this book, doing the exercises and review activities, and filling gaps in your project management knowledge.

Notes

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 the book. This information is NOT tested on the exam. It is simply provided for your interest and reference, if you choose to read the notes. For some people, understanding the development of an idea helps them remember it better. For others, such information is a distraction. If you find the notes distracting, DO NOT continue to read them. Instead, focus your study efforts on the main body of this book.

Tricks of the Trade® for Studying for This Exam

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Score Sheet

Use this score sheet to test your understanding. Make a copy of it for each chapter's practice exam. (NOTE: If you are using RMC's full PMP Exam Prep System, please see the study plan instructions on page 14.)

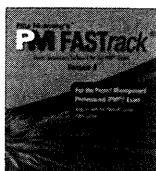
Question Number	First Time	Why I Got the Question Wrong	Second Time	Why I Got the Question Wrong
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Total Score	First Time		Second Time	
How will I improve how I take the exam next time?				

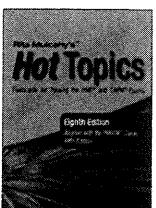
Other Materials to Use to Study for the PMP Exam

You can use this book as a stand-alone prep tool, or it can be combined 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.



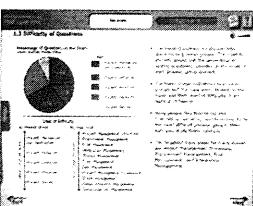
Rita Mulcahy's™ PM FASTrack® Exam Simulation Software (CD OR DOWNLOADABLE)

Our *PM FASTrack*® exam simulation software offers over 1,500 questions—including tricky situational questions with more than one “right” answer. In addition to this book, *PM FASTrack*® is the most important product for passing the exam. The software 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 with comprehensive grading and reporting capability. All questions are cross-referenced with this book or the *PMBOK® Guide*, making it easy to go back and study weak areas. Users say these questions are harder than the ones on the actual exam!



Rita Mulcahy's™ Hot Topics Flashcards (HARD COPY OR AUDIO CD)

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 in your car with RMC's portable and extremely valuable *Hot Topics* flashcards—in hard copy or audio CD format! Over 600 pages of the most important and difficult-to-recall PMP exam-related terms and definitions are now available for study as you drive, fly, or take your lunch break. Add instant mobility to your study routine.



PMP® Exam Prep—Online

This self-directed e-Learning course for the PMP exam offers over 150 video and audio clips, a 17-lesson interactive tutorial, dozens of exercises and games, multimedia flashcards, unlimited timed and scored practice exams, page number references back to the *PMBOK® Guide*, and all 35 contact hours necessary to apply to sit for the PMP exam. Includes a comprehensive document library and six months of unlimited access to all materials!

PMBOk® Guide, Fifth Edition

The *PMBOk® Guide, Fifth Edition* (2013), is the international standard for project management from the Project Management Institute (PMI).

What Is the PMP Exam Like?

Keep in mind three very important things about this exam. First, THE PMP 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* is critical! However, do not let any organization fool you into thinking you need weeks of training or a master's certificate in project management to take the exam.

The PMP 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

ONCE Tricks of the Trade® for Studying for This Exam

placed throughout the exam. You will not know which ones are which. They will be used by PMI to validate the questions for future inclusion in the master database. Your score will be calculated based on your response to the remaining 175 questions. PMI has not published 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 out of 175 answered correctly).

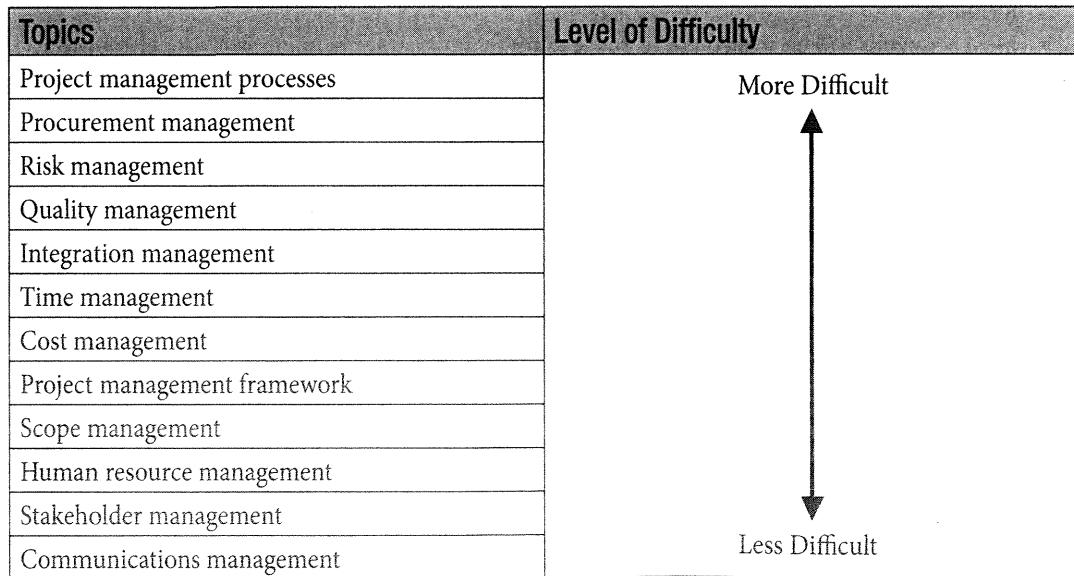
The questions are randomly generated from a database containing hundreds of questions. The questions may jump from topic to topic, and a single question may integrate multiple concepts. You get one point for each correct answer. There is no penalty for wrong answers.

The following table breaks out the percentage of scored questions currently on the exam in each process group:

Project Management Process Group	Percentage of Questions
Project initiating	13%
Project planning	24%
Project executing	30%
Project monitoring and controlling	25%
Project closing	8%

PMI occasionally makes changes to aspects of the exam, including qualification requirements, the application process, the passing score, and the breakdown of questions in each process group. For the latest information, please visit www.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 and their level of difficulty. For many people, the most difficult areas are project management processes, procurement management, risk management, quality management, and integration management.



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This next diagram indicates the level of difficulty of the process groups. Many people find project monitoring and controlling, executing, and initiating to be the most difficult. Make sure you study these carefully.

Project Management Process Group	Level of Difficulty
Project monitoring and controlling	More Difficult
Project executing	
Project initiating	
Project planning	
Project closing	Less Difficult

Be aware of the following for the exam:

- The PMP exam tests knowledge, application, and analysis. This makes the PMP 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.
- It is important to realize the PMP exam deals with real-world use of project management. The majority of the questions are situational (e.g., “What would you do in this situation?”). For those who have not used project management tools in the real world or whose project management efforts include common errors, these questions can be extremely difficult. You need to have “been there.”
- There may be instances on the exam where the same data is used for multiple questions, such as with network diagram questions.
- It always feels like more for the test taker, but historically, there have been only 10 to 12 questions requiring you to identify inputs or outputs from the *PMBOK® Guide*. To answer these questions correctly, however, you need to know more than just the input and output names: you need to understand the processes involved and how the inputs feed into and outputs result from the processes. (Inputs and outputs are discussed in later chapters.)
- Expect 10 to 15 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 (e.g., the exam typically uses the full term “work breakdown structure” rather than “WBS”), but you should know both the acronym and the full term.
- The correct answers should not include direct quotations from the *PMBOK® Guide*.
- Most people feel uncertain of only 40 or fewer of the 200 questions on the PMP exam.
- Many people need about two and a half hours to finish the first pass through the PMP exam and then take the rest of the time to review their answers.

The questions on the exam are mostly situational, many are ambiguous and very 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:

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

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- A. Replan your project to accommodate this delay.
- B. Notify your boss.
- 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 or less-qualified project managers would be likely to choose.

As you go through questions and review the answers in this book (or in *PM FASTrack** for PMP Exam Prep System users), look for questions for which you think there is 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 and have provided 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 certainly D, but isn't it also correct to tell the customer? Yes, but that is not the *first* thing to do. Essentially this question is really saying, "What is the BEST thing to do NEXT?" As you answer practice questions, keep in mind this 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 very 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

Many questions will be much longer than this one, possibly several paragraphs long. But again, you may not need all the information presented to answer the question. For example, imagine we changed the previous question to be wordier. It might read as follows:

"Your company is a major manufacturer of doors, and has received numerous awards for quality. As the head of the manufacturing department, you have 230 people reporting to you on 23 different projects. 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..."

Can you see how the additional data does not add any value to the question? The data is a distracter. On the exam, you may see whole paragraphs of data that are not needed to answer the question. The trick is to look at each question to determine "What is this question asking

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about?" rather than getting lost in all the information provided. You then need to determine what information to focus on to select the best answer to the question. Do not get upset if you have difficulty with these long, wordy questions. Just mark them, and come back to them later. If you know what to expect, you will stay calm and not lose confidence when you see such questions.

4. **Questions using made-up terms** Many people taking the exam expect that all the terms used as choices should mean something. They do not! There are often made-up terms on the exam. Perhaps the question writer needed another choice, or perhaps the made-up terms are added to trick test takers. If you consider yourself well trained and see a term you do not know on the exam, 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.

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, as well as the concept of decomposition and what value this technique has in the project management process. Memorization is not enough!

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 in the way the question describes. 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

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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.

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. If you are not a native English speaker, this can be an especially big problem, but it is also difficult for native English speakers. Just take your time, and practice reading wordy questions before you take the exam.

See chapter 15 of this book for more information on the exam, and additional help in assimilating the information provided throughout this book.

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 these mistakes! You should not read every book you can find, and there is a risk in overstudying. Instead, we recommend the following approach:

The Magic Three Studies have shown that if you visit a topic three times, you will remember it. Therefore, you should read this book once and skim through it two more times, focusing most on the activities you do not do in the real world or the concepts you have trouble understanding, in addition to using our other exam preparation products.

Be in Test-Taking Mode Get used to jumping from one topic to another, and practice taking an exam for four hours. Do not underestimate the physical, mental, and emotional aspects of taking an exam lasting that long.

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.

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

One common mistake made by people who purchase the PMP Exam Prep System is to spend most of their time answering question after question in *PM FASTrack®*, thinking that will prepare them to pass the exam. This approach won't work! As we mentioned earlier, you need to focus your study efforts on reading this book, doing the exercises and review activities, and filling the gaps in your project management experience. To do this, follow the steps listed here to study this book in conjunction with using *PM FASTrack®* and the *Hot Topics* flashcards:

1. Read this book for the first time and complete all the exercises, but don't do the practice exams at the end of each chapter. Focus more time on the chapters 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 for each chapter, 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. Use the *Hot Topics* flashcards to improve recall and test your understanding of that chapter.
3. If it is at all possible, form a study group any time after you have read the book for the first time on your own. This will actually make your study time shorter and 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 following discussion of "How to Use This Book in a Study Group.")
4. Skim through the book again.
5. Make sure you really know the material, and then take a full PMP exam simulation on *PM FASTrack®*. This step will give you a baseline against which to track your progress as you continue to study.

WARNING: You should limit yourself to no more than two full PMP exam simulations before you take the actual exam. Otherwise, you diminish the value of *PM FASTrack®*.

WARNING: If you do not score over 70 percent the first time you take a full PMP simulation (not just a knowledge area or process group exam), 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.

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6. Review each question you got wrong in the *PM FASTrack** simulation, writing down the specific reasons for each wrong answer. Assess why the correct choice is correct and why the other answers are wrong. This step is very important!
7. Use your list of why you got each question wrong (from step 6) to determine which material 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 in detail on the areas in which you have gaps in your knowledge and skimming the sections or chapters in 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. And remember, think “large project” and how proper project management should be done, regardless of how you manage projects in your real world.
8. If you had difficulty with certain knowledge areas, process groups, 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, Process Group, or Keyword function in *PM FASTrack**. Analyze why you got any questions wrong, and continue to study your gaps!

WARNING: You might be tempted to take more than 20 questions, but this is not a good idea. Twenty questions should be sufficient to help you assess whether you have progressed in the particular knowledge area, process group, or concept, or whether you need to study more. Taking more than 20 questions in a particular area can diminish the value of *PM FASTrack** and will not prepare you properly for the breadth of the exam experience.

9. Take your 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.
10. Use the *Hot Topics* flashcards and other materials to retain the information you have learned until you take the exam.

11. PASS THE EXAM!

Plan B: Using This Book as a Stand-Alone

1. Read this book for the first time and complete all the exercises, but don't yet do the practice exams at the end of each chapter. Focus more time on the chapters 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 for each chapter, 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, look at the Quicktest terms listed on the first page of the chapter and make sure you know the meaning of each term or concept. Review any terms you are unsure of to improve recall and test your understanding of the chapter.
3. If it is at all possible, form a study group any time after you have read the book for the first time on your own. This will actually make your study time shorter and 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 following discussion of “How to Use This Book in a Study Group.”)
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 after using the book. 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 that is provided in this chapter. Assess why the correct choice is correct and why the other answers are wrong. Continue to study this book, focusing in detail on the areas in which you have gaps in your knowledge and skimming the sections or chapters in 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.

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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 projects in your real world. Make sure you are confident you have filled your gaps before taking the exam.
8. PASS THE EXAM!

Those leading a PMP exam preparation course using RMC's products may want to contact RMC for information on our Teaching Partner Program. Partners may be allowed to create slides or other materials using content from this book. Also, ask about other tools for study groups and independent instructors and how to receive quantity discounts on this book, PM FASTrack®, or Hot Topics.

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 his or her own copy of the 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.)

TRICKS OF THE TRADE® Recurring Themes—PMI-isms to Know for the PMP Exam

Over the past 20 years of helping people pass the exam and become better project managers, RMC has put together the following list of things the exam emphasizes 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. Rita coined the term “PMI-isms” to refer to these things uniquely emphasized on the exam. Understanding PMI-isms 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 more fully later in the book. For the exam, assume that you have or do all of the following and that these items are true for your projects. As you review the list of PMI-isms here, place a checkmark next to the ones that are true for your projects.

General PMI-isms	Place ✓ Here If It's True of Your Projects
Project managers can save the universe, are “wonderful” and “great,” and must be very skilled (a “Hooray for project management!” topic).	
The project manager puts the best interests of the project first, not his or her own interests.	
The exam generally tests from the perspective of a project manager who understands the value of the tools and techniques of project management and knows how to adapt them to a large project. So it's helpful to assume, unless stated otherwise, that the project manager is working on a large project that involves more than 200 people from many countries, takes at least one year, has never been done before in the organization, and has a budget of US \$10 million or more.	

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General PMI-isms	Place ✓ Here If It's True of Your Projects
Project managers have all the power described in the <i>PMBOK® Guide</i> and perform all the stated activities in the real world.	
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!). (For more on this, see Rita's Process Chart and Rita's Process Game in the Project Management Processes chapter.)	
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 his or her project was selected by management to be done, and makes sure those objectives and the business case are met while planning and managing the project.	
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 controlling scope, time, 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 his or her 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 does his or her work.	
Organizations have records (historical information and lessons learned) for all previous projects that include what the work packages were, how much each work package cost, and what risks were uncovered (referred to in the <i>PMBOK® Guide</i> as part of organizational process assets). The project manager uses this past history from other projects to plan the current project. As the project progresses, 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) is used on every project.	
A project management plan is not a bar chart, but a series of management plans. The project manager knows what is involved in creating a real project management plan.	

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General PMI-isms	Place ✓ Here If It's True of Your Projects
The project manager creates and keeps current other documents (project documents) in addition to the project management plan to help plan, manage, 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 stakeholder management plan. They may also help identify and manage risks.	
People must be compensated for their work. (Seriously, a question about this concept has appeared on the exam.)	
PMI does not approve of gold plating (adding extra functionality).	
Since most projects are managed in a matrix environment, such seemingly easy topics as motivation theories or conflict resolution can be complicated on the exam.	
The project manager has a professional responsibility to properly use the tools and processes of project management.	
Planning the Project	Place ✓ Here If It's True of Your Projects
Planning is very important, and all projects must be planned.	
The project manager plans the project with input from the team and stakeholders, not on his or her own.	
Part of planning involves deciding which processes in the <i>PMBOK® Guide</i> should be used on each project and how to tailor those processes to the project.	
There are plans for how the knowledge areas of scope, time, cost, quality, human resources, communications, risk, procurement, and stakeholder management will be planned, managed, and controlled. These are called management plans, and every project has one for every knowledge area.	
If at all possible, all the required work and all the stakeholders are identified before the project work actually begins.	
The project manager determines metrics to be used to measure quality.	
The project manager has a plan for continually improving 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 like reporting responsibilities, risk management assignments, and meeting attendance, as well as project work.	
The project manager focuses extensively on identifying risks.	
The stakeholders, as well as team members, are assigned risk identification and risk management duties.	
The project manager realizes that managing risks saves the project time and money.	

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Planning the Project	Place ✓ Here If It's True of Your Projects
Project cost and schedule cannot be finalized without completing risk management.	
The project manager assesses whether the project can meet the end date and other project constraints and objectives. He or she then meets with management to resolve any differences BEFORE the project work starts. The project manager knows unrealistic schedules are his or her fault.	
The project manager plans when and how to measure performance against the performance measurement baseline, as documented in the project management plan, but he or she 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 exam defines a kickoff meeting in a way that may be different from your understanding of a kickoff meeting (see the Integration Management chapter).	
While the Project Work Is Being Done	
The project is managed to the project management plan, which is realistic and complete.	
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 and cost objectives will be met. Therefore, the project manager almost always knows if the project can meet the agreed-to end date and budget.	
Delays must be made up by adjusting future work, rather than asking for more time.	
The project manager has authority and power. He or she 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 time, 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, human 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.	

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While the Project Work Is Being Done	Place ✓ Here If It's True of Your Projects
The project manager spends more time focusing on preventing problems than 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 the project management plan flow through the change management process and integrated change control.	
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 completed.	
The project manager works closely with the quality assurance/quality control department in performing some of the quality activities discussed in the <i>PMBOK® Guide</i> .	
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 the contract are met, including those that do not seem important to him or her.	
Closing the Project	Place ✓ Here If It's True of Your Projects
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 real-world 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 you left unchecked. 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 on the exam.

Project Management Framework

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The trick to reading this chapter is to make sure you keep an open mind and specifically look for gaps in your knowledge. You will likely find a lot of small things, which can add up on the exam and can alter your understanding of more complex topics. Do not simply memorize the concepts in this chapter; instead, use this book to help you understand them and be a better project manager.

Definition of a Project PAGE 3*

(*All page number references are to the *PMBOK® Guide, Fifth Edition*)

Knowing the true definition of a project has helped many test takers get up to four questions right on the exam. Read the definition, and then read the rest of this section. Many people call their work a project when it is not.

A project:

- Is a temporary endeavor with a beginning and an end
- Creates a unique product, service, or result

Does the exam ask, "What is a project?" No, but it will describe situations, and part of your analysis of those situations will have to include, "Is this a project being described?"

So what is a project? If your boss 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?

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

QUICKTEST

- Enterprise environmental factors
 - Project management information system (PMIS)
- Organizational process assets
 - Processes, procedures, policies
 - Corporate knowledge base
 - Historical information
 - Lessons learned
- Constraints
- Definition of a project
- Organizational structure
 - Matrix
 - » Strong
 - » Weak
 - » Balanced
 - Functional
 - Projectized
 - Project expediter
 - Project coordinator
 - Project-based organization
 - Organizational hierarchy
- Project life cycle
 - Predictive
 - Incremental
 - Iterative
 - Adaptive
- Work performance data, information, and reports
- Stakeholder
- Stakeholder management
- Operational work
- Project management
- Project management office (PMO)
 - Supportive
 - Controlling
 - Directive
- Program management
- Portfolio management
- Organizational project management (OPM)
- OPM3
- Tight matrix

Project Management Framework T W O

Of the thousands of students RMC has taught, very few came into our classes understanding that you must first take what you are given and organize the work into appropriate projects. The project planning process will produce schedules and budgets. Can you schedule “fix it” if you do not know what is wrong? Of course not, so there are at least two projects in the previous story.

Remember that as a project manager, you must come up with a project management plan that can be agreed to, that people believe is realistic, and most importantly, that you can stake your reputation on. Excluding approved changes, if a project manager does not get the project completed for the time and cost agreed to (in addition to meeting other objectives), maybe he or she should be in another profession. Project managers should be held accountable for delivering success.

Are you really working on projects? For the exam, make sure the initiatives you are thinking about are truly projects. You need to imagine an initiative that would require you to use many of the tools of project management. If you work at a help desk and someone contacts you about a problem they are having, you may be able to use a WBS, but do you need a network diagram? How about management plans for scope, time, and cost? Probably not. Some activities are simply part of the company’s normal operations, rather than a project.

TRICKS OF THE TRADE You should have a large project in mind when you answer questions on the exam. Think of a project that is new to the organization (it has not been done before), utilizes resources from many countries, has more than 200 people on the team, lasts longer than one year, and has a budget of over US \$10 million.

Regardless of whether you work on such projects, you will need to answer questions on the exam as if you do. There is a big difference between managing small and large projects. For example, on a small project, you walk over to the person you need to speak to when you have an issue to resolve. On a large project, you may have spent weeks planning communications. When there is an issue, you have to figure out who is involved and where they are located, look up their preferred method of communication and their contact information, and then communicate with them in that way. If you keep this large-project focus in mind as you read this book, you will see that the many different elements being described here as part of project management make sense, are necessary, and add value. And if the concepts make sense to you, you do not have to memorize them—you can use logic to answer questions on the exam!

TRICKS OF THE TRADE Another thing to keep in mind for the exam is that you should assume project proposals are formally reviewed and approved by management in your organization after a comparison of all proposed projects. Projects are not selected arbitrarily or informally. (See the Business Case and Project Selection discussions in the Integration Management chapter.)

Operations vs. Projects PAGE 12

Most work being 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, and project work ends when the project is closed. It is important to 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, like manufacturing, as a project.

Although these are two distinct areas of work, they are closely connected. When a project is finished, the product is handed off to operations, which could require employee training or adjustments to the operational processes for those who will use the project’s product or service. 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.

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

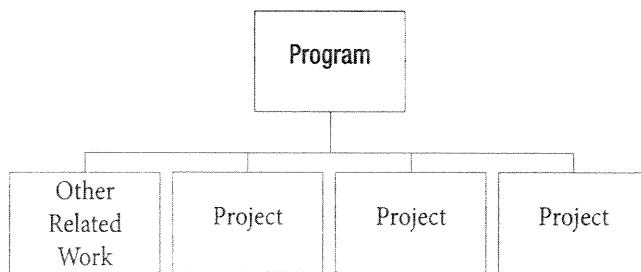
What Is Project Management? PAGE 5

Many people think project managers just need to know how to manage people or, even worse, that you can simply buy some software and be a project manager. The project management profession is growing rapidly. It is both a science and an art, and follows a systematic process. PMI breaks project management into process groups and knowledge areas. The process groups follow the high-level process of project management: initiating, planning, executing, monitoring and controlling, and closing. The knowledge areas are integration, scope, time, cost, quality, human resource, communications, risk, procurement, and stakeholder management, though PMI also gives a separate focus to project management framework concepts and project management processes.

Do you know what project management is? Chances are, there are some key aspects of project management you do not know. Even people with advanced degrees in project management sometimes fail this exam. The answer to "What is project management?" is described throughout this book. It can involve technical terms and processes, but it also involves roles and responsibilities and authority levels. Applying the practices, tools and techniques, and knowledge and skills of project management helps increase the likelihood of project success. As you read this book, you may find that project management involves more than you thought.

What Is Program Management? PAGE 9

A program is a group of related projects. By grouping related projects into a program, an organization can coordinate the management of those projects. The program approach focuses on the interdependencies between the projects and may help achieve decreased risk, economies of scale, and improved management. In addition to the work required to complete each individual project, the program also includes efforts like the program manager's coordination and management activities. So when you discover that you have more than one project, if there is a benefit to it, you can manage all the projects as a program. However, this should be done only when the program approach adds value.



If you want to learn more about program management, visit RMC's website at www.rmcproject.com for information about courses on this topic.

Figure 2.1: Program Management

What Is Portfolio Management?

PAGE 9

A portfolio includes a group of programs, individual projects, and other related operational work that are prioritized and implemented to achieve a specific strategic business goal. As with program management, combining the projects, programs, and operations into one or more portfolios helps optimize the use of resources, enhances the benefits to the organization, and reduces risk. The programs and projects that make up the portfolio may not be related, other than the fact that they are helping to achieve a common strategic goal.

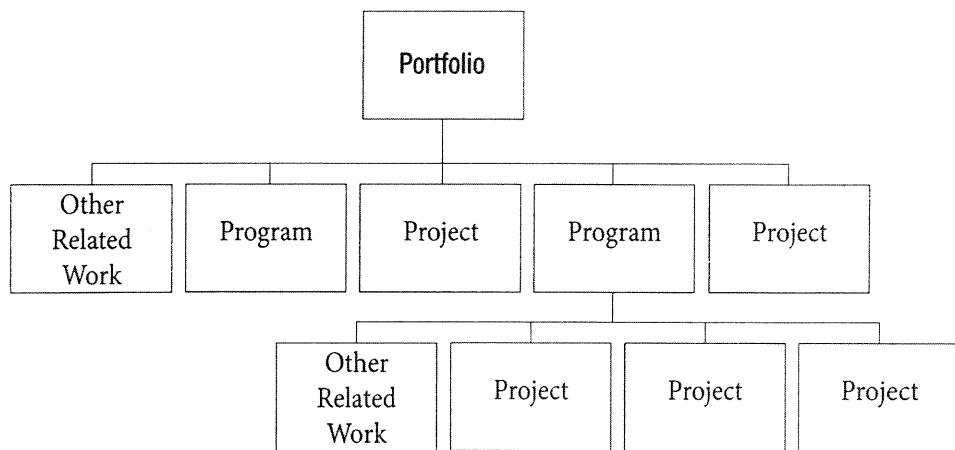


Figure 2.2: Portfolio Management

What Is Organizational Project Management (OPM)?

PAGE 7

We've talked about project, program, and portfolio management. How are these practices different from organizational project management, or OPM? OPM essentially serves as a guide or driver for these and other organizational practices. It is a framework for keeping the organization as a whole focused on the overall strategy. OPM provides direction for how portfolios, programs, projects, and other organizational work should be prioritized, managed, executed, and measured to best achieve the strategic goals. Figure 2.3 shows how organizational project management 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 answer questions correctly on the exam. Unless you are told otherwise, assume this organizational framework is in place when answering exam questions.

T W O Project Management Framework

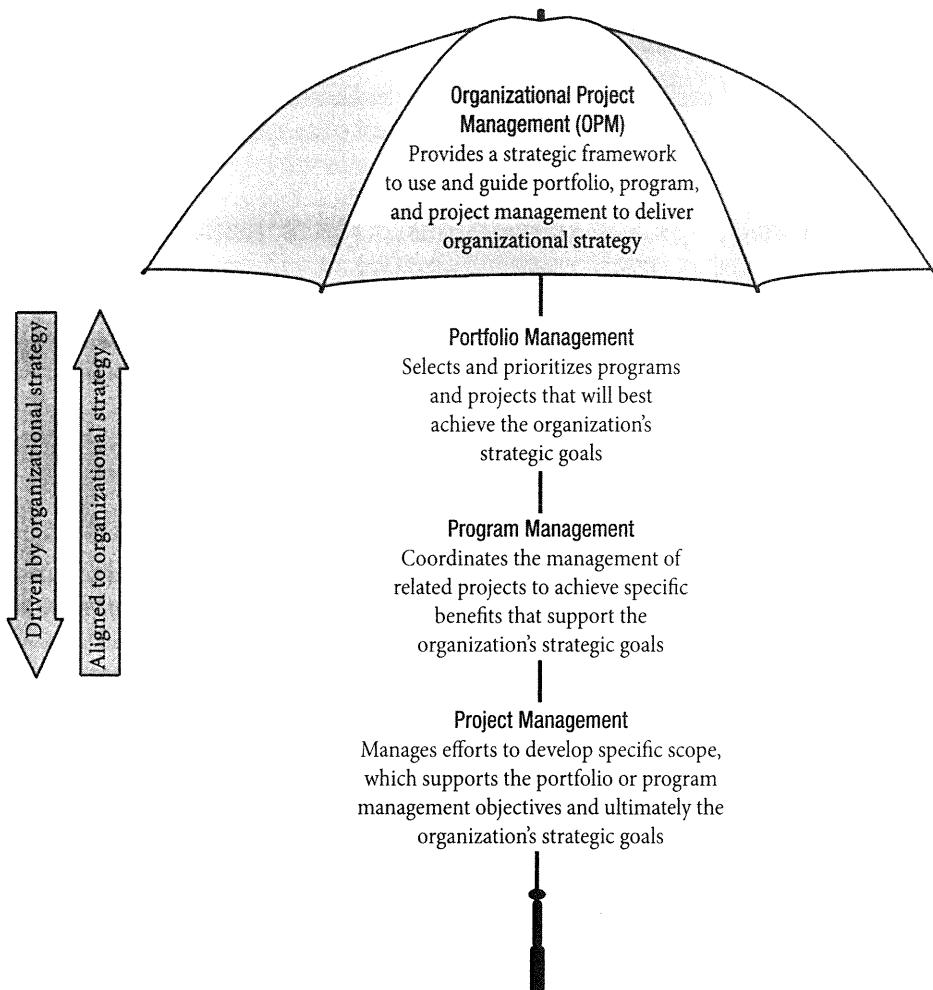


Figure 2.3: Organizational Project Management

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 and in turn support the organization's 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. As an 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.

Such a decision would also be guided by the organization's existing project governance. Project governance refers to an organization's established criteria, procedures, and guidelines intended to make sure projects meet the organization's strategic goals. Project governance should drive any actions, decisions, or work undertaken by the project manager, team, sponsor, and other stakeholders in relation to the project.

OPM3® PAGE 18

Yet another acronym! OPM and now OPM3! Despite the similarity in the acronyms, be careful not to confuse these concepts. OPM3 is PMI's organizational project management maturity model. This model is designed to help organizations determine their level of maturity in project management. For the exam, you should be familiar with the term "OPM3" and generally know what it is.

Project Management Office (PMO)¹

PAGE 10

The project management office (PMO) centralizes and standardizes the management of projects. (Note that some organizations refer to this as a portfolio management office.) A PMO can take one of several different forms, including:

- **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.
- **Controlling** A controlling PMO provides support and guidance in the organization on how to manage projects, trains others in project management and project management software, assists with specific project management tools, and ensures compliance to organizational practices. 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.

Be careful to understand the authority of the PMO and how it is different from the other players on a project. The PMO is a departmental unit within an organization; it is not a single person. The PMO may:

- Manage the interdependencies among projects, programs, and portfolios.
- Integrate information from all 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 and make them available to other projects.
- Provide templates (e.g., for work breakdown structures or communications management plans).
- Provide guidance and project governance.
- Provide centralized communication about the projects.
- Be more heavily involved during project initiating than later in the project.
- Be part of the change control board.
- Be a stakeholder.
- Prioritize projects.

Exercise Test yourself! Read the description of the PMO and try to determine whether it is most likely to be supportive, controlling, or directive, or a combination of the three.

	Description	Type of PMO
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, and reporting and other procedures to be used on projects throughout the organization to promote consistency and streamline effort	

	Description	Type of PMO
5	Appoints project manager	
6	Prioritizes projects	
7	Has the highest level of control over projects	

NOTE: You may wish the answers to exercises were not listed right after the questions. If this is distracting for you, simply keep a blank piece of paper available to cover the answers until you have completed each exercise and are ready to review it. Our analysis shows that having the answers right after the questions helps you more than it hurts.

Answer

	Description	Type of PMO
1	Manages all projects throughout the organization	Directive
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	Controlling
3	Coordinates all projects within the organization	Controlling or Directive
4	Recommends common terminology, templates, and reporting and other procedures to be used on projects throughout the organization to promote consistency and streamline effort	Supportive
5	Appoints project manager	Directive
6	Prioritizes projects	Controlling or Directive
7	Has the highest level of control over projects	Directive

To successfully implement a PMO, organizations should remember these key concepts:

- The role of the PMO must be clearly defined.
- An organization should initially define the role of the PMO (using, for example, one of the three previously identified roles) and then let that role evolve to fit the needs of the organization.
- The commitment of executive management is required.
- The PMO will not improve project performance without the use of proper project management processes and techniques, so professional project management must be promoted.



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

Project Management Framework T W O

Constraints² PAGE 6

As a project manager, you must juggle many things on a project, including project constraints like time, cost, risk, scope, quality, resources, customer satisfaction, and any other factors that limit options. 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 is allowed to have are all constraints.

You use constraints to help evaluate competing demands. Management directly or indirectly sets the priority of each constraint. You then use this prioritization throughout the project to properly plan the project, evaluate the impact of changes, and prove successful project completion. It is important to realize that you need to evaluate the effect a change to one constraint has on the other constraints. In other words, you probably cannot shorten the schedule without causing a negative impact to cost, risk, etc.

Stakeholders, managers, and others will inevitably try to change something or add work to the project. As the project manager, you are responsible for analyzing these change requests and identifying the impacts on all constraints through integrated change control. Constraints will be discussed in many areas of this book. Take time to really understand the integrated change control discussion in the Integration Management chapter and how it relates to constraints. Understanding the relationship between the constraints and how they impact a project can help you get several questions right on the exam.

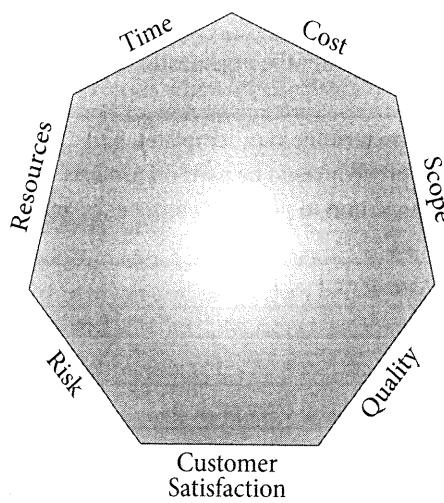


Figure 2.4: Project Constraints

Stakeholder³, Stakeholder Management⁴ PAGE 30

Think about the stakeholders on your real-world projects. Do you realize that stakeholders include more than the project manager, customer, sponsor, and team? Stakeholders are any people or organizations whose interests may be positively or negatively impacted by the project or its product. They can include individuals and groups you may not have thought about before, such as the performing organization, the project management staff, the project management office, portfolio managers, program managers, other departments or groups within the organization (e.g., marketing, legal, customer service, etc.), functional or operational managers, and sellers. They can be actively involved in the project work or take on more of an advisory role. Stakeholders may also be external to the organization, including government regulators, consultants, end users, customers, taxpayers, and banks and other financial institutions. People or groups who could exert positive or negative influence over the project but would not otherwise be considered part of the project are also considered stakeholders.

Now think about how you treat the stakeholders on your projects. Do you consider them to be like assistant team members? If not, this might be a gap in your knowledge that could result in getting questions wrong throughout the exam. Treating stakeholders like assistant team members means you keep them informed, solicit their input, and work to satisfy their needs and expectations. Without this effort, the project may fail.

The topic of stakeholders is discussed and expanded throughout this book, because a project manager should analyze and manage stakeholders' needs and levels of influence throughout the project. The Stakeholder Management chapter offers a dedicated discussion about the concept of managing stakeholders, and the Human Resource Management chapter gives a special focus to this topic. The Human Resource Management chapter provides a way to check your understanding about the role stakeholders play on the project. The Communications Management chapter is also relevant to the topic of stakeholders, because project communications are inextricably tied to stakeholder management.

NOTE: Several people may help complete project management activities, especially on large projects. The *PMBOK® Guide* refers to these people as the “project management team” or “project management staff.” To avoid confusion between the different types of teams, we will use only the following terms in this book: “project manager” and “team” or “project team.” The term “project manager” refers to anyone doing project management activities on the project—this includes the lead project manager and those in supporting roles as members of the project management team or project management staff. The terms “team” and “project team” refer to everyone who does work on the project, not just those who perform project management activities.

Organizational Structure PAGE 21

A project does not operate in a vacuum. Projects are impacted by, and have an impact on, the cultural norms, management policies, and procedures of the organizations of which they are a part. These factors are increasingly important in global organizations, in which team members are often located in different offices and in multiple countries. The best project managers look for these influences and manage them for the benefit of the project and the organization.

One of the main forms of influence 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 form of organization!

Questions related to organizational theory are often phrased in terms of the project manager's level of authority and the impacts on managing projects in such environments. For example, exam questions may deal with:

- Who has the power in each type of organization—the project manager or the functional manager
- The advantages of each type of organization
- The disadvantages of each type of organization

Many people have told RMC they wished they had spent more time studying this topic. So let's get it down now. As you read through the next paragraphs defining the different organizational structures, take the time to think about how each form would impact your real-world projects.

Functional This is a common form of organization. Such organizations are grouped by areas of specialization within different functional areas (e.g., accounting, marketing, and manufacturing). When you see “functional” on the exam, think “silo.” Projects generally occur within a single department. If information or project work is needed from another department, employees transmit the request to

Project Management Framework

T W O

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.

Projectized In a projectized organization, the entire company is organized by projects, and the project manager has control of the project. Personnel are assigned and report to a project manager. When you see “projectized” on the exam, remember “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.

Matrix⁵ This form is an attempt to maximize the strengths of both the functional and projectized structures. When you see “matrix” on the exam, think “two bosses.” The team members report to two bosses: the project manager and the functional manager (e.g., engineering manager). Communication goes from team members to both bosses. 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 or expediter. In a balanced matrix, the power is shared between the functional manager and the project manager.

As stated in the previous paragraph, the project manager’s role in a weak matrix (or in a functional organization) might be more of a:

- **Project Expediter⁶** The project expediter acts primarily as a staff assistant and communications coordinator. The expediter cannot personally make or enforce decisions.
- **Project Coordinator** This position is similar to the project expediter, except the coordinator has some power to make decisions, some authority, and reports to a higher-level manager.



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 get a few more questions right.



A tight matrix has nothing to do with a matrix organization. It simply refers to “colocation,” or locating the work spaces for the project team in the same room. Because it sounds similar to the other forms of organization, it has often been used as a fourth choice for these questions on the exam.

Exercise Test yourself! You can expect questions on the exam about the advantages and disadvantages of the functional, projectized, or matrix organizational structures. Practice by listing your answers in the spaces below.

Functional

Advantages	Disadvantages

T W O Project Management Framework

Projectized

Advantages	Disadvantages

Matrix

Advantages	Disadvantages

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	No 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 Management Framework TWO

Projectized

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 effective communications than functional	Duplication of facilities and job functions
	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	Project team members have more than one boss
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

In addition to the differences between functional, projectized, and matrix organizations, you should be aware of the following concepts related to organizational structures:

Project-Based Organizations (PBOs)⁷ PAGE 14 In order to achieve strategic goals, project-based organizations, or PBOs, create temporary frameworks around their projects that allow them to circumvent any obstacles inherent in their existing organizational structure (whether functional, projectized, or matrix). This ensures successful project completion while minimizing the impact or limitations (e.g., bureaucracy) that the established organization’s structure may otherwise have on a project and its success.

Organizational Hierarchy⁸ PAGE 26 Organizations are often divided into three hierarchical levels: operational, middle management, and strategic. The size of the organization, the systems and processes in place, the focus the organization gives to projects, and the significance of a particular project determine how the project manager will interact with people at each of these levels. This hierarchy also influences factors like the project manager’s authority level and the resources and team members available for the project.

Enterprise Environmental Factors PAGE 29 AND THROUGHOUT

Since the beginning of time, project managers have had to deal with and make use of company culture and existing systems. The *PMBOK® Guide* calls these “enterprise environmental factors.” Many of the concepts we’ve discussed in this chapter, such as organizational structure and hierarchy, are enterprise

environmental factors. Such factors are inputs to many processes, especially within the initiating and planning process groups.

TRICKS OF THE TRADE The trick is to think of enterprise environmental factors as what they really are—company culture and existing systems that the project will have to deal with or can make use of. They could also be thought of as the company “baggage” that comes with the project and is outside the control of the project team. Use this trick to more easily understand the meaning of questions or the choices on the exam, no matter how the term “enterprise environmental factors” is used.

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, plus repositories for historical information.

Organizational Process Assets PAGE 27 AND THROUGHOUT

TRICKS OF THE TRADE Since the beginning of time, project managers have also been dealing with existing processes, procedures, and historical information. The *PMBOK® Guide* calls these “organizational process assets,” and they are inputs to the majority of processes in all the project management process groups. They provide direction and guidance in planning and help the project benefit from past company experience.

The trick is to think of organizational process assets as what they really are—processes, procedures, and historical information.

The following are some examples of organizational process assets.

Processes, Procedures, and Policies Why reinvent the wheel? Over time, organizations develop processes, procedures, and policies that have proven to be best practices (and in some cases, required practices). These include processes and policies for quality assurance, continuous improvement, procurement, human resource management, change control, safety, and more. Such information is a key part of organizational process assets.

Corporate Knowledge Base⁹ 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 those records into an indexed corporate knowledge base available to all. Does your organization do this?

Many project managers do not even have their own historical databases from previous projects, and so they essentially plan, estimate, and schedule each project from scratch. The creation of a corporate knowledge database of historical information and lessons learned is an organizational responsibility that can contribute to continuous improvement. For the exam, assume you have such historical information from all company projects readily accessible.

Historical Information Historical information (or data) is a record of past projects. It is used to plan and manage future projects, thereby improving the process of project management. Historical information can include:

- Activities
- Lessons learned (described next)

Project Management Framework

- WBSs
 - Benchmarks
 - Reports
 - Risks and risk response plans
 - Estimates
 - Resources used
 - Project management plans
 - Correspondence

Lessons Learned (Postmortem)¹⁰ In the first chapter of this book, we described lessons learned as a PMI-ism. Lessons learned are an essential asset to managing a project; they are taken into account as well as created throughout a project. Complete the following exercise to test your understanding of lessons learned.

Exercise Test yourself! Lessons learned include what type of information?

Answer

The lessons learned document includes what was done right, what was done wrong, and what would be done differently if the project could be redone. Another way of saying this is that lessons learned include the causes of the issues, change requests, workarounds, reestimating, preventive and corrective actions, and defect repair the project has faced, and the reasoning behind the changes implemented. To be as valuable as possible, lessons learned should cover three areas:

- Technical aspects of the project: What was right and wrong about how we completed the work to produce the product?
 - Project management: How did we do with WBS creation, risk planning, etc.?
 - Management: How did I do with communications and leadership as a project manager?

**TRICKS
OF THE
TRADE**

Many project managers do not understand the role of lessons learned on projects. The following graphic helps explain their function:

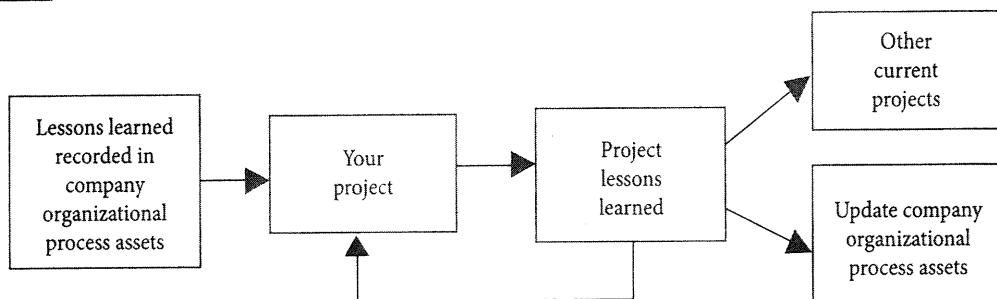


Figure 2.5: Lessons Learned on a Project

As a project manager, you need to collect and review lessons learned from similar projects before starting work on a new project. Why make the same mistakes or face the same problems others have faced? Why not benefit from others' experience? Imagine you could reach into a filing cabinet or access a database to see such data for all the projects your company has undertaken. How valuable would that be?

Once your project is underway, you are required to add lessons learned to the company database (the organizational process assets). Wait—were you paying attention to what you just read? Documenting lessons learned is a required project management practice. Lessons learned are both an input to and an output of projects. As an input, they help improve the current project. As an output, they help make the organization better. Lessons learned are realized throughout the project and should be shared with the project team to improve the current project and with the organization as part of the Manage Communications process (see the Communications Management chapter). They are then finalized during closing.

Work Performance Data, Information, and Reports PAGE 59

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 are the initial measurements and details about activities gathered during project work (executing). During controlling, these work performance data are analyzed to make sure they conform to the project management plan and to assess what they mean for the project as a whole; the result is known as work performance information. This 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; these reports are an output of Monitor and Control Project Work.

As an illustration, let's say the team for a project you're managing performs their assigned work according to the project management plan. They provide information and data on their progress: for example, a certain activity took 10 hours and was completed on July 21st. 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 schedule in the plan). The activity in this example was estimated to take 12 hours and be completed on July 22nd. You need to 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 on 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 the work performance information. This information can then be organized into the appropriate work performance reports (e.g., a project status report).

Project Life Cycle and the Project Management Process PAGE 38

A life cycle is a progression through a series of developmental stages. A product has a life cycle (from its conception to its withdrawal from the marketplace), but there is also a life cycle for projects. For the exam, you should understand the difference between the project life cycle and the project management process defined in the *PMBOK® Guide*. Both of these concepts are necessary to complete a project. The project life cycle is what you need to do to *do* the work, and the project management process is what you need to do to *manage* the work.

Project Life Cycle¹¹ The project life cycle is sometimes referred to as the performing organization's or department's methodology for projects. This is the logical breakdown of what you need to do to produce the deliverables of the project. There are many different types of project life cycles, depending on the type of product being developed, the industry, and the organization's preferences.

Project life cycles range from plan-driven to change-driven. Plan-driven projects have predictive life cycles (sometimes referred to as waterfall or traditional life cycles) that require scope, schedule, and cost to be determined in detail early in the life of the project, before the work begins to produce the project deliverables. For example, a construction project would typically be managed using a predictive approach, undergoing the life cycle phases of feasibility, planning, design, production, turnover, and startup.

Change-driven projects, on the other hand, use iterative, incremental, or adaptive (agile) life cycles, and will have varying levels of early planning for scope, schedule, and cost. (Note that the *PMBOK® Guide* classifies only adaptive as change driven, though incremental and iterative can also be considered change driven.) 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. Incremental delivers a complete, usable portion of the product for each iteration. With iterative, the complete concept is built in successive levels of detail to create the end result. 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. To build the same project using an iterative life cycle would involve first creating a prototype of the entire website; the basic skeleton of the site is built, and each successive iteration adds more detail and resonance until there is a complete, fully functioning site upon delivery. Note that a project may use a combination of incremental and iterative life cycles throughout the project or for phases of the project.

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



The processes, tools and techniques, and concepts identified in the *PMBOK® Guide* and discussed in this book can be tailored based on the project, the organization, and various other factors, including the project life cycle. As you read through this book and seek to understand the concepts presented here, however, it's often useful to think in terms of a plan-driven life cycle. Just remember that these processes, tools, and techniques can be used on change-driven projects as well,

and that tailoring project management practices to the situation and the needs of the project and organization is your responsibility as a project manager.

Project Management Process As noted earlier, the project management process is what you need to do to *manage* the work. The project management process includes the management efforts of initiating, planning, executing, monitoring and controlling, and closing the project. Figure 2.6 illustrates the project management process, and shows how the process groups interact:

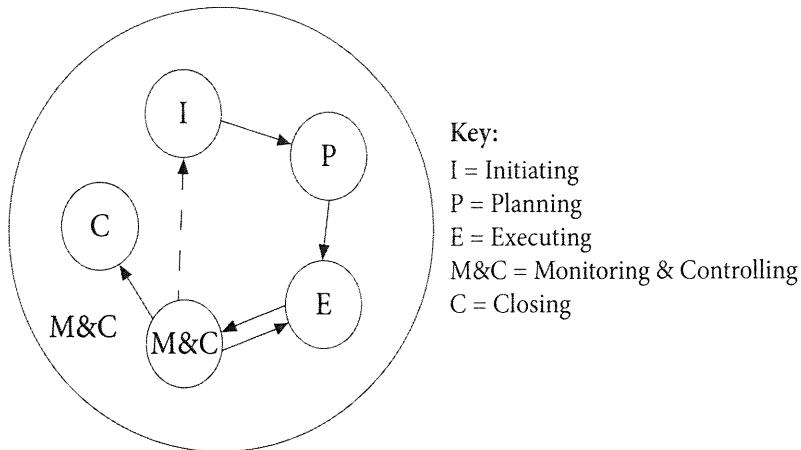


Figure 2.6: Project Management Process

The process groups are described in detail in the next chapter, but let's take some time now to discuss the difference between the project management process and the project life cycle, and see how the overall project management process interacts with the project life cycle. For small projects following a predictive (or plan-driven) life cycle, you may go through the overall project management process once for the entire project, although portions of the process may be iterated or repeated throughout the project life cycle (see figure 2.7).

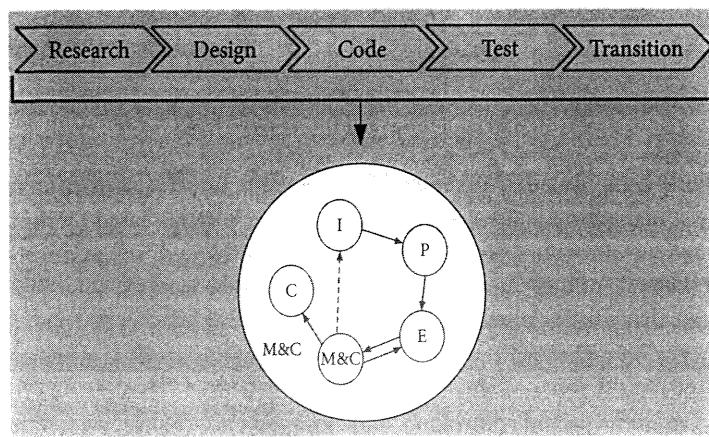


Figure 2.7: Small Project with a Predictive Life Cycle

However, large projects often require each of the life cycle phases to be managed through the project management process groups. The example illustrated in figure 2.8 is for a large construction project. In this project, the efforts of feasibility, planning, design, production, turnover, and startup are each

Project Management Framework TWO

extensive enough to warrant their own project management process groups. 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. Once this high-level framework is done, there would be a separate initiating process for each phase, followed by a planning effort for the work that will be done in the phase, the execution and control of the work, and a close-out of the phase, which typically includes a hand-off of deliverables (e.g., results of the feasibility analysis). The project would then move on to the next phase and progress through the project management process groups again for that phase.

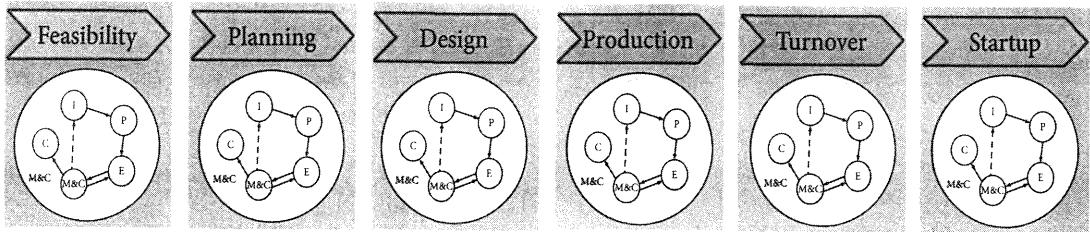


Figure 2.8: Large Project with a Predictive Life Cycle

Large change-driven projects may also be broken into phases, and then into smaller releases and iterations within those phases. The project management process of initiating, planning, executing, monitoring and controlling, and closing is done for each phase, and this process is also generally done within each release and iteration. The level of detail and the time spent on each of the project management process groups may vary based on the particular part of the project you are in, but the entire project management process is typically followed, as indicated in figure 2.9, which depicts an adaptive life cycle.

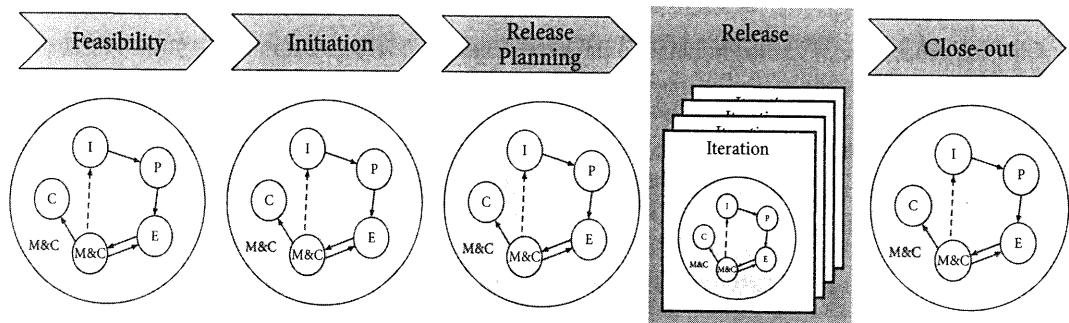


Figure 2.9: Large Project with an Adaptive Life Cycle

This may all seem fairly complicated. Don't worry! For the exam, understand that there is a project life cycle and a project management process. The project life cycle varies based on the industry, the organization, and the type of product, service, or result being developed. The exam won't ask you to identify the correct life cycle or determine what life cycle should be used for a particular project. But you may see questions that require you to understand how the project life cycle (plan driven vs. change driven) would influence how a project is planned and the flow of the work. Also remember that there is only one project management process, regardless of the life cycle used. The process groups of initiating, planning, executing, monitoring and controlling, and closing do not change, even if there are variations in the level of attention and formality given to each of the process groups. Read exam questions carefully to determine whether the project life cycle or project management process is being discussed.

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

Practice Exam

1. Understanding the culture, policies, and procedures of the organization in which the project is being performed is MOST challenging in:
 - A. Global organizations.
 - B. Manufacturing organizations.
 - C. Small organizations.
 - D. Agile organizations.

2. In a projectized organization, the project team:
 - A. Reports to many bosses.
 - B. Has no loyalty to the project.
 - C. Reports to the functional manager.
 - D. Will not always have a “home.”

3. 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

4. A project manager has very little project experience, but he has been assigned as the project manager of a new project. Because he will be working in a matrix organization to complete his project, he 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

Project Management Framework TWO

6. 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 expeditor, and the other realizes he is really a project coordinator.

How is a project expeditor different from a project coordinator?

- A. The project expeditor cannot make decisions.
- B. The project expeditor can make more decisions.
- C. The project expeditor reports to a higher-level manager.
- D. The project expeditor has some authority.

7. Who has the MOST power in a projectized organization?

- A. The project manager
- B. The functional manager
- C. The team
- D. They all share power

8. All of 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. Which of the following BEST describes the major constraints on a project?

- A. Scope, number of resources, and cost
- B. Scope, cost, and time
- C. Scope, time, cost, quality, risk, resources, and customer satisfaction
- D. Time, cost, and number of changes

11. 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.

12. A project manager is managing his second project. It started one month after the first, and both are in process. Though his first project is small, this one seems to be growing in size every day. As each day passes, the project manager is beginning to feel more and more in need of help. The project manager has recently heard that there was another project in the company last year that is similar to his second project. What should he do?
 - A. Contact the other project manager 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.
13. The project life cycle differs from the project management process in that the project management process:
 - A. Is the same for every project.
 - B. Does not incorporate a methodology.
 - C. Is different for each industry.
 - D. Can spawn many projects.
14. 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. Ensures that the management plan includes the management of team members.
15. Your management 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 US \$100 to US \$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.
16. The previous project manager for your project managed it without much project organization. There is a lack of management control and no clearly defined project deliverables. Which of the following would be the BEST choice for getting your project better organized?
 - A. Adopt a life cycle approach to the project.
 - B. Develop lessons learned for each phase.
 - C. Develop specific work plans for each work package.
 - D. Develop a description of the product of the project.

Project Management Framework

T W O

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 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 objective.
 - D. A project is a contracted endeavor with a beginning and end, a portfolio is a group of projects with more open-ended completion dates, and a program combines two or more portfolios.
20. Operational work is different from project work in that operational work is:
 - A. Unique.
 - B. Temporary.
 - C. Ongoing and repetitive.
 - D. A part of every project activity.
21. Company procedures require the creation of a lessons learned document. Which of the following is the BEST use of lessons learned?
 - A. Historical records for future projects
 - B. Planning record for the current project
 - C. Informing the team about what the project manager has done
 - D. Informing the team about the project management plan
22. Lessons learned are BEST completed by:
 - A. The project manager.
 - B. The team.
 - C. The sponsor.
 - D. The stakeholders.

Two Project Management Framework

23. 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. Have 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.
24. 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
25. 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.

Answers

1. **Answer A**

Explanation Understanding the culture, policies, and procedures of the organization in which the project is being performed is especially challenging in global organizations. Culture, policies, and procedures in the performing office may be different from those of the office from which the project is managed, and may also vary between international offices of the same organization. This will influence how the project is managed.

2. **Answer D**

Explanation The main drawback of a projectized 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.

3. **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.

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 functional manager is the team member’s boss and probably also the project manager’s boss.

6. **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.

7. **Answer A**

Explanation In a projectized organization, the entire company is organized by projects, giving the project manager the most power.

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.

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.

10. **Answer C**

Explanation “Scope, time, cost, quality, risk, resources, and customer satisfaction” is the most accurate list of constraints, or competing demands, that a project manager must deal with.

T W O Project Management Framework

11. 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.

12. 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. His 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.

13. Answer A

Explanation The project management process ALWAYS includes the work of initiating, planning, executing, monitoring and controlling, and closing a project. This methodology is the same for projects within any industry. The work of these process groups may be repeated (iterated).

14. 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 a communications management plan nor an overall management plan directly addresses obtaining 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.

15. Answer C

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

16. Answer A

Explanation Developing lessons learned would help improve subsequent phases, but would do nothing for control or deliverables. Having plans for each work package would help control each phase, but would not control the integration of those phases into a cohesive whole. A description of the product of the project would help, but that would not improve both control and deliverables for each phase. Effective project management requires a life cycle approach to running the project. Adopting a life cycle approach is the only answer that covers both control and deliverables.

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.

Project Management Framework TWO

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 objective. Remember to use the process of elimination, ruling out any answer that is not completely correct.

20. **Answer C**

Explanation Operational work is that which is ongoing to sustain an organization.

21. **Answer A**

Explanation Notice that this question asks about the use of a tool of project management. Many people can learn from a book what a lessons learned document is, but questions like this can more readily be answered if you actually use the tool and know from experience its value. Ask yourself about the other tools of project management. Why are they beneficial? The BEST use of lessons learned is as historical records for future projects. There are other tools that are better for accomplishing the things listed in the other choices.

22. **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 other groups.

23. **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.

24. **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.

25. **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.

Project Management Processes

THREE

As we just discussed in the Project Management Framework chapter, the project life cycle describes what you need to do to *do* the work, whereas the project management process describes what you need to do to *manage* the project. People often think they need to understand various industries to pass this exam, since the exam refers to different types of projects done in different types of industries (e.g., “You are building a bridge” or “You are creating a new system for your company”). However, that type of information is mostly background data. The exam will not ask you how to do the work in different industries, such as what the specific project life cycle should be or how to perform IT, construction, engineering, or any other type of projects; instead, it will ask you about managing projects. The questions are general and can be answered without an understanding of the industry, if you know project management.

This chapter will examine the project management process, both at a high level and in more detail with Rita’s Process Chart. Carefully review the information in the chapter, especially the process chart, and complete all the exercises. These are valuable tools for helping you identify the gaps in your knowledge and will significantly cut down your study time. Understanding the process of managing a project and knowing what should be done at what times provide a framework for understanding all the inputs, tools and techniques, and outputs involved in project management. If you understand the process, you can use logic on the exam, rather than having to rely on memorization. So are you ready? Read on!

First, here is the high-level look at the project management process. It includes:

- Initiating the project (Start)
- Planning the project (Plan)
- Executing the project (Do)
- Monitoring and controlling the project (Check and act)
- Closing the project (End)

QUICKTEST

- What is done during each of the project management process groups
 - Initiating
 - Planning
 - Executing
 - Monitoring and controlling
 - Closing
- What you do not do but should do in your real world during each of the project management process groups

Project Management Processes THREE

Figure 3.1 shows how the project management process groups fit together:

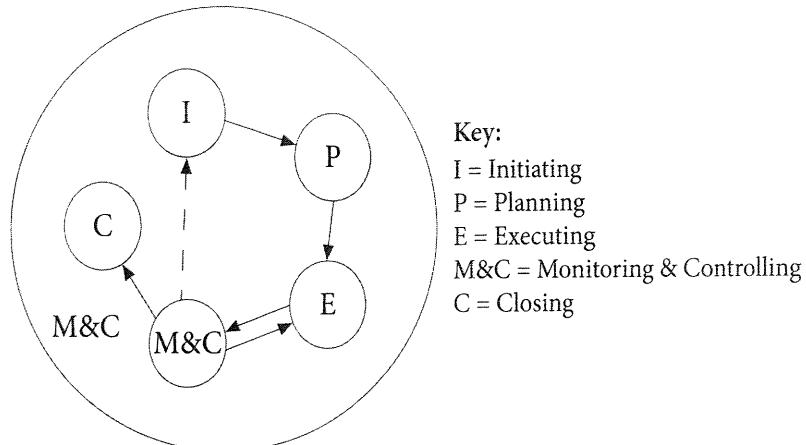


Figure 3.1: Project Management Process

The project is officially approved in project **initiating**. As the project manager, you determine whether the business case can be met and do some high-level planning during initiating to verify that it is likely the project can be completed within the given constraints of scope, time, cost, etc.

Once the project has been approved, it moves from initiating into detailed **planning**, where you create the plan for how you will do planning and how you will execute, monitor and control, and close the project.

The project then moves into **executing**, in which the team completes the work according to the processes and procedures detailed in the project management plan.

While the work is being done, the work results (or work performance data) are fed into **monitoring and controlling**, to make sure the project is tracking to the baselines in the project management plan.

If there are variances from the plan that require changes, the change requests are evaluated during the Perform Integrated Change Control process (part of **monitoring and controlling**) to determine their impact on the project, identify the best options for dealing with them, and decide whether they should be approved or rejected. Approved changes that don't affect the baseline (such as corrective action, preventive action, or rework) are fed back into **executing** to be implemented as part of the project work. The implementation of these approved changes should help fix the variance. For approved changes that require adjustments to the baselines and project management plan, a replanning effort must be completed before the team can start working from the new updated version of the plan and baselines in executing. This replanning effort is also done as part of the Perform Integrated Change Control process in **monitoring and controlling**.

Once the changes to the baseline are identified and the plan is modified, the revised plan is provided to the team in **executing**, and the project is again executed according to the updated plan and monitored and controlled to the revised baselines. If the project gets so far off the baselines that it requires an analysis of whether the project should continue at all, it may move back into **initiating** for that decision (since the charter, which is created in initiating, would have to change in such a situation).

Ultimately, when the work is done (or the project is terminated), the project moves into **closing**.

There's one last point to keep in mind about figure 3.1. Did you notice the large **monitoring and controlling** circle encompassing the project management processes? It's there to signify that all of the

work of the project and project management must be monitored and controlled. This is an important concept to remember for the exam: throughout the life of the project you'll be taking measures of the project and project management and analyzing them to help identify variance from the plan, so that you can make proactive decisions to keep the project on track.

As explained in the Project Management Framework chapter, for small projects, this process might be exactly what you need to use to manage your projects. For large projects that are broken into phases, this process may be repeated multiple times. For example, on a project with a research phase, you complete initiating through closing for that phase, and then do the process again for the design phase. For situational questions on the exam, remember that how the processes are performed will be adjusted or tailored to the type and strategic importance of the project and the chosen life cycle.

Now let's look at the project management process in more detail, using Rita's Process Chart.

TRICKS OF THE TRADE **Rita's Process Chart** There have been over 70 questions on the PMP exam that require knowledge of the project management process. Therefore, to pass the exam, you must understand this process. It can seem like a lot to know, but we can help you learn and understand it with little or no memorization.

Since the first edition of this book, people all over the world have used the following chart as a trick to learning the project management process 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. It 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 necessary context to clearly understand the project management process 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.
- Understand why each item is in the column (process group) it falls into.
- Be able to replicate the specific order of the planning process by understanding what happens when, how previous work supports what comes next, and why. Knowing the 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.
- Understand the project management process groups of initiating through closing and when each effort should be done on projects. The exam asks questions that present a situation and require you to know the process group the project is in.
- Understand that project planning is an iterative process. Think about how you might go back and redo (iterate) some of the items in the planning column for a large project.
- Complete Rita's Process Game that follows the chart at least three times. Going through the game will solidify your understanding of the overall project management process and help you fill gaps in your knowledge. Find your gaps before they find you on the exam!

INITIATING	PLANNING <i>(This is the only process group with a set order)</i>	EXECUTING	MONITORING & CONTROLLING	CLOSING
<ul style="list-style-type: none"> Select project manager Determine company culture and existing systems Collect processes, procedures, and historical information Divide large projects into phases Understand the business case Uncover initial requirements, assumptions, risks, constraints, and existing agreements Assess project and product feasibility within the given constraints Create measurable objectives Develop project charter Identify stakeholders and determine their expectations, influence, and impact 	<ul style="list-style-type: none"> Determine how you will plan for each knowledge area Determine detailed 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 time and cost Determine critical path Develop schedule Develop budget Determine quality standards, processes, and metrics Create process improvement plan Determine 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 documents Create change management plan Finalize the “how to execute and control” parts of all management plans Develop realistic and final PM plan and performance measurement baseline Gain formal approval of the plan Hold kickoff meeting 	<ul style="list-style-type: none"> Execute the work according to the PM plan Produce product deliverables (product scope) Gather work performance data Request changes Implement only approved changes Continuously improve Follow processes Determine whether processes are correct and effective (quality assurance) Perform quality audits Acquire final team Manage people Evaluate team and individual performance 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 Manage stakeholder engagement and expectations Hold meetings Select sellers 	<ul style="list-style-type: none"> Take action to control the project Measure performance against the performance measurement baseline Measure performance against other metrics in the PM plan Analyze and evaluate performance Determine if variances warrant a corrective action or other change request Influence the factors that cause changes Request changes Perform integrated change control Approve or reject changes Update the PM plan and project documents Inform stakeholders of the results of change requests Monitor stakeholder engagement Manage configuration Create forecasts Gain acceptance of interim deliverables from the customer Perform quality control Perform risk reassessments and audits Manage reserves Control procurements 	<ul style="list-style-type: none"> Confirm work is done to requirements Complete procurement closure Gain final acceptance of the product Complete financial closure Hand off completed product Solicit feedback from the customer about the project Complete final performance reporting Index and archive records Gather final lessons learned and update knowledge base

Rita's Process Chart

Notes on the Chart

- Notice in the Initiating column the phrase “Understand the business case.” This could be read as “Understand the project’s business case (the case for why the project is being done), because it will guide all other project management activities to ensure the project is worth the required investment when completed.” This is a major concept on the exam that many project managers miss.

There is a reason the project is initiated, and the project results must support that reason. It seems easy, but so many projects do not satisfy the business needs when completed. Project managers may create the project they want, rather than what was asked of them, or they may complete the project to the technical requirements and forget the reasons (stated or otherwise) the project was initiated. The problem is that many project managers do not understand the initial effort that takes place, even before the project has a charter and is therefore authorized.

Here is what should be happening in your organization: the company should know what its strategic objectives are, and all projects should help meet those objectives. This is not what actually happens in many real-world organizations, however, to the detriment of those organizations. A company that manages itself well will have strategic objectives. It will evaluate various options for achieving those objectives. Many project ideas will be proposed, and the company will conduct an analysis to see which proposed projects meet the objectives for the least cost, time, resources, and, if it is a very well-run company, the least risk. The organization will then authorize one or more projects by issuing project charters. This is the project selection process you need to understand for the exam, and you need to know how that process affects project management activities.

As the project manager, you should understand why the project you are assigned to was selected, and manage the project accordingly. Is the project being done to enter a new market? Is it intended to meet a governance expectation or regulatory requirement? Is it the result of a customer request? Is it just a pet project for a company executive? Is it expected to dramatically improve the future of the company? You should know what these objectives are, including intangible objectives such as “improve the company’s reputation,” and keep them in mind when planning and managing the project. If you lose sight of the objectives, the project may finish on time and on budget but still fail because it does not achieve those objectives.

- Team building, risk identification, risk response planning, and many other activities are focused in the process groups in which they are placed on the chart, but these activities can start in initiating and continue until closing.
- In the Planning column, note the first box: “Determine how you will plan for each knowledge area.” Management plans are required for each of the knowledge areas (integration, scope, time, cost, etc.). The first thing we need to do as we start planning is figure out how we are going to plan, execute, and control for each knowledge area. This will help guide the rest of your planning efforts.
- Notice the phrase “Determine all roles and responsibilities” in the Planning column. You should be aware that this involves more than determining who is going to do which product-related work activities. It also includes who will be required to provide reports, who will attend meetings, who will help with risk identification, who will work with the quality department, etc. All roles and responsibilities on a project should be defined. They may be documented as part of the human resource management plan, in project job descriptions, and in the management plans for each knowledge area. This process also involves developing a staffing management plan, responsibility assignment matrix, and rewards and recognition system. If all this effort seems unnecessary to you, you may be thinking about it in the context of a small project that uses the same handful of team members as the last project. Remember to think in terms of large projects that have hundreds of team members.

Project Management Processes THREE

- Look at the phrase “Go back—iterations” in the Planning column of Rita’s Process Chart. This is an important concept. When planning a project, the project manager and the team complete each item listed in the chart above this point to the best of their ability. But a project will evolve as each item is planned, and much of the earlier planning work will need to be modified or added to. 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 (see the Risk Management chapter) might be to avoid a portion or all of a threat by planning to perform additional testing as part of the project. This testing will require adjusting the WBS for added scope, the network diagram to determine the order of the work, the budget for added cost, etc. The project manager might also work with discretionary dependencies (see the Time Management chapter) to decrease some risk and thereby change the network diagram. 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.
- On a related note, the Planning column is the only process group with a set order, but occasionally a planning process will require an input that according to this column won’t be available yet. The risk register, for example, is an input to several processes leading to the creation of the schedule. The schedule is developed before we get to risk management activities in the Planning column, so how can the risk register be an input? In such situations, you’ll start off using a preliminary version of the input. 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, the 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 through iterations to refine your schedule.
- Notice the term “procurement documents” in the Planning column. In the *PMBOK® Guide* this term generally refers to documents like the request for proposal (RFP), request for quotation (RFQ), and invitation for bid (IFB). But the *PMBOK® Guide* also uses the term in a broader sense to encompass other documents such as the procurement statement of work (a description of the work to be done), contract provisions, and source selection criteria. Rita’s Process Chart uses this broader sense to encompass the breadth of preparation required in planning for procurements. Note also the placement of “Finalize procurement documents” after “Go back—iterations.” It’s likely the risk management process will generate risk response strategies involving contracts; through iterations the procurement documents can be created and refined, but may not be finalized until the iterations are complete.
- Resources can be released at any time during the project, once their work is approved and accepted and they have completed any documentation or other 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 can then be released from the project while the people doing drywall are still working (executing their part of the plan). Keep in mind that some team members remain on the project to its end in order to assist the project manager in creating the final lessons learned, archiving final records, and producing the final report.
- As project executing progresses, the project manager may determine that a change to the project is needed. The same could happen while monitoring and controlling the activities. That is why changes can be requested in both the executing and monitoring and controlling process groups. The change requests are then evaluated and approved or rejected as part of the Perform Integrated Change Control process (see the Integration Management chapter).

- Do the project management process groups occur sequentially? No; they all overlap. You could be using monitoring and controlling processes to control the identification of stakeholders, adherence to organizational requirements for project planning, or the creation of baselines and project documents. Defects could be identified in executing that will 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 closing 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. Make sure in particular that 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 to manage people and work to accomplish the project as planned. The focus of monitoring and controlling is to make sure the project is progressing according to plan, and to approve necessary changes to the plan to meet the organization's strategic objectives. Project managers wear many hats at the same time.

**TRICKS
OF THE
TRADE****Rita's Process Game** The following pages contain the pieces for Rita's Process Game.

Cut them out and practice putting each item into the correct process group, on your own or in a group. When you think the cards are sorted into the correct process groups, put the planning efforts in order. Lastly, 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 process that will be discussed throughout this chapter.



THREE Project Management Processes

INITIATING	PLANNING	EXECUTING
MONITORING & CONTROLLING	CLOSING	Create measurable objectives
Determine how you will plan for each knowledge area	Control procurements	Execute the work according to the PM plan
Determine company culture and existing systems	Determine whether processes are correct and effective (quality assurance)	Create activity list
Go back—iterations	Develop project charter	Develop schedule



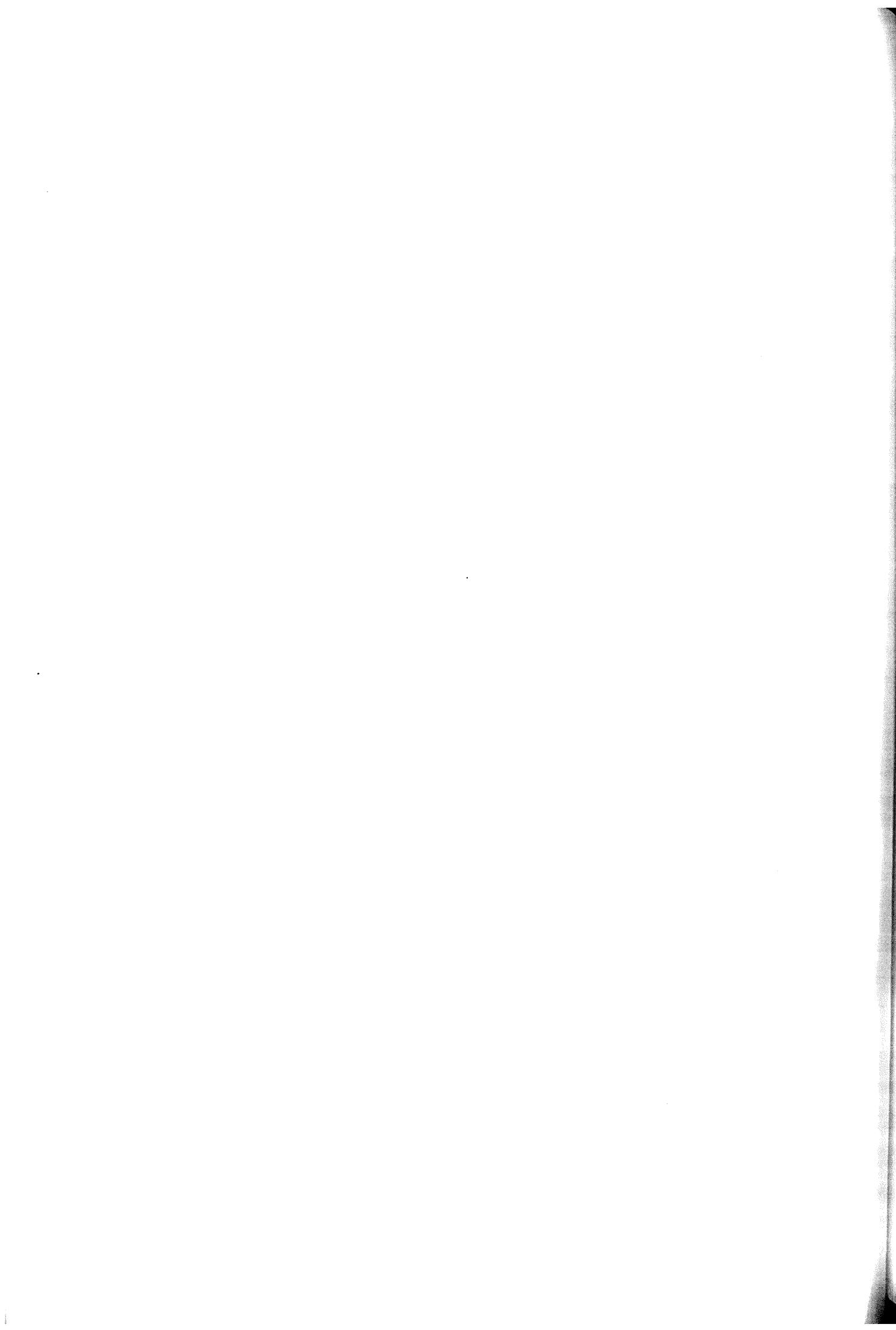
THREE Project Management Processes

Update the PM plan and project documents	Measure performance against other metrics in the PM plan	Collect processes, procedures, and historical information
Hand off completed product	Determine planning team	Request changes
Index and archive records	Determine if variances warrant a corrective action or other change request	Gain final acceptance of the product
Create WBS and WBS dictionary	Implement only approved changes	Take action to control the project
Estimate time and cost	Create network diagram	Manage people



THREE Project Management Processes

Evaluate team and individual performance	Inform stakeholders of the results of change requests	Influence the factors that cause changes	
Divide large projects into phases	Understand the business case	Produce product deliverables (product scope)	
Request changes	Perform quality audits	Uncover initial requirements, assumptions, risks, constraints, and existing agreements	
Estimate resource requirements	Determine quality standards, processes, and metrics	Use issue logs	
Perform integrated change control	Create process improvement plan	Identify stakeholders and determine their expectations, influence, and impact	



THREE Project Management Processes

Determine critical path	Release resources as work is completed	Monitor stakeholder engagement
Perform quality control	Plan communications and stakeholder engagement	Perform risk identification, qualitative and quantitative risk analysis, and risk response planning
Gain formal approval of the plan	Facilitate conflict resolution	Approve or reject changes
Hold kickoff meeting	Assess project and product feasibility within the given constraints	Finalize procurement documents
Hold team-building activities	Send and receive information, and solicit feedback	Finalize the “how to execute and control” parts of all management plans



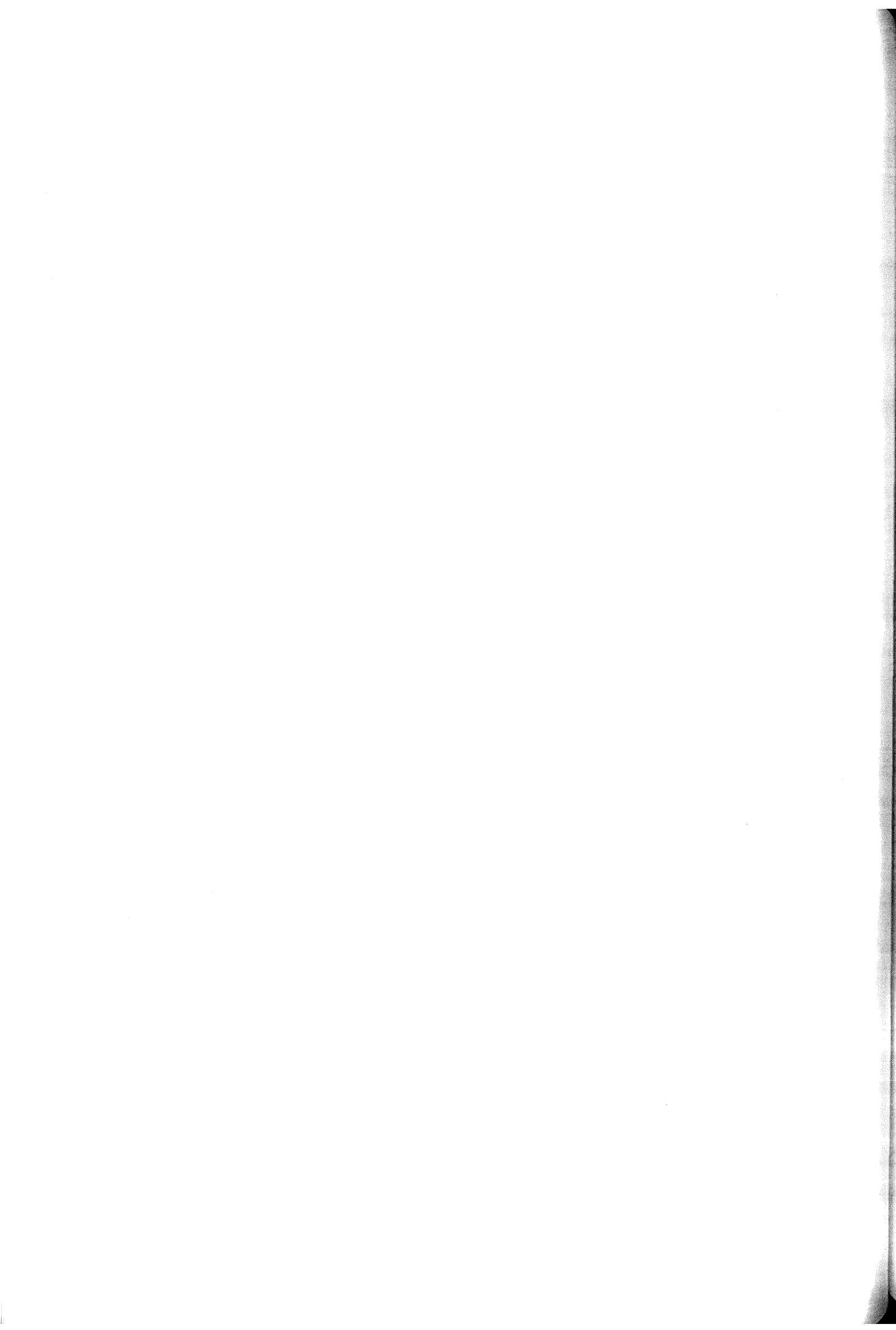
THREE Project Management Processes

Give recognition and rewards	Continuously improve	Develop realistic and final PM plan and performance measurement baseline
Determine all roles and responsibilities	Follow processes	Develop budget
Gain acceptance of interim deliverables from the customer	Create forecasts	Hold meetings
Complete procurement closure	Perform risk reassessments and audits	Select sellers
Manage configuration	Manage reserves	Measure performance against the performance measurement baseline



THREE Project Management Processes

Confirm work is done to requirements	Report on project performance	Acquire final team
Determine detailed requirements	Assess what to purchase and create procurement documents	Complete final performance reporting
Select project manager	Create project scope statement	Gather final lessons learned and update knowledge base
Complete financial closure	Create change management plan	Solicit feedback from the customer about the project
Gather work performance data	Manage stakeholder engagement and expectations	Analyze and evaluate performance





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 Game at least three times will really help solidify your understanding of these concepts.

Name the project planning effort that comes before each of the following items on Rita's Process Chart.

	Planning	What Comes Before?
1	Create network diagram	
2	Finalize procurement documents	
3	Create project scope statement	
4	Create WBS and WBS dictionary	
5	Determine critical path	
6	Develop budget	
7	Estimate time and cost	
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	Create process improvement plan	
15	Determine all roles and responsibilities	
16	Perform risk identification, qualitative and quantitative risk analysis, and risk response planning	
17	Estimate resource requirements	
18	Create activity list	

Project Management Processes THREE

Answer

Planning	What Comes Before?
1 Create network diagram	Create activity list
2 Finalize procurement documents	Go back—iterations
3 Create project scope statement	Determine detailed requirements
4 Create WBS and WBS dictionary	Determine planning team
5 Determine critical path	Estimate time and cost
6 Develop budget	Develop schedule
7 Estimate time and cost	Estimate resource requirements
8 Gain formal approval of the plan	Develop a realistic and final project management plan and performance measurement baseline
9 Hold kickoff meeting	Gain formal approval of the plan
10 Determine quality standards, processes, and metrics	Develop budget
11 Assess what to purchase and create procurement documents	Create project scope statement
12 Plan communications and stakeholder engagement	Determine all roles and responsibilities
13 Go back—iterations	Perform risk identification, qualitative and quantitative risk analysis, and risk response planning
14 Create process improvement plan	Determine quality standards, processes, and metrics
15 Determine all roles and responsibilities	Create process improvement plan
16 Perform risk identification, qualitative and quantitative risk analysis, and risk response planning	Plan communications and stakeholder management
17 Estimate resource requirements	Create network diagram
18 Create activity list	Create WBS and WBS dictionary

How to Use the Rest of This Chapter For many, this is the hardest chapter in the book and uncovers the most gaps in their knowledge. If this chapter is difficult for you, trust us to help you; follow along with the book, really try each exercise, and then look for gaps in your knowledge. Do not simply skip to the answers!

The exercises in this chapter are extensive and are designed to help you explore what a project manager needs to do during each of the project management process groups. Spend about 2 to 5 minutes trying to answer each exercise and about 5 to 15 minutes reviewing the answers to each exercise. Note your gaps on a separate sheet. Then spend some time making sure you research each knowledge gap and clear it from your list.

Again, we encourage you to take these exercises seriously! The exam includes common project management errors as choices and will focus on things most people do not know they should be doing. RMC has helped people all over the world find their knowledge gaps, and many of those are included in these exercises. So approach these exercises with the intent of discovering your gaps, NOT memorizing long lists of data, and make sure you are thinking of a large project when you complete the exercises.

Also remember that you should read each chapter in this book more than once in preparing for the exam. When you go through this chapter the second time, focus on filling the gaps you discovered in the first pass through the chapter, rather than recreating the complete list for each exercise answer.

Initiating Process Group

The processes in the initiating process group formally start a new project or project phase. The initiating process group involves identifying and analyzing stakeholders to align their expectations about the project. It also provides a guiding vision for the project in terms of the organization's strategic objectives that the project will help achieve, the project's high-level scope, and any known constraints. The project is officially authorized through project initiating, and this process group provides the project manager with the authority and information necessary to begin the project.

The project charter and the stakeholder register are the outputs of this process group.

Inputs to Project Initiating You do not have to memorize inputs to pass this exam. It is much better to use logic and rely on your understanding of the project management process. Try this exercise.

Exercise What do you think you would need to know or have before you initiate a project?

Answer If you know what efforts are involved in project initiating (e.g., drafting the project charter and identifying and analyzing the stakeholders), the inputs should be easy to guess. In order to initiate a project, you need to know or have the following:

- The business case for the project
 - The product description or project statement of work detailing the product 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

Project Management Processes THREE

- Any known constraints (e.g., imposed schedule, budget, or resources), risks, and assumptions
- Any relevant agreements, including contracts, if the work will be done under a contract
- Industry standards
- Marketplace trends
- The company's change control system
- Defined processes and procedures for how the company operates
- Past 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, the major projects, and the potential impact current and planned initiatives could have on this project
- Understanding of the company's future
- Understanding of the company's culture
- A list of people who may be good team members

Make sure you identify anything from the previous list that you did not think of, and add it to your gap list.

TRICKS OF THE TRADE

Remember, many questions on the exam will include common errors in project management and require you 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. So do not skip the exercises, and do not go right to the answers! You will need to know much more than what is in the *PMBOK® Guide* to pass the exam. The following should help you.

Exercise Let's go beyond inputs, outputs, and tools and techniques. What are the specific ACTIONS required to complete project initiating?

Answer If you are thinking only in terms of the *PMBOK® Guide*, you probably came up with the following:

- Develop Project Charter (Integration Management chapter)
- Identify Stakeholders (Stakeholder Management chapter)

Knowing the names of these two processes will not be enough to help you pass the exam, however. While the *PMBOK® Guide* lists the processes of project management and features their inputs, tools and techniques, and outputs, it does not directly discuss the efforts involved in each process. You need to have a more detailed understanding of what really should be done (the actions) in project initiating in order to pass the exam.

The following table provides a list of the actions involved in project initiating from the time the project manager is assigned. Remember that what needs to be done on a project varies based on the specific project and the industry, so it may not be practical to do all of these actions on every project.

As you review the list, place a checkmark next to the actions you have done on your real-world projects and leave any actions you do not know or have never done unchecked. Then make sure you study the areas that are unchecked. The items in the list are not in any particular order.

	ACTIONS Involved in Project Initiating	Place ✓ Here If You Do It; Study Areas Unchecked
1	Select the project manager.	
2	Determine the authority of the project manager.	
3	Collect historical information.	
4	Divide large projects into phases.	
5	Identify stakeholders and determine their influences, expectations, and impact.	
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	Ensure the product scope is as final as practical (this will most likely be documented in the project statement of work).	
10	Understand how the project supports the organization's strategic objectives.	
11	Collect and use any relevant existing agreements (including contracts) that might be generating the project or will be required during the project.	
12	Determine measurable project and product objectives.	
13	Facilitate the resolution of conflicting objectives.	

Project Management Processes THREE

	ACTIONS Involved in Project Initiating	Place ✓ Here If You Do It; Study Areas Unchecked
14	Become familiar with the company culture and structure as they relate to the project.	
15	Find existing processes, standards, and compliance requirements that affect the project.	
16	Understand how the organization does business and what procedures and policies are already in place to use on the project.	
17	Do planning on a high-level basis using the project planning process.	
18	Perform high-level estimating for the project schedule and budget.	
19	Use the high-level planning and estimating data to determine whether the product can be achieved within the given constraints.	
20	Determine what form the project charter will take, including the length and level of detail, and the reasons for the selected format.	
21	Coordinate project initiating efforts with stakeholders, including the customer.	
22	Work with the customer and others to determine high-level acceptance criteria and clarify what is and is not in the project.	
23	Determine the initial project organization.	
24	Identify any inherent or required milestones on the project.	
25	Determine what specifically will constitute project success.	
26	Finalize the project charter.	
27	Obtain formal approval of the project charter.	

The following are some points from the previous list of actions that could use further clarification.

Progressive Elaboration You may notice that many of the items in the previous list (e.g., estimates, product scope, etc.) are begun in the initiating process group and iterated or refined later into plans that can be used to manage the project. Although the project management plan is finalized in planning, items such as the detailed estimate, project scope, and product scope may be clarified over time as the work is being done during the executing and monitoring and controlling processes. The process of continually refining estimates and scope is called progressive elaboration.

Project Manager Assigned You should notice in the previous list that the project manager is assigned early in the process. This means the project manager is involved in project initiating. Is this true in your real world? For the exam, assume you are involved this early in the project, and make sure you understand what is going on during initiating.

Business Case In the real world, do you know why your project was selected? Does it matter? As described in the earlier discussion of Rita's Process Chart, the project manager needs to keep in mind throughout the project the reason the project was started. It will influence how the project is planned, what changes are allowed, and the definition of the project scope. Projects are initiated for many reasons. As the person managing the project, you need to know the reasons. (See the Develop Project Charter discussion in the Integration Management chapter for more about the importance of the business case on a project.)

High-Level Planning Is Done during Project Initiating The other important thing to notice in the previous exercise is that high-level planning is done during project initiating. Such planning may include creating a high-level WBS, performing order of magnitude estimating, and doing high-level risk identification. You use this information to determine whether the product of the project can be delivered by the end date and within the budget the organization has requested. In other words, you need to assess whether the project has a chance of being successful before the organization commits money and resources to it. This high-level planning effort is part of creating the project charter, which then documents measurable project objectives, milestone schedules, and an initial budget for the project.

Figure 3.2 shows the reasons why project initiating is begun.

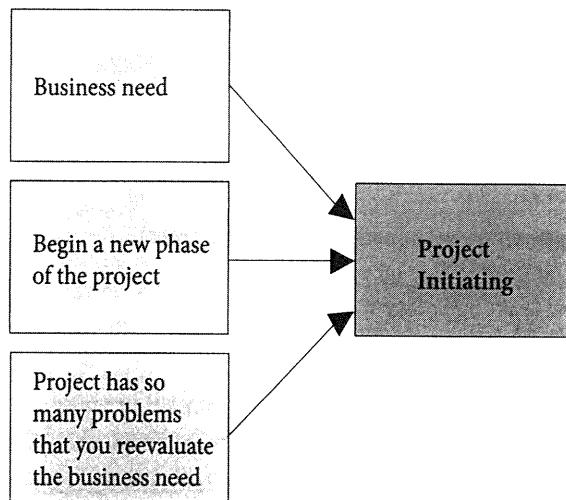


Figure 3.2: Reasons for Entering Project Initiating

Planning Process Group

How much better would your last project be if you could magically do it over again? This is the power of planning. Project planning entails walking through the project and getting it organized before actually doing the work. It presents a huge opportunity to save resources, time, and money, and it encourages increased stakeholder buy-in and commitment to the project.

In project planning, the project manager and the team perform a detailed analysis of whether the objectives in the project charter can be achieved. They then decide how the project—including its strategic objectives—will be accomplished, addressing all appropriate project management processes and knowledge areas. This means determining what processes in the *PMBOK® Guide* are appropriate for the needs of the project, to avoid wasting resources on activities that are not relevant to the particular project.

Project Management Processes THREE

Exercise What are the specific ACTIONS required to complete project planning?

Answer If you are thinking only in terms of the *PMBOK® Guide*, you may have come up with the following:

- Develop Project Management Plan (Integration Management chapter)
 - Plan Scope Management (Scope Management chapter)
 - Collect Requirements (Scope Management chapter)
 - Define Scope (Scope Management chapter)
 - Create WBS (Scope Management chapter)
 - Plan Schedule Management (Time Management chapter)
 - Define Activities (Time Management chapter)
 - Sequence Activities (Time Management chapter)
 - Estimate Activity Resources (Time Management chapter)
 - Estimate Activity Durations (Time Management chapter)
 - Develop Schedule (Time Management chapter)
 - Plan Cost Management (Cost Management chapter)
 - Estimate Costs (Cost Management chapter)
 - Determine Budget (Cost Management chapter)
 - Plan Quality Management (Quality Management chapter)
 - Plan Human Resource Management (Human Resource Management chapter)
 - Plan Communications Management (Communications Management chapter)
 - Plan Risk Management (Risk Management chapter)
 - Identify Risks (Risk Management chapter)
 - Perform Qualitative Risk Analysis (Risk Management chapter)
 - Perform Quantitative Risk Analysis (Risk Management chapter)
 - Plan Risk Responses (Risk Management chapter)
 - Plan Procurement Management (Procurement Management chapter)
 - Plan Stakeholder Management (Stakeholder Management chapter)

Again, simply knowing the names of processes will not be enough to help you pass the exam. You need to have a more detailed understanding of what really should be done (the actions) during project planning, and you need to find out if there are any actions you do not know or have never done.

THREE Project Management Processes

As you check your answers against the following list, note which items you do in the real world. Make sure you understand that the following actions are done during project planning.

NOTE: Do not fall into the trap of losing focus when you are working through these long lists. This list is intended to contain a lot of information to save you the time of reading pages and pages of boring text. Spend about 15 minutes thinking through the list.

	ACTIONS Involved in Project Planning	Place ✓ Here If You Do It; Study Areas Unchecked
1	Determine how you will plan the planning, executing, and controlling efforts for stakeholders, requirements, scope, schedule, cost, quality, process improvement, human 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; 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 (i.e., resources, schedule, cost, etc.) from project initiating so they are more specific and detailed.	
5	Create a description of the project deliverables and the work required to complete those deliverables (project scope statement).	
6	Use the project scope statement to gain approval of the “final” scope from the stakeholders before further planning is done.	
7	Assess what may need to be purchased on the project (e.g., identify any pieces of work that may be outside the organization’s abilities to complete, assess whether new equipment or technology would be needed to perform the project work, etc.).	
8	Create a draft of the procurement documents for necessary contracts, including procurement statements of work, source selection criteria, and contract provisions.	
9	Determine who will be on the project team to help with project planning.	
10	Break down the deliverables into smaller, more manageable pieces (WBS).	
11	Create descriptions of each work package in a WBS dictionary so that the work can be understood by those assigned, without gold plating.	

Project Management Processes

THREE

	ACTIONS Involved in Project Planning	Place ✓ Here If You Do It; Study Areas Unchecked
12	Break down the work packages from the WBS into lists of activities to produce them.	
13	Sequence activities and determine predecessors and successors in the network diagram.	
14	Estimate resource requirements (e.g., staff, facilities, equipment, materials, etc.).	
15	Meet with managers to gain resource commitments.	
16	Decide what level of accuracy is needed for estimates.	
17	Use historical data to support estimating time and cost.	
18	Have those working on the activities estimate time and cost.	
19	Determine how long the project will take without compressing the schedule (determine critical path).	
20	Develop a schedule model, ignoring the schedule constraint contained 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.	
21	Develop a preliminary budget, ignoring the budget constraint contained in the project charter, and reconcile the two to come up with the final budget for the project management plan.	
22	Determine quality practices and standards, and determine which metrics will be used to measure quality performance.	
23	Determine what processes should be followed on the project to reduce the need to supervise work, and to improve quality and make use of standards.	
24	Determine how you will improve the processes in use on the project.	
25	Create a system for recognizing and rewarding the efforts of project team members to help keep them motivated and engaged in project efforts.	
26	Clearly determine all roles and responsibilities so the team members and stakeholders know what their roles are on the project and what work they will need to do.	
27	Determine what information you will need from other projects and what information you can send to other projects.	
28	Plan what will be communicated on the project, to whom, by whom, when, and how.	
29	Plan how to involve stakeholders and manage their expectations during the project.	
30	Complete detailed risk identification, subjectively analyze risks (qualitative risk analysis), perform quantitative risk analysis as necessary, and do risk response planning.	

THREE Project Management Processes

	ACTIONS Involved in Project Planning	Place ✓ Here If You Do It; Study Areas Unchecked
31	Iterations—go back, updating project documents as necessary, in order to work toward a project management plan that is bought into, approved, realistic, and formal.	
32	Finalize the procurement statement of work and other procurement documents for each contract.	
33	Look for potential positive and negative interactions with other projects that can affect this project.	
34	Determine the process that will be used to request, approve, and manage changes on the project.	
35	Plan ways to measure project performance, the measurements to be used, when they will be taken, and how they will be interpreted.	
36	Determine what meetings, reports, and other activities you will use to control the project to the project management plan.	
37	Finalize the “execute” and “control” aspects of all management plans.	
38	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.	
39	Gain formal approval of the project management plan from the sponsor, team, and managers of resources.	
40	Hold a kickoff meeting with all the key stakeholders, team, team members’ managers, and the customer to make sure everyone is on the same page and to gain buy-in.	

The results of the planning effort are the project management plan and project documents that will guide the execution and control of the project. Project planning is iterative. Each planning process may use the results of the previous processes, and each process may affect or cause changes to the previous processes. The idea, in the real world, is to attempt to complete each planning process as fully as possible. Then, after risk identification, qualitative and quantitative risk analysis, and risk response planning, you go back to finalize all the components of the project management plan and project documents. This approach to planning saves time and is efficient. Do you understand why iterations start after risk management? Because it is only after risk management is completed that the final cost and schedule can be determined. Risk management could also result in changes to the scope, deliverables, resources and when they are used, the sequence in which activities are performed, and almost all other parts of the project.

Did the last two sentences make sense? If so, you are in excellent shape. If not, we encourage you to read the Risk Management chapter of this book carefully, and make sure you understand how risk management affects the entire project.

Notice the references to management plans in the previous table. As described in chapter 1, management plans are a PMI-ism. Too often, project managers jump right into whatever they are doing without

Project Management Processes THREE

thinking about it beforehand. Such actions lead to inefficiencies, rework, mistakes, conflict, needless overtime, and just plain bad project management. Project managers are supposed to think about things before they do them. The exam assumes you take a more formal approach to considering “How will I do this?” before doing the work, and that you document this information in a management plan.

There are many components to management plans, but generally they answer the questions of “How will I go about planning scope, schedule, cost, etc.?” and “How will I manage and control scope, schedule, cost, etc., now that I have planned what needs to be done?” The answers to these questions are determined as part of project planning. For clarity, the previous table groups management plans together instead of listing each management plan separately. It also accounts for the iterations of the management plans by separating them into the planning, executing, and control pieces. The individual management plans are combined into the overall project management plan. (See more about management plans and the project management plan in the Integration Management chapter.)

Another important aspect to understand about planning is that the amount of time the team spends in project planning and the level of detail achieved in the plan should be appropriate to the needs of the project. If a high-priority project has a tight schedule that does not allow much room for variance, the project will require more planning than a low-priority project with a fairly flexible schedule.

Some projects cannot be fully planned to a detailed degree prior to starting work on the project. Such projects are often organized by phases (e.g., test phase, install phase, etc.), or they may be conducted using an adaptive life cycle approach. In such cases, only the first part of the project may be fully planned, while the later pieces are planned at a higher level and then progressively elaborated when more is known about the project. Detailed planning for the next phase is done as the previous phase nears completion. This approach is called “rolling wave planning.”¹

Who is involved in the planning processes? Everyone! The project manager compiles the project management plan and project documents with input from stakeholders. The project manager may also use information gathered from resources like historical records from previous projects, company policies, magazine articles about projects, and other such sources to plan the project.

Figure 3.3 shows the reason for entering project planning.

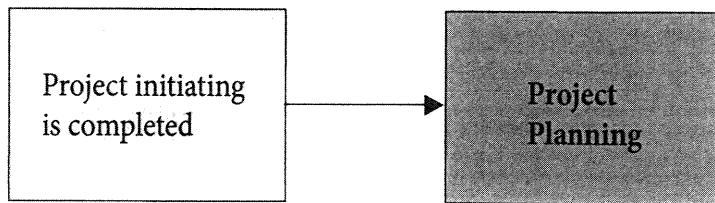


Figure 3.3: Reasons for Entering Project Planning

See the rest of the book for descriptions of each of the individual planning processes, particularly the Integration Management chapter, which discusses the project manager’s role in creating the project management plan.

Executing Process Group

The purpose of project executing is to complete the project work as defined in the project management plan and to meet the project objectives. In other words, the goal is to achieve the project deliverables within the project’s planned budget and schedule, and to meet any other objectives established for the

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project. This is the “do” step of the process defined at the beginning of this chapter (start, plan, do, check and act, end). The focus is on managing people, following processes, and communicating according to plan. During executing, the project manager essentially has a guiding, proactive role, constantly referring back to the project management plan and project documents.

Let's think about project planning again for a moment. On your real-world projects, do you create a project management plan that is realistic and approved? Does your project management plan contain subsidiary management plans for each knowledge area (i.e., scope, time, cost, quality, etc.)? Many project managers do not create such a project management plan. As a result, they may find exam questions in this area to be extremely difficult and tricky. For the exam, get your mind around the critical difference planning makes, and assume the project was properly planned before work began (unless the question indicates otherwise) as you answer the questions.

Exercise Imagine you are about to begin project executing. What type of ACTIONS must be taken?

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Answer If you are thinking only in *PMBOK® Guide* terms, you may have come up with the following as part of the executing process group:

- Direct and Manage Project Work (Integration Management chapter)
- Perform Quality Assurance (Quality Management chapter)
- Acquire Project Team (Human Resource Management chapter)
- Develop Project Team (Human Resource Management chapter)
- Manage Project Team (Human Resource Management chapter)
- Manage Communications (Communications Management chapter)
- Conduct Procurements (Procurement Management chapter)
- Manage Stakeholder Engagement (Stakeholder Management chapter)

Again, you need to know more than the names of processes. Let's look at the actions involved in executing a project. As you check your answers against the following table, note which items apply in your real world, which items were not on your list, and if there are items you wrote that are not included here. Note that a couple of these items, such as "Complete work packages," will be largely undertaken by the project team.

NOTE: This is another long list. Keep focused, and spend 15 minutes thinking through these actions. The list intentionally jumps around.

	ACTIONS Involved in Project Executing	Place ✓ Here If You Do It; Study Areas Unchecked
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 original project management plan or the project management plan that was revised as a result of control activities.	
3	Complete work packages.	
4	Collect and document 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	Perform quality assurance to ensure the defined 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.	
11	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.	

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	ACTIONS Involved in Project Executing	Place ✓ Here If You Do It; Study Areas Unchecked
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 and release project resources in accordance with the project management plan.	
19	Guide, assist, communicate, lead, negotiate, facilitate, and coach.	
20	Utilize your technical knowledge.	
21	Hold meetings to identify or 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	Focus on looking for exceptions to the approved project management plan in team members' performance, rather than checking up on every person's work or babysitting.	
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 that 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 in focus while managing the project, especially when problems occur.	
34	Solve problems.	
35	Stop during the project to see where changes are coming from and what you can do to eliminate the root cause of the need for change.	
36	Implement the recognition and reward system created during the planning processes.	

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	ACTIONS Involved in Project Executing	Place ✓ Here If You Do It; Study Areas Unchecked
37	Determine team members who could not be named during the planning processes.	
38	Gather initial measurements and details about activities of project work (work performance data).	
39	Implement approved process improvements.	
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 procurement documents.	
42	Review bids and quotes, negotiate contract terms with prospective sellers, and select sellers.	
43	Expend and manage project funds.	
44	Facilitate conflict resolution using conflict resolution techniques.	
45	Assess individual team member performance.	

Did your list contain items that were not in the previous table? If so, make sure those items should actually be part of executing a properly managed project. Did you include such things as getting the team to cooperate, discovering added scope, or coordinating unplanned overtime work? Although these things could (and often do) occur on a project, they result from a lack of proper project management. Therefore, do not expect to see them on the exam.

How about dealing with problems? Notice that “Solve problems” is only one of 45 items on the list of actions to be done during project executing. As a project manager, you should be spending time preventing problems so you do not have to spend much time dealing with them. The exam assumes problems do not occur very often, nor should they have a major impact on the project. Again, for the exam, assume proper project management was done unless the questions say otherwise!

Did you list meetings? Meetings are certainly part of executing a project, but many people do not realize that proper planning can decrease the number of meetings they need. If you were thinking about “go around the room and report what you have done” types of meetings, realize that status can also be collected through other means. The occasions when the team gets together are too important to just focus on collecting status. How about reviewing risks and upcoming contingency plans during meetings? Having too many meetings can cause you to lose buy-in from your team if they feel you are wasting their time.



As you work through these lists, make sure you have identified what you do “wrong” on your real-world projects before you take the exam!

Keep the words “work to the project management plan,” “be proactive,” “manage,” and “guide” in mind as a way to summarize executing activities while you take the exam, to make sure you have your PMI hat on.

The processes of project management are not always performed in the same sequence. Executing means executing the latest revision of the project management plan. In other words, you are always executing

to the project management plan, but the plan might change over time. Figure 3.4 illustrates when you might enter project executing.

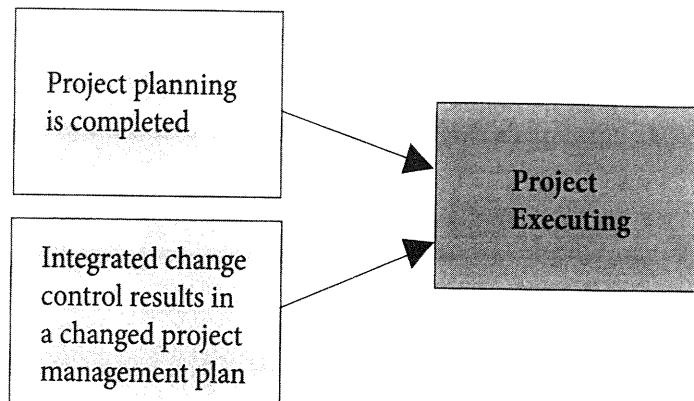


Figure 3.4: Reasons for Entering Project Executing

Monitoring and Controlling Process Group

Monitoring and controlling means measuring the performance of the project against the project management plan and approving change requests, including recommended corrective actions, preventive actions, and defect repair. Project monitoring and controlling is among the worst-scoring process groups on the exam for test takers. One reason for this is that you are expected to know how to control a project that has been planned and managed in a very formal, proper way, when many people do not do this in their real world. Project managers who spend most of their time asking for percent complete, being unsure if the project will meet its performance measurement baseline, and thinking that an unrealistic schedule should simply be blamed on management typically have trouble in this area on the exam. We saw in the previous chapter that monitoring and controlling applies to change-driven projects as well as plan-driven ones, but it can be useful to think in terms of plan-driven projects to understand this process group and to answer questions on the exam (unless, of course, a question specifies a change-driven project).



For the exam, assume:

- You have a formal project management plan that is realistic and complete to the level appropriate for the project.
- You have plans already in place for how and when you will measure time, 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.

The following exercise should help you get your mind around what a project manager should do to monitor and control a project. Again, we encourage you to work through this exercise; do NOT jump right to the answers. Find the gaps in your knowledge and experience, and fill those gaps, rather than relying on memorization for the exam. As a result, you will pass the exam—and be a better project manager!

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Exercise What are the specific ACTIONS required as part of project monitoring and controlling?

Answer If you are thinking only in *PMBOK® Guide* terms, you might have come up with the following:

- Monitor and Control Project Work (Integration Management chapter)
 - Perform Integrated Change Control (Integration Management chapter)
 - Validate Scope (Scope Management chapter)
 - Control Scope (Scope Management chapter)
 - Control Schedule (Time Management chapter)
 - Control Costs (Cost Management chapter)
 - Control Quality (Quality Management chapter)
 - Control Communications (Communications Management chapter)
 - Control Risks (Risk Management chapter)

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- Control Procurements (Procurement Management chapter)
- Control Stakeholder Engagement (Stakeholder Management chapter)

The previously listed processes are described in the chapters of this book as referenced. Now let's look at what actions should be done in monitoring and controlling a project. Review the following list, and identify any you do not know or have never done. Also notice if you included items that are not listed here. Are you sure those items are part of monitoring and controlling?

NOTE: Because this is one of the worst-scoring 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 the list intentionally jumps around.

	ACTIONS Involved in Project Monitoring and Controlling	Place ✓ Here If You Do It; Study Areas Unchecked
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.	
5	Exercise 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 or rejected.	
8	Manage configuration to ensure 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.	
11	Refine control limits as needed.	
12	Identify the root causes of problems.	
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 time and cost reserves.	

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ACTIONS Involved in Project Monitoring and Controlling		Place ✓ Here If You Do It; Study Areas Unchecked
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 inspections.	
22	Make decisions to accept or reject work.	
23	Evaluate the effectiveness of implemented corrective actions.	
24	Reassess the effectiveness of project control systems.	
25	Spend time trying to improve quality.	
26	Get information from stakeholders to determine if project controls need to be updated.	
27	Identify and analyze trends.	
28	Evaluate the effectiveness of risk responses in a risk audit.	
29	Look for newly arising risks.	
30	Reanalyze existing 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—inspections, Pareto charts, cause and effect diagrams, etc.	
37	Influence any factors that could result in the project's change control and configuration management measures being circumvented.	
38	Control changes.	
39	Control to make sure that only approved changes are implemented.	
40	Work with the change control board.	
41	Evaluate customer satisfaction.	
42	Control procurements through actions like reviewing, approving, and paying invoices; administering claims; and performing inspections and audits.	
43	Validate defect repair.	

ACTIONS Involved in Project Monitoring and Controlling		Place ✓ Here If You Do It; Study Areas Unchecked
44	Stop during the project to see where 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.	

Keep in mind that monitoring and controlling is almost certain to involve adding some information to the various project documents and the project management plan. Not all monitoring and controlling efforts result in the discovery of variance that warrants preventive or corrective action, defect repair, or changes to the baselines or plan. When a project has been planned appropriately, control efforts will largely result in information that proves that work is being done correctly to plan and that scope is being produced to the agreed-upon standards and metrics. You should document all of this information in case you need it in the future. Take a moment to leaf through the *PMBOK® Guide* to see how often updates to the project management plan and project documents are an output of the monitoring and controlling processes. You did all that work, measured, and gathered lessons learned: why would you not capture it all in your project management plan and documents for reference and review?

The exam assumes a project manager spends time and focused effort controlling scope, time, communications, risks, etc. Do you do this? These concepts overlap and repeat themselves throughout the knowledge areas. Since people score so poorly in this process group, we have included the following information about many of the control processes to provide a better overall understanding of project monitoring and controlling. These control processes are only briefly discussed in the other chapters of this book, so read the following carefully to get a better sense of what “control” is.

Control Scope

- Follow the change management plan.
- Measure scope performance against the performance measurement baseline.
- Influence the factors that cause changes.
- Control scope changes and the impacts of those changes.
- Analyze work performance data and variances.
- Request changes.
- Update the scope baseline, other parts of the project management plan, and requirements documentation with approved changes.
- Validate changes to make sure they do not over- or undercorrect the problems.
- Document lessons learned.

Control Schedule

- Follow the change management plan.
- Measure schedule performance against the performance measurement baseline.
- Influence the factors that cause changes.
- Control schedule changes and the impacts of those changes.
- Analyze work performance data and variances.
- Request changes.
- Update the schedule baseline, other parts of the project management plan, and schedule-related documentation.

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- Document lessons learned.
- Manage the time reserve.
- Use earned value analysis to create schedule forecasts.
- Validate changes to make sure they do not over- or undercorrect the problems.

Control Costs

- Follow the change management plan.
- Measure cost performance against the performance measurement baseline.
- Influence the factors that cause changes.
- Control cost changes and the impacts of those changes.
- Analyze work performance data and variances.
- Request changes.
- Update the cost baseline, other parts of the project management plan, and cost estimates.
- Document lessons learned.
- Manage the budget reserve.
- Use earned value analysis to recalculate the estimate at completion and other cost forecasts.
- Obtain additional funding when needed.
- Validate changes to make sure they do not over- or undercorrect the problems.

Control Quality

- Hold periodic inspections.
- Ensure the deliverables are meeting the standards.
- Influence the factors that cause changes.
- Request changes or improvements to work and processes.
- Make decisions to accept or reject work.
- Evaluate the effectiveness of implemented changes.
- Reassess the effectiveness of project control systems.
- Analyze work performance data and variances.
- Update the quality management and process improvement plans, as well as quality- and process-related documentation.
- Validate changes to make sure they do not over- or undercorrect the problems.
- Document lessons learned.

Control Communications

- 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.
- Update documentation related to forecasts, performance reports, and issue logs.
- Analyze information about communications to make sure they are meeting stakeholder needs.
- Document lessons learned.
- Validate changes to make sure they do not over- or undercorrect the problems.

Control Risks

- Reassess risks, planned risk responses, and risk reserves.
- Identify new risks.
- Use risk management procedures.
- Create and implement workarounds.
- Evaluate the effectiveness of implemented risk response plans and risk processes.
- Analyze work performance data, work performance reports, and variances.
- Request changes.

- Perform risk audits.
- Update the project management plan and lists of risks and risk response plans.
- Document lessons learned.

Control Procurements

- 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.
- 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 to updated version, and evaluate effectiveness of changes.
- Document lessons learned.

Control Stakeholder Engagement

- Analyze work performance data and variances.
- Evaluate stakeholder engagement and 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.
- Document lessons learned.
- Validate success of changes to stakeholder engagement strategy.

The process of project management does not cleanly go from initiating to planning to executing to monitoring and controlling to closing. In fact, you are doing some level of monitoring and controlling throughout the project—from initiating through closing. Figure 3.5 illustrates key project outputs that trigger a focus on monitoring and controlling. It also shows that you might go from monitoring and controlling to other process groups (i.e., initiating, executing, or closing), depending on the needs of the project.

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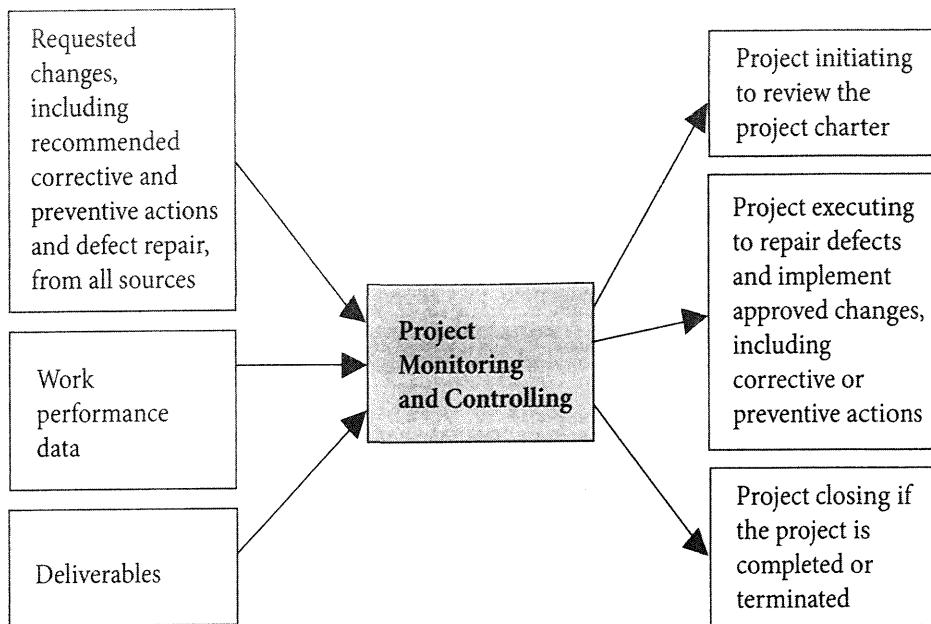


Figure 3.5: Key Outputs That Trigger Project Monitoring and Controlling, and Potential Next Steps

Closing Process Group

You have completed all the product scope. Is the project finished? No. There's still more work to do. Project closing is where the project is finished. Closing is one of the most ignored parts of the project management process. However, if you take time now to understand the concepts that we'll discuss in this section, the 14 or so scored questions about closing on the exam should be easy.

The closing effort will include administrative activities such as collecting and finalizing all the paperwork 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.

In many real-world situations, projects never seem to officially finish. Sometimes the project manager just goes on to do other things. Sometimes work on the project just stops. Sometimes the project priority decreases. There are no official titles for the ways projects can end, but they should all be completed using the closing processes.

In any situation, ignoring project closing is a real mistake, as the work done during closure is extremely important to the performing organization and to the customer. The exam asks questions in this area to see if you know what those valuable activities are and when a project is really done. Try this exercise!

Exercise What are the specific ACTIONS required to complete project closing?

Answer The *PMBOK® Guide* lists the following processes:

- Close Project or Phase (Integration Management chapter)
 - Close Procurements (Procurement Management chapter)

Now review the list of closing actions in the following table, and identify any that you do not know or have never done. Look for gaps in your knowledge.

ACTIONS Involved in Project Closing		Place ✓ Here If You Do It; Study Areas Unchecked
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 the project was terminated before completion, document the reasons for termination and the status of the project and deliverables.	
5	Make final payments, and complete cost records.	
6	Gather final lessons learned.	
7	Update project records.	
8	Ensure all the project management processes are complete.	

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ACTIONS Involved in Project Closing		Place ✓ Here If You Do It; Study Areas Unchecked
9	Update corporate processes, procedures, and templates based on lessons learned.	
10	Add new skills acquired to team members' human resource records.	
11	Complete procurement closure and 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 (e.g., the customer, operations and maintenance, etc.).	
17	Celebrate!	

Does this list of actions make sense? Take a moment to go back and look again at the previous table, and make sure you can envision how each item should be done in the real world. Spend some time on this and the lists for the other process groups to help you on the exam and to provide a solid understanding of the overall project management process as you read the rest of this book.

There are a couple of very valuable actions listed in the previous table that many people miss. Some project managers consider the end celebration and the final project performance report to be unimportant parts of the project. But there is a reason these points are tested on the exam. Having some form of celebration and a final report that shows, beyond a shadow of a doubt, the project's success sends a strong message to all stakeholders that your team finished the project. Isn't that a good thing? Would you sign your name to the last few projects you completed? If not, why not? What about having a party where the entire team autographs the project charter or notebook?

Confirming that all the requirements have been met is another item on the previous list that may seem unimportant. Most studies show that many requirements are not met on projects, however, especially on projects with numerous pages of requirements. This confirmation needs to happen 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? Did you realize that 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.

We noted in the first chapter of this book that historical records are a PMI-ism. Make sure you understand the value of these records for the exam 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 made available to other projects and the project management office. In addition, project closing involves a concerted effort to index all files, letters, correspondence, and other records of the project into an organized archive that is stored for use on future projects.

Now let's think about formal sign-off and formal acceptance. These are important because they indicate that the customer considers the project completed and accepts the whole project. Formal sign-off in a procurement situation constitutes legal acceptance. Without that acceptance, you cannot be sure the project was finished. Imagine the team never gains formal acceptance on a project for an external customer, but moves on to other projects. Then the customer calls for additional scope to be added to the project. How difficult would it be to regroup the team to perform the new work? Gaining formal acceptance helps ensure this is not necessary.

In addition to obtaining formal acceptance, another important part of project closing is measuring customer satisfaction. Have you ever had a customer accept your work although they were not happy with the project? This is a common occurrence. It's highly beneficial for project managers to solicit feedback from the customer about both the project and the product and evaluate the customer's satisfaction level during project closing. Just like lessons learned, measuring customer satisfaction should be ongoing throughout the project, but it MUST occur during project closing.

Once the administrative pieces of project closure are completed and the customer, sponsor, and/or other stakeholders provide formal sign-off that the product of the project is acceptable, the project is closed. At that point, any resources who had been helping to close the project or project phase are released.

Figure 3.6 illustrates when a project might enter the closing process group.

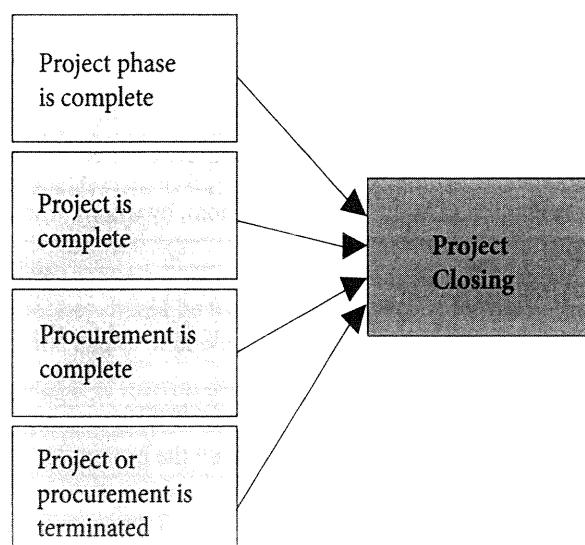


Figure 3.6: Reasons for Entering Project Closing



The Project Management Scramble Game

The following exercise is an extension of Rita's Process Game and should help in assessing how well you've understood what you've read. This exercise will look at more specific actions, rather than the generalized ones stated in Rita's Process Chart. For each item listed in the following table, simply determine if it is done in initiating, planning, executing, monitoring and controlling, or closing.

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	Actions	During Which Process Group Is This Done?
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 existing risks.	
6	Use the 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	Hold team-building activities.	
9	Evaluate the effectiveness of risk responses in a risk audit.	
10	Determine how you will plan the planning, executing, and controlling efforts for stakeholders, requirements, scope, schedule, cost, quality, process improvement, human 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.	
17	Evaluate how effectively the team members function as a team.	
18	Determine how you will improve the processes in use on the project.	
19	Determine measurable project and product objectives.	
20	Manage the time 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 or babysitting.	
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.	

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	Actions	During Which Process Group Is This Done?
25	Calculate estimate to complete.	
26	Understand how the project supports the organization's strategic objectives.	
27	Implement approved process improvements.	
28	Identify stakeholders and determine their influences, expectations, and impact.	
29	Determine variances.	
30	Add new skills acquired to team members' human resource records.	
31	Meet with managers to gain resource commitments.	
32	Use and interpret earned value calculations.	
33	Ensure the product scope is as final as practical (this will most likely be documented in the project statement of work).	
34	Create and distribute a final report of project (or phase) performance.	
35	Exercise judgement to determine what variances are important and if they warrant recommending a change or corrective action.	
36	Finalize the "execute" and "control" aspects of all management plans.	
37	Index and archive project records.	
38	Keep managers apprised of when their resources will be needed on the project.	
39	Evaluate customer satisfaction regarding the project and the deliverables.	
40	Determine who will be on the project team to help with project planning.	
41	Create recommendations for the performing organization that increase its effectiveness.	
42	Perform procurement inspections.	
43	Turn high-level stakeholder needs, wants, and expectations into requirements.	
44	Look for newly arising risks.	
45	Determine what processes should be followed on the project to reduce the need to supervise work, and to improve quality and make use of standards.	
46	Obtain formal acceptance of interim deliverables from the customer.	
47	Identify the need for replanning.	
48	Determine what specifically will constitute project success.	
49	Assess individual team member performance.	
50	Make or obtain a decision in integrated change control about whether changes should be approved or rejected.	
51	Perform quality assurance to ensure the defined practices and procedures are being followed and are still appropriate for the project.	
52	Evaluate the effectiveness of implemented corrective actions.	
53	Manage stakeholder engagement and expectations, increase project support, and prevent possible problems.	
54	Plan ways to measure project performance, the measurements to be used, when they will be taken, and how they will be interpreted.	

Project Management Processes THREE

	Actions	During Which Process Group Is This Done?
55	Keep the project's business case in focus while managing the project, especially when problems occur.	
56	Determine the process that will be used to request, approve, and manage changes on the project.	
57	Obtain seller responses to procurement documents.	

Answer

	Actions	During Which Process Group Is This Done?
1	Use the project scope statement to gain approval of the "final" scope from stakeholders before further planning is done.	Planning
2	Determine high-level requirements, constraints, assumptions, and risks.	Initiating
3	Measure against the performance measurement baseline.	Monitoring and controlling
4	Implement approved changes, including corrective actions, preventive actions, and defect repair.	Executing
5	Reanalyze existing risks.	Monitoring and controlling
6	Use the high-level planning and estimating data to determine whether the product can be achieved within the given constraints.	Initiating
7	Verify and document that the project, or project phase, meets completion or exit criteria set in place during project planning.	Closing
8	Hold team-building activities.	Executing
9	Evaluate the effectiveness of risk responses in a risk audit.	Monitoring and controlling
10	Determine how you will plan the planning, executing, and controlling efforts for stakeholders, requirements, scope, schedule, cost, quality, process improvement, human resources, communications, risk, procurement, changes, and configuration, and put that information into the beginnings of management plans.	Planning
11	Obtain formal (legal) sign-off and final acceptance of the product of the project from the customer.	Closing
12	Increase the effectiveness of processes.	Executing
13	Recalculate how much the project will cost and how long it will take, and create forecasts.	Monitoring and controlling
14	Plan what will be communicated on the project, to whom, by whom, when, and how.	Planning
15	Spend time trying to improve quality.	Monitoring and controlling

THREE Project Management Processes

	Actions	During Which Process Group Is This Done?
16	Make sure the business case and the analysis supporting the need for the project are documented and understood.	Initiating
17	Evaluate how effectively the team members function as a team.	Executing
18	Determine how you will improve the processes in use on the project.	Planning
19	Determine measurable project and product objectives.	Initiating
20	Manage the time and cost reserves.	Monitoring and controlling
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 or babysitting.	Executing
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.	Planning
23	Gather final lessons learned.	Closing
24	Keep everyone focused on completing the project to the project charter and project management plan.	Executing
25	Calculate estimate to complete.	Monitoring and controlling
26	Understand how the project supports the organization's strategic objectives.	Initiating
27	Implement approved process improvements.	Executing
28	Identify stakeholders and determine their influences, expectations, and impact.	Initiating
29	Determine variances.	Monitoring and controlling
30	Add new skills acquired to team members' human resource records.	Closing
31	Meet with managers to gain resource commitments.	Planning
32	Use and interpret earned value calculations.	Monitoring and controlling
33	Ensure the product scope is as final as practical (this will most likely be documented in the project statement of work).	Initiating
34	Create and distribute a final report of project (or phase) performance.	Closing
35	Exercise judgement to determine what variances are important and if they warrant recommending a change or corrective action.	Monitoring and controlling
36	Finalize the "execute" and "control" aspects of all management plans.	Planning
37	Index and archive project records.	Closing
38	Keep managers apprised of when their resources will be needed on the project.	Executing
39	Evaluate customer satisfaction regarding the project and the deliverables.	Closing
40	Determine who will be on the project team to help with project planning.	Planning
41	Create recommendations for the performing organization that increase its effectiveness.	Executing

Project Management Processes THREE

	Actions	During Which Process Group Is This Done?
42	Perform procurement inspections.	Monitoring and controlling
43	Turn high-level stakeholder needs, wants, and expectations into requirements.	Initiating
44	Look for newly arising risks.	Monitoring and controlling
45	Determine what processes should be followed on the project to reduce the need to supervise work, and to improve quality and make use of standards.	Planning
46	Obtain formal acceptance of interim deliverables from the customer.	Monitoring and controlling
47	Identify the need for replanning.	Monitoring and controlling
48	Determine what specifically will constitute project success.	Initiating
49	Assess individual team member performance.	Executing
50	Make or obtain a decision in integrated change control about whether changes should be approved or rejected.	Monitoring and controlling
51	Perform quality assurance to ensure the defined practices and procedures are being followed and are still appropriate for the project.	Executing
52	Evaluate the effectiveness of implemented corrective actions.	Monitoring and controlling
53	Manage stakeholder engagement and expectations, increase project support, and prevent possible problems.	Executing
54	Plan ways to measure project performance, the measurements to be used, when they will be taken, and how they will be interpreted.	Planning
55	Keep the project's business case in focus while managing the project, especially when problems occur.	Executing
56	Determine the process that will be used to request, approve, and manage changes on the project.	Planning
57	Obtain seller responses to procurement documents.	Executing

Inputs and Outputs Why worry about inputs and outputs? Here is a trick to help you gain confidence in your understanding of the project management processes.

TRICKS OF THE TRADE An input means:
• “What do I need before I can...”

TRICKS OF THE TRADE An output means:
• “What will I have when I am done with...”
• Or, “What am I trying to achieve when I am doing...”

Inputs and outputs are logical. If you really know project management, they should not require memorization. So what is an input to a WBS? If you cannot give some form of answer right now, you may need more basic training before preparing for the exam. Make sure you read the Create WBS

THREE Project Management Processes

discussion carefully in the Scope Management chapter and pay attention throughout this book to when and how the WBS is used.

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 project team) to create a work breakdown structure, yet the team is not specifically listed as an input to creating the work breakdown structure in the *PMBOK® Guide*. The remaining chapters of this book will help you understand the processes of project management and the inputs and outputs so you can see the logic behind them.

Practice Exam

1. In which project management process group is the detailed project budget created?
 - 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. The project team has just completed the initial project schedule and budget. The NEXT thing to do is to:
 - A. Identify risks.
 - B. Begin iterations.
 - C. Determine communications requirements.
 - D. Create a bar (Gantt) chart.
4. 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.
5. The person who should be in control of the project during project planning is the:
 - A. Project manager.
 - B. Team member.
 - C. Functional manager.
 - D. Sponsor.
6. 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
7. The project sponsor has just signed the project charter. What is the NEXT thing to do?
 - A. Begin to complete work packages.
 - B. Validate scope.
 - C. Start integrated change control.
 - D. Start to create management plans.

THREE Project Management Processes

8. 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

9. The WBS and WBS dictionary are completed. 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 US \$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.

10. 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.

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

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

Project Management Processes THREE

13. A team member notifies the project manager that the activities comprising a work package are no longer appropriate. It would be BEST for the project manager to be in what part of the project management process?
 - A. Corrective action
 - B. Integrated change control
 - C. Monitoring and controlling
 - D. Project closing
14. 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 BEST considered to be in what part of the project management process?
 - A. Closing
 - B. Monitoring and controlling
 - C. Executing
 - D. Initiating
15. Which of the following is the MOST appropriate thing to do during the initiating process group?
 - A. Create a detailed description of the project deliverables.
 - B. Get familiar with the company culture and structure as they relate to the project.
 - C. Identify the root cause of problems.
 - D. Ensure all project management processes are complete.
16. Which of the following is a characteristic of project management processes?
 - A. Iterative
 - B. Unique
 - C. Unnecessary
 - D. Standardized
17. Which project management process group generally takes the MOST project time and resources?
 - A. Planning
 - B. Design
 - C. Integration
 - D. Executing
18. All of the following must be performed during project initiating EXCEPT:
 - A. Identify and document business needs.
 - B. Create a project scope statement.
 - C. Divide a large project into phases.
 - D. Accumulate and evaluate historical information.
19. Closure includes all of 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.

THREE Project Management Processes

20. 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.
21. 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
22. Which process groups must be included in every project?
 - A. Planning, executing, and closing
 - B. Initiating, planning, and executing
 - C. Initiating, planning, executing, monitoring and controlling, and closing
 - D. Planning, executing, and monitoring and controlling
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. Collect historical information from previous projects.
 - C. Confirm all the requirements in the project have been met.
 - 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 of 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/or 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.

Project Management Processes

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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 C

Explanation Communications requirements and quality standards are needed before risks (especially risks relating to communications and quality) can be determined. Iterations cannot begin until the risks are identified, qualified and quantified, and responses are developed. Through iterations, the WBS and other parts of the project management plan are revised. A bar chart would have been done during the creation of the schedule, so it cannot be the next thing. Of the choices listed, determine communications requirements is the best option.

4. 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.

5. Answer A

Explanation The project manager should be named early in the project, during project initiating if possible. It is then his or her responsibility to control the project throughout its life.

6. 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.

7. 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.

8. Answer A

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

9. 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.

10. **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.

11. **Answer C**

Explanation The project manager should be assigned during project initiating.

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 If you chose another part of the project management process, you probably forgot that the situation needs to be evaluated by the project manager before recommending a change or beginning integrated change control.

14. **Answer C**

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

15. **Answer B**

Explanation A detailed description of the project deliverables is created during project planning, as part of creating the project scope statement. Root cause analysis occurs during project monitoring and controlling, not initiating. Ensuring all project management processes are complete occurs during project closing. It is important for a project manager to become familiar with the company culture and structure as they relate to the project as early in the project as possible. This is the most appropriate choice to do in project initiating.

16. **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.

17. **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.

18. **Answer B**

Explanation A project scope statement is created during project planning.

19. **Answer A**

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

20. **Answer C**

Explanation A phase or project must be formally closed and accepted.

Project Management Processes

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21. **Answer C**

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

22. **Answer C**

Explanation All five process groups are addressed in each project. It is the responsibility of the project manager to determine the level of attention to give to each process group.

23. **Answer C**

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 during project initiating.

26. **Answer B**

Explanation These are all reasons projects are initiated.

Integration Management

FOUR

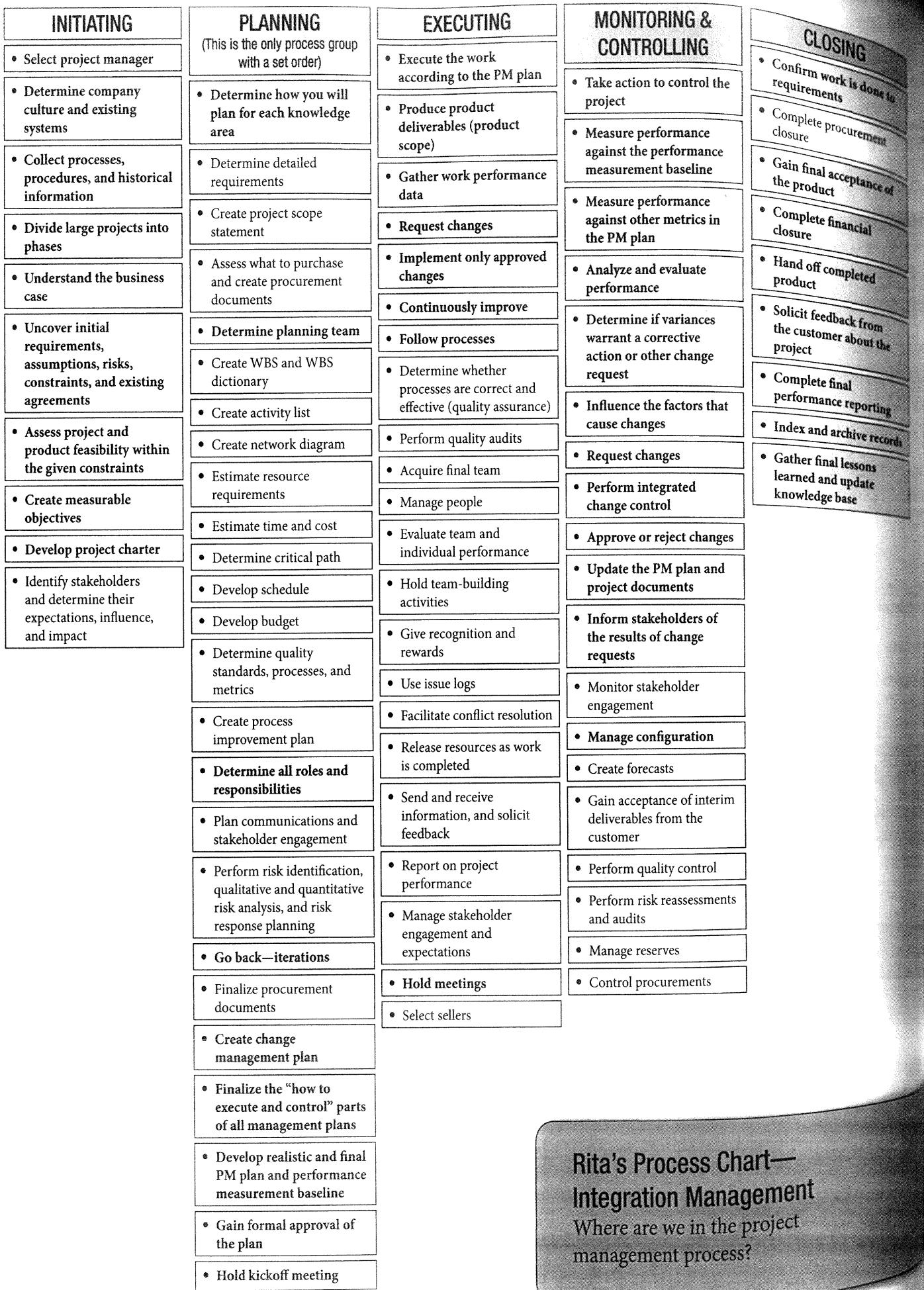
If you were asked, "What is a project manager's main role?" what would you say? The answer is to perform integration management—to pull all the pieces of a project together into a cohesive whole. This is so much a part of a project manager's job that it is arguably the reason for the project manager's existence in an organization and on a project.

Many people who have trouble with this knowledge area on the exam either do not currently perform integration management on their projects or they do not think about integration management from a large-project perspective. While the work of the project is being done, the team members are concentrating on completing the work packages, the project sponsor should be protecting the project from changes and loss of resources, and 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 in the knowledge areas (scope, time, cost, quality, human resource, communications, risk, procurement, and stakeholder management) with each other. Project management processes do not happen independently. In order to complete a cost estimate, for example, the number of resources on the project, the scope being estimated, the risk reserves, etc., should be taken into account. As another example, adding a new resource to the project may require cost or schedule changes. In dealing with each situation that comes up on a project, the project manager is integrating the processes of project management.

QUICKTEST

- Integration management process
- Integrated change control
- Process for making changes
- Project management plan
 - Knowledge area management plans
 - Baselines
 - Requirements management plan
 - Change management plan
 - Configuration management plan
 - Process improvement plan
- Project charter
- Business case
- Project selection
 - Benefit measurement methods
 - Constrained optimization methods
- Project documents
- Change requests
- Corrective action
- Preventive action
- Defect repair
- Project manager's role as integrator
- Constraints and assumptions
- Project management plan and project document updates
- Configuration management system
- Change control system
- Change control board
- Cost-benefit analysis
- Kickoff meeting
- Work authorization system
- Project statement of work
- Net present value
- Internal rate of return
- Payback period
- Present value
- Economic value added
- Opportunity cost
- Sunk costs
- Law of diminishing returns
- Working capital
- Depreciation



**Rita's Process Chart—
Integration Management**
Where are we in the project management process?

This chapter is about the high-level work a project manager needs to do. The other knowledge area chapters in this book explain the detailed work. Read this chapter carefully. Integration management is a difficult area on the exam.

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

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
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

Integration management cannot be understood without a solid understanding of the process 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 the project manager. You must understand integration from a real-world, large-project perspective.

Figure 4.1 shows the relationship between the knowledge areas and the process groups. All of the knowledge areas include processes that occur in planning, and most include monitoring and controlling processes. Integration management is the only knowledge area that has processes occurring in all process groups, throughout the project management process. The project manager is always integrating.

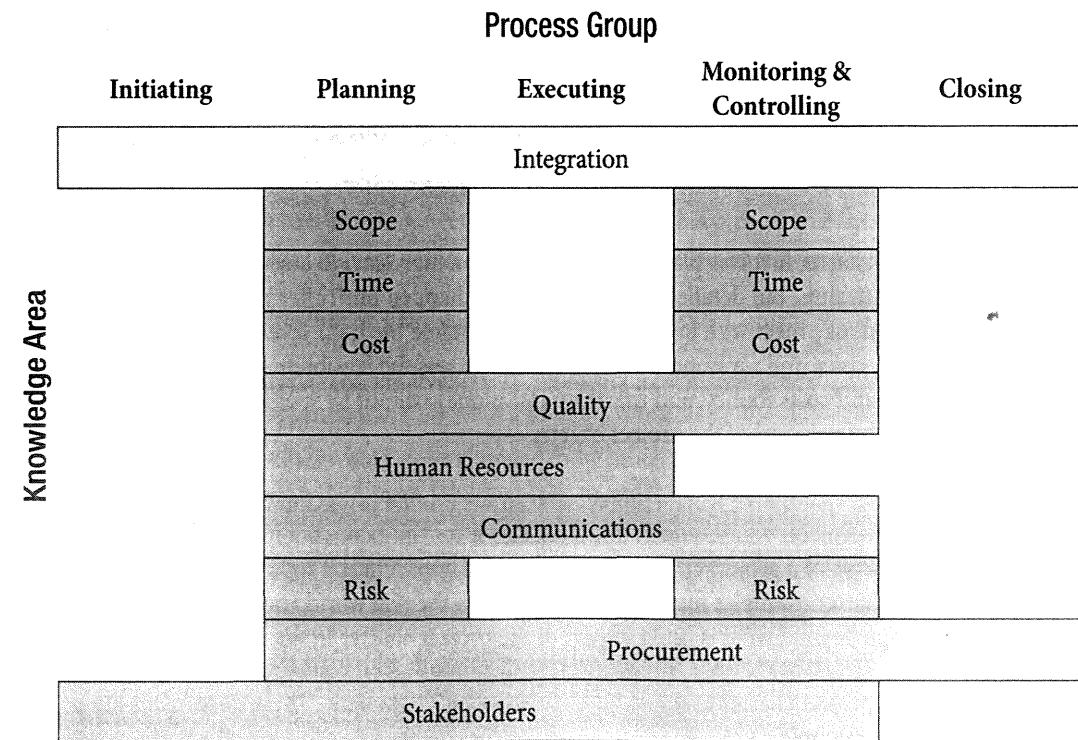


Figure 4.1: The Relationship between the Knowledge Areas and Process Groups

Develop Project Charter¹

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Process: Develop Project Charter
Process Group: Initiating
Knowledge Area: Integration Management

The first part of integration management is coming up with a project charter. The exam could include up to eight questions that reference a project charter. You should understand what a project charter is, why it is important, and how it is used throughout the life of the project.

Exercise Test yourself! Answer the following question.

What Is Included in a Project Charter?

Answer Unfortunately, many companies expect project charters to include information such as a detailed schedule and a full risk analysis. Such information is not available at this point in the project management process, however. A project charter is not a project management plan! Read the rest of this section to learn what is included in a project charter and to see examples.

Creating the project charter involves planning the project at a high level to assess whether it is feasible within the given constraints, but detailed planning does not happen until after the charter is signed. In project initiating, you may meet with key stakeholders and define the high-level objectives, constraints, requirements, scope, risks, and assumptions in an effort to assess the feasibility of the project. Detailed planning takes time and costs money, and this time and money cannot be spent until the project is officially authorized by approval of the project charter.

The following is a brief example of what a project charter for a small project may include. It does not represent the scale of projects you should be thinking about for the exam, but it should help you to understand the elements of a project charter. You will see a sample charter for a large project later in this chapter. These charter examples focus on what is done in the real world and what you need to know for the exam. They go beyond what is listed as part of the project charter in the *PMBOK® Guide*.

NOTE: The following project charter example refers to attached documents. These documents are not shown as part of this example.

Project Charter

Project Title and Description (*What is the project?*) Customer Satisfaction Fix-It Project

Over the last few months, the quality assurance department has discovered many of our customers' orders for our XYZ equipment have taken the customer four times longer to place through our online ordering system than through our competitors' systems. The purpose of this project is to investigate the reasons for the problem and propose a solution. The solution will be authorized as a subsequent project. The quality control department has detailed records of their findings that can be used to speed up this project.

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

Jan Navratil shall be the project manager for this project and have authority to select team members and determine the final project budget.

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

This project is being completed in order to prevent a further breakdown of customer satisfaction. We expect that improved customer satisfaction will increase revenue to the company in the first year by at least \$200,000 due to a decrease in service calls. As a side benefit, we hope the project will generate ideas on improving customer satisfaction while fixing this problem.

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

Steve Peterson and Rich Conniff are already dedicated to the project because of their expertise in computer systems of this type. Other resources will be determined by the project manager.

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

Stakeholders include Jason Craft representing Quality Control, Mary Cookinham in Customer Service, and Eric Rudolf in Marketing. These resources are available to assist the project as needed by the project manager.

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

Attached to this document are the detailed specifications for the existing system, the requirements the existing system was designed to meet. It is expected that this project will not change how the system affects the existing requirements, aside from those relating to the speed of order entry.

The project must include utilizing the data available from Quality Control.

Product Description/Deliverables (*What specific product deliverables are wanted, and what will be the end result of the project?*)

1. A report that outlines what can be changed, how much each change will cost, and the expected decrease in the time it takes to place an order resulting from each change. Few words are necessary in the report, but it must be created electronically and be agreed to by the representatives of Quality Control, Customer Service, and Marketing, in addition to the project team.
2. A list of the interactions with our customers necessary to complete the changes.
3. A work breakdown structure, due within two weeks, that outlines what will be involved in the project, followed one week later by a list of risks in completing the project.

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?*)

- The existing requirements for the current system (aside from those relating to the speed of order entry) are sufficient and correct for an online ordering system that is four times faster than the current system.
- The current network will be able to support the program changes.
- No new hardware is required.
- The current subject matter experts and developers have the expertise to evaluate the problem and recommend a solution that will achieve the objectives.
- Internal resources will have the time to work on the project in addition to their current responsibilities.

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

- WBS must be complete in two weeks.
- Risk register is due in three weeks.
- The scope is only to improve the time to complete an online order.

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 objective of this project is to improve customer satisfaction rates for online orders to 95 percent by reducing the time customers spend placing orders to 25 percent of the current time. Scope and customer satisfaction are the top priorities on this project, closely followed by schedule and then cost.

- **Summary milestone schedule:** Due no later than September 1, 20XX
- **Summary budget:** \$50,000

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

Approvals for this project include:

- The sponsors will approve the WBS before planning efforts continue.
- The sponsors will approve the list of risks before planning efforts continue.
- Final project approval will be provided by the sponsors.

High-Level Project Risks (*Potential threats and opportunities for the project*)

- Because this project analyzes customer satisfaction, the project may help generate ideas to improve customer satisfaction, resulting in higher levels of customer retention.
- Because we have little experience in this area, implementing an inadequate solution could cause more frustration and more time delays for customers, resulting in additional lost business.
- Because this problem is greatly troubling to our customers, project delay could result in lost customers, jeopardizing the likelihood of meeting this year's sales goals.
- Because assessment of this system is difficult, changes to the system could affect the requirements the system was designed to meet, resulting in impacts to other business functions.

Project Sponsors Authorizing This Project:

Connor Mulcahy, Executive Vice President

Kerry Mulcahy, Vice President

Exercise Test yourself! Answer the question below.

What Does the Project Charter Do for the Project Manager?

Answer Do not underestimate the value of the project charter! The project charter is such an important document that a project cannot be started without one. If the project charter is your target for the project and serves as a definition of how success will be measured, then without a project charter, the project and project manager cannot be successful! Know the following for the exam.

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 so it does not NEED to change as the project progresses. It provides, at a minimum, the following benefits:

- The project charter formally recognizes (authorizes) the existence of the project, or establishes the project. This means that a project does not exist without a project charter.
 - It gives the project manager authority to spend money and commit corporate resources to the project. On the exam, this is the most commonly described benefit or use of the project charter. In most project situations, the project team does not report to the project manager in the corporate structure. This reporting structure can lead to cooperation and performance issues. The project charter helps resolve these issues.
 - The project charter provides the objectives, high-level requirements, and success criteria for the project.
 - The project charter identifies the constraints and high-level risks for the project.
 - The process of creating the charter uncovers assumptions about the project, which the project manager can later address in the detailed requirements gathering, scope definition, and risk management efforts.
 - The project charter links the project to the ongoing work of the organization.

Any change to the project charter should call into question whether the project should continue.

Can you see that the creation of a project charter is influenced by all the project management knowledge areas (i.e., scope, time, cost, quality, human resource, communications, risk, procurement, and stakeholder management)? This is why Develop Project Charter is an integration process.

Large Projects As we discussed in earlier chapters, you need to maintain a large-project perspective when answering questions on the exam. To help you understand this critical concept, review the following project charter for a large project, and then complete the exercise.

NOTE: The following charter example refers to attached documents. These documents are not shown as part of this example.

Project Charter

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

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 manual clerical time to maintain. Consolidated corporate reporting and analysis for the different systems is also very expensive and inefficient.

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

Whitney Thulin will be the project manager for this project. She may request any team members she sees fit and will work with resource managers to secure the needed resources. She has signature authority up to \$10,000. Tony Korpi 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, which would be \$2 million overall per year. This 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 vendor 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 resources needed must be identified and negotiated for by the project manager.

Stakeholders (*Who will affect or be affected by the project [influence the project], as known to date?*) Attached is a list of stakeholder classes 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.

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

Requirement Number	High-Level Requirement/Request
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 purchase 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.

Product Description/Deliverables (*What specific product deliverables 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 features desired include:

- The systems should allow direct deposit of employee pay into any financial institution in the world and notification of deposit via e-mail, 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.

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?*)

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

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 process all international payroll rules and global direct deposit.
- The solution and the supporting systems will 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).

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. 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 new worker on-boarding process from an average of 1 week to 2 days within 18 months.
- Summary milestone schedule: Due no later than October 6, 20XX
- Summary budget: US \$1,200,000

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

Approvals for this project include:

- Decision to purchase application software to support the payroll systems (VP of Operations)
- Choice of vendor 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)

High-Level Project Risks (*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 vendor for delivery of the payroll-processing application(s) (high impact).

Project Sponsors Authorizing This Project:

Timothy Mulcahy, Executive Vice President

Rick Kolb, Director of Human Resources

Exercise Make a list of what is different about managing the large project described in this charter versus managing the small project described in the earlier charter example.

What Would Be Different about Managing the Large Project vs. the Small Project?

Answer The following are some possible answers to this question, though there are certainly other correct answers. The large project:

- Has a larger stakeholder group, and therefore requires more effort to manage relationships and stakeholder expectations and involvement
 - Has a more diverse team composition
 - Requires a broader and more complex communications management plan to deal with the number of stakeholders and language issues
 - Contends with multiple nations, cultures, time zones, languages, and laws
 - Will be affected by currency exchange rates
 - Requires a more formal change management process to handle the possible scope changes
 - Has thousands of activities to track
 - Has larger activities, making it more difficult to get good time and cost estimates
 - Has a more complex network diagram with many discretionary and external dependencies
 - Requires a more robust tracking system for all the project metrics

- Involves multiple contracts, requiring more management of the sellers
- Has much more risk, requiring a more detailed risk management process

Regardless of whether you have a large or small project, developing the project charter requires the following actions:

- Identifying stakeholders
- Meeting with key stakeholders to confirm high-level requirements, project scope, risks, assumptions, and issues
- Defining product scope
- Defining project objectives, constraints, and success criteria
- Documenting risks

The following influence the creation of the project charter:

Business Case² PAGE 69 Stop for a minute, and think about your real world. How is one project selected over another in your organization? Do you know? In some companies, the selection is arbitrary, based on what a manager feels like doing. If this is the reality in your world, make sure you understand that the exam assumes there is a defined business case for every project and that it is unacceptable to select a project based on anything but a sound business case. The business case captures the business need; it explains why the project was selected, how it fits into the organization's strategic goals, and how it will bring business value to the organization. (How each organization defines business value will vary, but this can include quantifiable benefits such as financial gain as well as less obvious benefits such as increased name recognition.)

Imagine you are an executive of a very large company. The departments within your company present you with ideas about many different initiatives (potential projects) to spend money on. Arbitrarily picking one project over another may result in a waste of available resources. Your organization should instead have a method to determine which of the possible projects or programs will provide the greatest benefit or, in *PMBOK® Guide* terms, will best support your company's strategic plan. There might even be a project selection committee in place to put all the data together on the various project ideas. For the exam, you should be familiar with project selection methods (described next), but understanding these methods is not as important as knowing (or assuming) that such activities occur prior to initiating a project. These activities fall outside the project boundaries (the period from project authorization through closure). Although project managers are not typically involved in project selection, they need to keep the business case in mind throughout the project to make sure the project achieves the objectives for which it was selected.

Let's look at an example of how a business case can affect the way a project is managed. A company has selected a particular project because the project will contribute to its strategic plan of entering a new area of business. The project manager has a project management plan that includes an approved schedule and budget. The project manager finds that the approved budget is a constraint that could inhibit the company's successful entrance into the new market. She asks for a change in budget, rather than cutting costs on the project to stay within the project management plan. If the project manager had not asked for the budget increase, the company might have missed its objective of successfully launching itself into the new area of business.

So project managers must know why their project was selected and how it fits into the organization's strategic plan. They then have to make sure the project meets those needs. The business case described in the project charter explains the business need and the analysis used to justify the project.

Project Selection There are various ways to select which projects to initiate from among many possible choices. As we just discussed, the project manager is not typically involved in project selection,

but the projects the organization considered before a particular initiative was chosen, as well as the process the company used to select that project, influence how the project manager will plan and manage the project. Therefore, you should be familiar with project selection terms and concepts.

The following are two categories of project selection methods and examples of approaches that can be used with each method. Simply know that these terms relate to project selection:

1. **Benefit measurement methods (comparative approach)³**
 - Murder board (a panel of people who try to shoot down a new project idea)
 - Peer review
 - Scoring models
 - Economic models (described next)

2. **Constrained optimization methods (mathematical approach)⁴**
 - Linear programming
 - Integer programming
 - Dynamic programming
 - Multi-objective programming

Economic Models for Project Selection

The following are economic models for selecting a project. As noted previously, such economic models take a comparative approach and fall into the category of benefit measurement methods.

- Present value
- Net present value
- Internal rate of return
- Payback period
- Cost-benefit analysis⁵

We will briefly discuss each of these concepts. Keep in mind that the calculations from these models aren't generally used on their own; that is, an organization would likely consider more than one of these models (along with other factors) when selecting a project. Also keep in mind as you read this section that 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 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. These reasons can impact what constraints are most flexible, and knowing this information will influence the way the project manager plans and manages the project.

Present Value (PV)

PLEASE NOTE: You may encounter a couple of questions that require you to calculate present value.

Present value means the value today of future cash flows and can be found using the following formula:

$PV = \frac{FV}{(1 + r)^n}$	FV = future value r = interest rate n = number of time periods
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Watch out! The acronym PV is also used for planned value (described in the Cost Management chapter). Avoid confusing these two terms.

In a simple example, without using the formula, see if you can guess the answer to the following question:

Question *What is the present value of \$300,000 received three years from now if we expect the interest rate to be 10 percent? Should the answer be 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 solve the problem, if you were inclined to do so: $\$300,000/(1 + 0.1)^3 = \$300,000/1.331 = \$225,394$.*

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. Calculating the NPV of each possible project provides a means for the organization to compare many projects and select the best project to initiate. 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 to choose from. 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 it would have been taken into account in the calculation of the NPV. See the following sample calculation if you are confused. If you understand the concept of NPV already, skip the example.*

To calculate NPV, you need to calculate the present value of both income and cost figures using the present value formula. You then add the present values as shown in the following table. (This table does not refer to the project examples in the previous question.)

Time Period	Income/Revenue*	Present Value of Income at 10% Interest Rate*	Costs*	Present Value of Cost at 10% Interest Rate*
0	0	0	200	200
1	50	45	100	91
2	100	83	0	0
3	300	225	0	0
Total		353		291

*In thousands of dollars

Therefore, $NPV = 353 - 291 = 62$.

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 of 1 percent. You can think of a project in the same way. If a company has more than one project in which to 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 (read it as “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 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 or Project B with an IRR of 15 percent. Which one is a better option?*

Answer *Project A*

Payback Period

This term refers to the length of time it takes for the organization to recover its investment in the 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 or 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 keep in mind that payback period is likely to be one of only several financial and other considerations for project selection. 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 the 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 the same.

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.*

Please note that although the organization may use the benefit cost ratio to help it choose from among many potential projects, a project manager may also perform cost-benefit analysis to determine the best way to implement a project once it 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 like 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.

Exercise Remember, you do not have to be an accountant to pass this exam. You do NOT have to use accounting formulas (aside, possibly, from a couple of present value questions). But you may need to have a general understanding of what the terms mean. So test yourself! For each row on the following chart, enter the letter of the project you would select based on the information provided.

	Project A	Project B	Which Project Would You Pick?
Net present value	\$95,000	\$75,000	
IRR	13 percent	17 percent	
Payback period	16 months	21 months	
Benefit cost ratio	2.79	1.3	

Answer

	Project A	Project B	Which Project Would You Pick?
Net present value	\$95,000	\$75,000	A
IRR	13 percent	17 percent	B
Payback period	16 months	21 months	A
Benefit cost ratio	2.79	1.3	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)⁶

In terms of project selection, this concept is concerned with whether the project returns to the company 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, discussed in the Cost Management chapter, is frequently mentioned on the exam, whereas economic value added should rarely appear in questions or choices.)

Opportunity Cost⁷

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 or 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 Costs⁸

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. The project is half complete, and it has spent \$2,000,000. Should the organization consider the fact that it is already \$1,000,000 over budget when determining whether to continue with the project?*

Answer *No. The money spent is gone.*

Be aware that accounting standards say that sunk costs should not be considered when deciding whether to continue with a troubled project.

Law of Diminishing Returns⁹

This law states that after a certain point, adding more input (e.g., programmers) will not produce a proportional increase in productivity (e.g., 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, added coordination is required between programmers.

Working Capital

This term refers to current assets minus current liabilities for an organization. In other words, it is the amount of money the company has available to invest, including investment in projects.

Depreciation¹⁰

Large assets (e.g., equipment) purchased by a company 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 do not have to perform any calculations. (See, we said we could make this easy for you!) The following information is all you need to know.

There are two forms of depreciation:

1. **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 (how much the item is worth at the end of its life) would be depreciated at \$100 per year.

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

- There are two forms of accelerated depreciation. (You do not have to understand what these two forms mean or do any calculations.)
 - 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 (how much the item is worth at the end of its life) would be depreciated at \$180 the first year, \$150 the second, \$130 the next, etc.



The exam may present questions about project selection in the following ways:

- Easier questions may be direct, such as “What type of project selection technique is linear programming?” The answer is “a constrained optimization method.” The exam has not required test takers to know what “constrained optimization method” or the other project selection methods mean. Instead, just know what categories the methods fall into.
- The exam may also ask more challenging questions relating to business cases and project selection methods. You need to understand that there is a selection process for a project, to know what that process is, and to know that the project must support the company’s strategic goals.
- The exam may use project selection concepts like internal rate of return as distractors. Such information may be provided in the question when you do not need the data to answer the question. Read the questions carefully to pick out which data is relevant.

Now that we’ve discussed the importance of the business case and understanding why the organization selected the project, let’s look at other aspects of the Develop Project Charter process.

Constraints and Assumptions PAGE 124 AND THROUGHOUT It is important to identify and document high-level project constraints and assumptions that are uncovered in discussions with stakeholders during project initiating. Constraints are factors that limit the team’s options, such as limits on resources, budget, schedule, and scope (e.g., management saying the project must be completed with only five resources). Assumptions are things that are assumed to be true but that may not be true (e.g., it is assumed that we will not need engineering department approval before we start the activity). Constraints and assumptions are inputs to many project management processes. They are identified at a high level in project initiating and are then refined and documented in detail as part of the Define Scope process in project planning.

Once they are identified, constraints and assumptions need to be managed. The sponsor, the team, and other stakeholders may help identify constraints and assumptions and review them for validity throughout the life of the project. If the constraints change or the assumptions are proven wrong, the project management plan may need to change. Assumptions analysis is part of the risk management process.

Project Statement of Work¹¹ (SOW) PAGE 68 The project statement of work is created by the customer or sponsor and describes their needs, the product scope, and how the project fits into the organization’s or customer’s strategic plan. If you have worked with contracts, think of this as the long, wordy document the buyer sends the seller. This document may not be complete when received as an input to the Develop Project Charter process. It is further defined in the project scope statement during project planning.

Agreements/Contracts All projects should have charters, whether the project is an internal initiative or is being done for an external customer. The development of a charter often starts with some form of agreement or understanding, which may include the project statement of work. In the case of an internal project, the initial agreement may be as informal as an e-mail or a conversation about what the project will entail. It could also take the form of a memorandum of understanding (MOU) or letter of agreement. When the work is being done for an outside organization, a formal contract is typically involved. (See the Procurement Management chapter for more information about agreements and contracts.)

Although we often think of the buyer creating a project charter, the organization providing services to the buyer should also create a charter from their own perspective. This means that on a project where there is a buyer and a seller, both organizations would create project charters that have different points of view. The buyer’s reason for the project, as stated in their project charter, might be to achieve a particular product scope while meeting project constraints. The seller’s reason for working on the project, as stated in their project charter, might be to increase revenue, enhance their reputation, or gain additional work from the buyer.

In addition to these items, any relevant organizational process assets (e.g., processes, templates, historical information, and lessons learned) or enterprise environmental factors (e.g., applicable standards and existing infrastructure) that are present in the organization should be taken into consideration when creating the charter. The project manager works with the sponsor and others who can offer expertise for different aspects of the project to create the charter.

Develop Project Management Plan PAGE 72

Process: Develop Project Management Plan
Process Group: Planning
Knowledge Area: Integration Management

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.

Management Plans The concept of management plans is very important to understand for the exam. Management plans document the strategy for managing the project and the processes related to the knowledge areas of scope, schedule, cost, quality, human resource, communications, risk, procurement, and stakeholder management. This means there is a management plan for each knowledge area. These plans are in essence a set of documents with processes, procedures, practices, standards, and metrics that you want the project stakeholders to 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?" In other words, you think ahead and document how you will plan for the knowledge area (and ultimately the project) based on its particular needs, how you will manage for that knowledge area during execution, and how you will control it. This effort to think through the project in advance should cover all aspects of the project management process. You also need to think about the people involved in the project and how you will manage those people, evaluate their work, and keep them engaged. Management plans are, of necessity, unique to each project in order to address the project's particular needs. The format and level of detail of management plans should be customized to fit the needs of the project, the style of the project manager, and the organizational influences.

If you don't create management plans for your projects or don't create them to the level described here, this can be a difficult area on the exam. So let's consider as an example how you would address planning, executing, and monitoring and controlling in a cost management plan. The planning portion of a management plan is where we define the processes and procedures to follow to complete planning for the knowledge area. In our cost example, we need to address questions such as: How do we make sure all costs are identified and estimated? Who will be involved in estimating costs? What methods of estimating costs will we use? 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?

The executing portion of the plan focuses on the processes and procedures for doing the work (note that some knowledge areas, such as cost management, don't have separate executing processes; in such a case, the work performance data related to the knowledge area still needs to be gathered as part of Direct and Manage Project Work and must still be planned for). The executing component of a cost management plan answers question 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 control component of the plan defines the processes and procedures to follow on how to evaluate cost data, assess variance, escalate changes, create and analyze forecasts, and so on. This is where we document guidelines on evaluating how the actual costs compare to the metrics, standards, and processes in the plan. The control component documents how variances will be found, what variances are acceptable, and how to handle variances that require a change.

The creation of management plans is an integral part of a project manager's job. If you are not familiar with management plans and have no experience creating them, do not just study this concept. Before you read further, spend some time imagining what management plans for scope, schedule, quality, human resource, communications, risk, procurement, and stakeholder management might contain for a large project. 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 the topic of management plans for the exam. Know that management plans look forward in time, and that there are management plans for all the knowledge areas. There are also the following management plans:

- Change management plan
- Configuration management plan
- Requirements management plan
- Process improvement plan

When taking the exam, assume the project manager has created each of these management plans. For example, if a question talks about 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 to handle such a problem. Or when the work is being done, the project manager might refer to the cost management plan to see how costs are supposed to be measured on the project.

Project Management Plan¹² Now let's talk about the project management plan. What do you currently think of as a project management plan or project plan? If you think of such a plan as a schedule, then it's time to significantly expand your understanding of this concept.

The project management plan serves an integration function—it 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 Project Management Processes 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 project management plan includes:

- **Project management processes that will be used on the project** Think about the science of project management for a moment. Would you want to use everything in the *PMBOK® Guide* for every project? No! A project manager should determine what 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.
- **Knowledge area management plans** These are the management plans for scope, schedule, cost, quality, human resource, communications, risk, procurement, and stakeholder management. (The individual management plans will be discussed in more detail in chapters 5 through 13 of this book.)
- **Scope, schedule, and cost baselines** Baselines are used to compare the project's actual performance against its planned performance. (Baselines are described next.)
- **Requirements management plan** This plan defines how requirements will be gathered, analyzed, prioritized, evaluated, managed, and controlled on the project. (The requirements management plan is described later in this section.)
- **Change management plan** This is a plan for managing changes and the change process on the project. (The change management plan is described later in this section.)
- **Configuration management plan** This is a plan for managing changes to the documentation about the deliverables and processes of the project. (The configuration management plan is described later in this section.)
- **Process improvement plan** This plan defines how processes that are used on the project to complete the work or perform project management activities will be evaluated and improved. (The process improvement plan is described later in this section.)

Baselines (Performance Measurement Baseline)¹³

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. 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
- **Cost baseline** The time-phased cost budget (i.e., the spending plan indicating how much money is approved for the project and when the funds are required)

Together these baselines are called the **performance measurement baseline**.

What do baselines mean for the project manager and team? The project manager must be able to clearly, completely, and realistically define the scope, schedule, and cost budget to derive the baselines. That's not all, however. The project performance, and the performance of the project manager, will be measured against the baselines. The project manager will look for deviations from the baselines while the work is being done. If a deviation is discovered, he or she needs to 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, but the baselines themselves would not usually change. If adjustments will not correct the deviation, however, a change request to the baselines might be necessary. A substantial part of project control 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, not only is your ability to plan a project important, but your ability to control the project and to get the project completed as planned is also very important.

Baselines can be changed, but it should not be an easy thing to do. Changes to the baselines can be formally requested during project executing and monitoring and controlling. These requests 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 why and when changes were made.

TRICKS OF THE TRADE

The exam tests you at an expert level. So how would you like to get a sophisticated question right without studying? You need to understand the following: 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?

Baselines are mentioned frequently on the exam. Make sure you understand the concepts described here and what the project manager's attitude should be regarding the project's baselines and any changes to those baselines.

Requirements Management Plan

Part of the scope management process (which is 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 describes how this effort of identifying, analyzing, evaluating, prioritizing, and documenting the requirements will be done, 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 real-world projects? Regardless of whether you work on small or large projects, your role is not to just facilitate the making of changes by others. Instead, you need to stand as a barrier to prevent unnecessary changes and to plan the project in a way that minimizes the need for changes. Changes are much more costly than if the work had been included from the beginning. Changes should not be undertaken lightly.

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

- Change control procedures (how and who)
- The approval levels for authorizing changes
- The creation of a change control board to approve changes, as well as the roles and responsibilities of those on the board (the change control board is described later in this chapter)
- A plan outlining how changes will be managed and controlled
- 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 discussion for addressing each of the knowledge areas.

Change Control System

Many organizations have a change control system as part of their project management information system (PMIS). This system includes standardized forms, reports, processes, procedures, and software to track and control changes. It is part of an organization's enterprise environmental factors.

Configuration Management Plan

With all the product and project documentation that is part of managing a project and all the changes to this documentation that will occur throughout the life of the project, wouldn't it be wise to have a plan for making sure everyone knows what version of the scope, schedule, and other components of the project management plan is the latest version? This is the purpose of the configuration management plan. It defines how you will manage changes to the deliverables and processes and the resulting documentation, including which organizational tools you will use in this effort (part of the configuration management system).

Configuration Management System¹⁴

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 can be used to track and control the evolution of the project documentation.

Process Improvement Plan¹⁵

As part of planning, you need to identify existing processes to use on the project and may need to create some processes. You also need to plan in efforts to improve these processes during the project. The focus on improvement is important because good processes help the team complete work faster, cheaper, and with higher quality. Imagine that a project includes installing software on hundreds of computers. Because there is a lot of repetitive work on the project, the project manager should find or create a process for doing the work. After a few installations are completed, and then again after more installations are completed, the project manager should look for ways to improve the process. This effort will help the team complete higher-quality work more efficiently and at a lower cost.

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. 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 plan, and it needs to remain a formal document that is controlled 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.

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

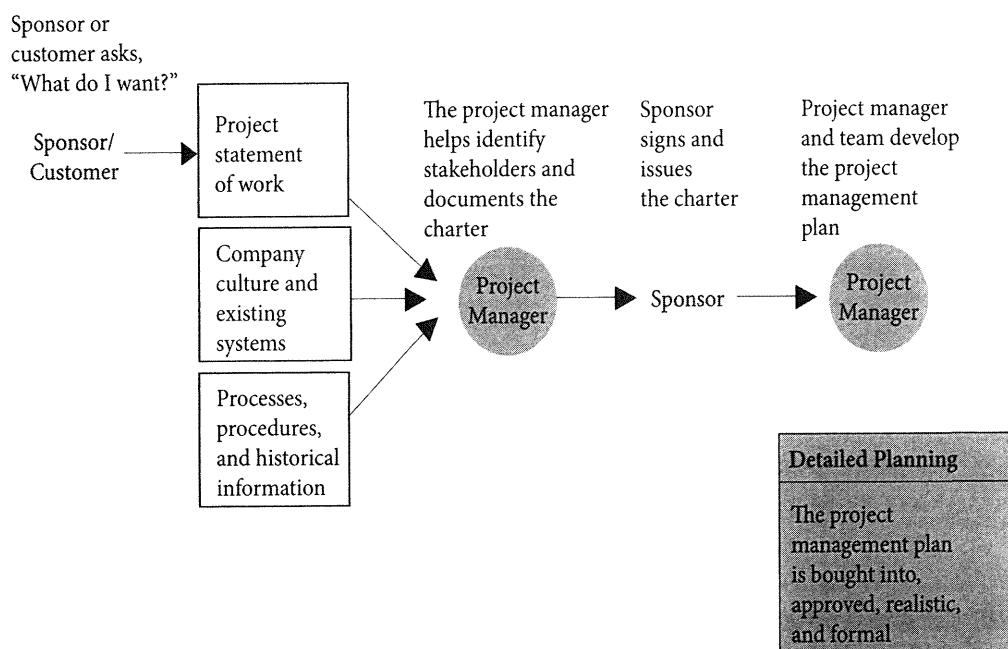


Figure 4.2: Project Initiating and Planning

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 or 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.

Exercise Test yourself! 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:

- Determine a methodology for creating the project management plan.
 - Agree on reporting formats and communications plans.
 - Agree on processes to report, control, and incorporate changes.
 - Make sure the approach and processes are consistent with the PMO and/or program management plan, if the project is part of a program.
 - Analyze the stakeholders' needs, wants, expectations, and assumptions.
 - Capture the project requirements as completely as possible.
 - Analyze the skills and knowledge of all the stakeholders, and determine how you will use them on the project.
 - Meet with stakeholders to define their roles on the project.
 - Meet with resource managers to get the best resources 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 when their resources will be used.
 - Work through iterations of the plan (e.g., update the work breakdown structure after you complete risk analysis).
 - Create the necessary project documents.
 - Apply risk reserves to the project schedule and budget.
 - Look for impacts on your project from other projects.
 - Hold meetings or presentations to let the sponsor know if any of the project requirements or constraints that were outlined in the project charter cannot be met.
 - Perform schedule compression (i.e., crash, fast track, change scope or quality, etc.) and present options to the sponsor.

If you included most of the answers in 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 later in the project management process, you will need to constantly 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 is no excuse. You use the project management plan (including the scope, schedule, and cost baselines contained in the plan) as a measurement tool to make sure the project meets these constraints.

So when you think of the project management plan, think of all the facilitation, meetings, sign-offs, interactions with other projects, conflict resolution, negotiations, schedule compressions, juggling, begging, crying, etc., that will be required to bring the plan to the point of being bought into, approved, realistic, and formal.

Project Documents PAGE 78 There is a lot of information that needs to be captured on a project, and not all of that information is recorded in the project management plan. “Project documents” is the term the *PMBOK® Guide* uses to refer to any project-related documents that are not part of the project management plan. They include the project charter, project statement of work, procurement statements of work, agreements and contracts, the stakeholder register, requirements documentation, the activity list, quality metrics, the risk register, the issue log, the change log, and other such documentation (see page 78 in the *PMBOK® Guide* for a complete list). While the sponsor and/or key stakeholders will see and approve the project management plan, most project documents (excluding some documents like the charter, agreements, contracts, and statements of work) are created by the project manager for use on the project and typically are not shown to or approved by the sponsor.

Due to the iterative nature of planning, updates to project documents are frequently needed. For the exam, know that project documents updates are an output of many of the project management processes, though this book will not cover these updates as an output of every process.

Project Management Plan Approval Since the project management plan is a formal document that defines how the project will be managed, executed, and controlled and includes items like the project completion date, milestones, costs, etc., 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 the 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 will be less difficult.

Kickoff Meeting Before the Develop Project Management Plan process can really 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 (e.g., customers, sellers, the project team, senior management, functional management, the sponsor). The purpose of this meeting is to announce the start of the project and to ensure everyone is familiar with its details and with the people working on it. In other words, the meeting is held to make sure everyone is on the same page. In addition to introducing those involved in the project, the meeting may review such items as project milestones, project risks, the communications management plan, and the meetings schedule.

Direct and Manage Project Work PAGE 79

Process: Direct & Manage Project Work
Process Group: Executing
Knowledge Area: Integration Management

This process represents the integration aspect of project executing. 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 to completing the activities and deliverables in the project management plan, Direct and Manage Project Work involves gathering work performance data, requesting changes, and completing the work resulting from approved change requests.

The Direct and Manage Project Work process and the Monitor and Control Project Work process account for the majority of the project work. Make sure you remember that the Direct and Manage Project Work process involves managing people and keeping them engaged in the project, doing the work, improving the processes involved in the work, requesting changes, and implementing approved

changes. It is about being of service to the team to help them get the work completed, and ensuring a common understanding of the project among stakeholders to keep everyone focused and informed. In other words, the project manager needs to do things like facilitate meetings and technical discussions, make sure the stakeholders whose scope was not included in the project understand they will not receive that scope, keep the team and functional managers informed of the next month's schedule, increase efficiency by following the process improvement plan, and inform other departments within the organization how the project may affect their work.

Take a moment to remember what is in the Executing column of Rita's Process Chart, and think about what has to be integrated into a cohesive whole through this process.

There is another piece of the Direct and Manage Project Work process that you need to be aware of for the exam. PMI assumes that when executing the project, the project manager takes time to focus on managing the schedule, managing the budget, managing risks, managing quality, and managing all the other knowledge areas. This way of thinking about project executing is not an approach that many project managers take. We just manage the project as a whole, rather than giving individual attention to each knowledge area. This can also mean we do not take the time to properly look at how issues relating to one knowledge area affect other knowledge areas (e.g., scope management issues can affect quality and human resource management). Inevitably we forget to even think about some of the knowledge areas. Integration management requires project managers to keep all the knowledge areas in mind at all times.

The Direct and Manage Project Work process can be illustrated as follows:

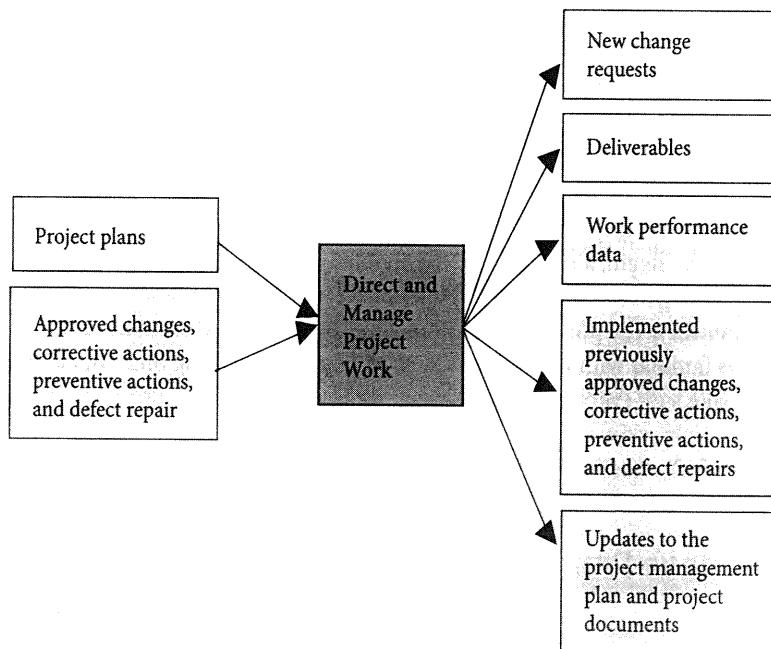


Figure 4.3: Direct and Manage Project Work

Monitor and Control Project Work PAGE 86

Process: Monitor & Control Project Work
Process Group: Monitoring & Controlling
Knowledge Area: Integration Management

Monitoring and controlling project work involves looking at what is happening on the project and comparing the actual and forecasted performance to what was planned. It is a control function that is done from project initiating through project closing, because the product scope, project scope, and our project management efforts must be monitored and controlled.

When you think of a large project, it makes sense that the project manager would need a formal effort to monitor and control how the project management and knowledge area processes are going, because he or she would not personally be involved in performing the project work. The results of Monitor and Control Project Work are change requests (including recommended corrective and preventive actions and defect repairs), work performance reports, and updates to the project management plan and project documents. The change requests from this and other processes are evaluated and approved or rejected in the Perform Integrated Change Control process, described later in this chapter.

TRICKS OF THE TRADE Please note the confusing terms. If the exam talks about monitoring and controlling project work, it may NOT be talking about the entire monitoring and controlling process group. Instead, it may just be referring to the integration management process.

TRICKS OF THE TRADE Remember that monitoring and controlling means measuring against the project management plan.

As you already know, scope may be completed on a project but the quality may not be acceptable, or the schedule might be met but at excessive costs. Monitor and Control Project Work is an integration function, because the project manager must balance the demands of the different knowledge areas to control the project. This process also involves monitoring any other performance measures that were included in the project management plan.

Keep in mind that a project must be controlled. This effort all too often does not happen in the real world. 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 knowledge is the value of controlling the project. What do you do in your real world?

The integration function of monitoring and controlling project work also includes activities like analyzing and tracking risks, performing quality control activities, assessing possible outcomes across the project using analytical techniques (e.g., regression analysis, trend analysis, earned value management, root cause analysis, etc.), reviewing changes and corrective actions made on the project to see if they were effective, creating work performance reports and additional change requests, and updating the project plan and project documents accordingly.

The following concepts are important to the process of Monitor and Control Project Work:

Work Authorization System¹⁶ PAGE 90 This is the project manager's system for authorizing the start of work packages or activities. It is part of the project management information system, which is part of the enterprise environmental factors that are an input to this process.

If you have never used such a 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 particular project. There might be instances where the project manager needs to manage to a more detailed level, however, as in the case of the plumber and the electrician. 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 for authorizing work is a company-wide system used on the project, not created just for the project. There will likely only be one question about this on the exam, but the term may be included more frequently as an answer choice.

Change Requests PAGE 92 AND THROUGHOUT No matter how well you plan a project, there will always be changes. Some changes are additions to the project or even changes to the policies and procedures used on the project. Other changes are identified as you manage the execution of the project or as part of monitoring and controlling when you measure project performance against the performance measurement baseline. See the Perform Integrated Change Control section for more about changes.

Corrective Action PAGE 93 AND THROUGHOUT A corrective action is any action taken to bring expected future project performance in line with the project management plan. Stop! Do not go on until you read the last sentence again. Many project managers do not have a realistic performance measurement baseline and/or project management plan with acceptable variances identified to measure against, so they cannot determine when variance has occurred and when corrective action is needed. Those who have serious problems with this in their real world have problems on the exam. What do you do now on your project? 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 the project is on schedule and on budget?

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

- Have a purposeful focus rather than a random focus in identifying areas that need corrective action.
- Look for problems rather than just wait for them to be brought to your attention.
- Create metrics during project planning that cover all aspects of the project.
- Have a realistic project management plan to measure against.
- Continue to measure throughout the project.
- Know when the project is off track, and know when to recommend corrective action.
- Find the root cause of the variance, rather than the surface cause.
- 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.

Typically, corrective actions are undertaken to adjust performance within the existing project baselines and do not change them. All corrective actions should be reviewed and approved or rejected as part of the Perform Integrated Change Control process. Those changes that would affect the project management plan, 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.

As you can see, a significant portion of the project manager's time while the work is being done is spent measuring performance (to determine the need for corrective action) and implementing corrective actions. Therefore, you can expect many questions about this topic on the exam. Do not expect all of 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?" In order to answer those questions, you need to know when to look for corrective actions. Try the next exercise to see if you understand when you might identify the need for such actions.

Exercise

When in the Project Management Process Would You Identify the Need to Recommend Corrective Actions?

When in the Project Management Process Would You Identify the Need to Recommend Corrective Actions?

Answer There are two approaches to take in answering this question. A general answer would say that recommended corrective actions are determined during (are outputs of) the following processes. (Notice that corrective actions can be recommended in the executing and monitoring and controlling processes.)

- Direct and Manage Project Work (Integration Management chapter)
- Monitor and Control Project Work (Integration Management chapter)
- Validate Scope (Scope Management chapter)
- Control Scope (Scope Management chapter)
- Control Schedule (Time Management chapter)
- Control Costs (Cost Management chapter)
- Perform Quality Assurance (Quality Management chapter)
- Control Quality (Quality Management chapter)
- Manage Project Team (Human Resource Management chapter)
- Control Communications (Communications Management chapter)
- Control Risks (Risk Management chapter)
- Control Procurements (Procurement Management chapter)
- Manage Stakeholder Engagement (Stakeholder Management chapter)
- Control Stakeholder Engagement (Stakeholder Management chapter)

A more specific way to answer the question would be to think about particular situations that may arise on a project. Some of the possible answers are listed in the following table:

When	PMBOK® Guide Title
When meeting with the customer to obtain acceptance of interim deliverables	Validate Scope
When measuring project performance against the performance measurement baseline	Control Scope, Control Schedule, Control Costs
When making sure people are using the correct processes	Perform Quality Assurance
When it has been determined that performance reports are not meeting stakeholders' needs	Control Communications

When	PMBOK® Guide Title
When working with the project team	Manage Project Team
When assessing stakeholder relationships	Control Stakeholder Engagement
When you notice that there are many unidentified risks occurring	Control Risks
When you discover that the seller's performance is not meeting expectations	Control Procurements
When you discover that a team member is not performing	Manage Project Team
When making sure deliverables meet quality standards	Control Quality
When communicating with stakeholders to resolve issues and manage their perceptions about the project	Manage Stakeholder Engagement



Because this topic is so important, here is a trick. If you are a member of PMI and have access to an electronic version of the *PMBOK® Guide*, search for the term “corrective action.” Seeing how it is used will improve your understanding of the topic.

Preventive Action PAGE 93 AND THROUGHOUT Whereas 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 performance measurement baseline and other metrics. The process for taking preventive actions is not as clear as it is for taking corrective actions. 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 performance measurement 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 gain 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

Typically, preventive actions are undertaken to adjust performance within the existing project baselines and do not change them. All preventive actions should be reviewed and approved or rejected as part of the Perform Integrated Change Control process. Those changes that would affect the project management plan, 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.

You will see preventive action mentioned throughout the *PMBOK® Guide*. Preventive action can be implemented at any time for any project management process, but recommended preventive actions are specifically mentioned in the *PMBOK® Guide* as being an output of the following processes:

- Direct and Manage Project Work (Integration Management chapter)
- Monitor and Control Project Work (Integration Management chapter)
- Control Scope (Scope Management chapter)
- Control Schedule (Time Management chapter)
- Control Costs (Cost Management chapter)
- Perform Quality Assurance (Quality Management chapter)

- Control Quality (Quality Management chapter)
- Manage Project Team (Human Resource Management chapter)
- Control Communications (Communications Management chapter)
- Control Risks (Risk Management chapter)
- Manage Stakeholder Engagement (Stakeholder Management chapter)
- Control Stakeholder Engagement (Stakeholder Management chapter)

Defect Repair¹⁷ PAGE 93 AND THROUGHOUT 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 the Perform Integrated Change Control process.

The need for defect repairs is discovered during (or, defect repairs are outputs of) the following processes:

- Direct and Manage Project Work (Integration Management chapter)
- Monitor and Control Project Work (Integration Management chapter)
- Validate Scope (Scope Management chapter)
- Control Scope (Scope Management chapter)
- Perform Quality Assurance (Quality Management chapter)
- Control Quality (Quality Management chapter)

Perform Integrated Change Control¹⁸ PAGE 94

Process: Perform Integrated Change Control
Process Group: Monitoring & Controlling
Knowledge Area: Integration Management

At any time during the project, changes to any part of the project may be requested. Keep in mind, however, that just because a change is requested, it does not mean the change has to be—or even should be—implemented. All change requests are evaluated and accepted or rejected in the Perform Integrated Change Control process. A key focus of integrated change control is to look at the impact of each change on all the project constraints. For example, any scope change needs to be assessed for its impact on quality, risk, time, cost, resources, and customer satisfaction. For those changes that are accepted, updates and replanning efforts are required to make sure the project team is working with a completely current and integrated project management plan, performance measurement baseline, and project documents. These updating and replanning efforts take place during Perform Integrated Change Control; the approved changes are then implemented in Direct and Manage Project Work.

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 creating the outputs of processes in initiating (the charter) and planning (the project scope statement, WBS, baselines, and project management plan), changes can be made without a formal change request. But once something like the charter has been issued, any requested changes would need to go through integrated change control for approval or rejection. Read exam questions carefully to understand whether a suggested change pertains to something that is still in the process of being finalized or has already been finalized. This will help you determine if integrated change control is required.

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. There can be up to 20 questions on this topic on the exam.

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 the correct answer. Instead, the NEXT thing to do would be to see how the proposed change impacts the project cost, quality, risks, resources, and possibly customer satisfaction. Whenever the exam mentions changes, keep in mind that a change to one of the project constraints should be evaluated for impacts on all of the other constraints.

In order to fully evaluate the impacts of a change, it is necessary to have:

- A realistic project management plan to measure against
- A complete product scope and project scope (see the definitions in the Scope Management chapter)

Are changes bad? This can be a controversial question in many industries. Changes can have negative effects. In fact, changes can be very expensive and disrupt the project. Some studies show that changes made late in the project can be up to 100 times more expensive than if they were made early in the project. The function of each process within the monitoring and controlling process group is to control changes. If there are a lot of changes on a project, it can become impossible for a project manager to coordinate the work, because it is constantly shifting. Team members who are trying to complete work packages are frequently pulled off that work to help implement or evaluate changes.

Change is inevitable on projects, but a project manager should work to prevent the root cause of changes whenever possible. And in many cases, the root cause may be that the project manager did not properly plan the project. The need for changes may indicate that the project manager did not fully identify stakeholders and uncover their requirements or that he or she did not properly complete other project management actions. All possible changes must be planned, managed, and controlled.

To control changes on the project, the project manager should:

- Work to obtain comprehensive requirements as soon as possible.
- Spend enough time on risk management to comprehensively identify the project's risks.
- Establish time and cost reserves (see the discussion of reserve analysis in the Time Management, Cost Management, and Risk Management chapters).
- Have a process in place to control changes.
- Follow the process to control changes.
- Have a process and templates in place for creating change requests.
- Have clear roles and responsibilities for approving changes.
- 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.
- Allow only approved changes to be added to the project baselines.

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

Change Control Board (CCB)¹⁹ PAGE 96 Why should the project manager always have to be the one to deny a change request? He or she might not even have the knowledge or expertise to analyze

a change request. Depending on the project manager's level of authority, his or her role might be to facilitate decisions about certain changes, rather than actually make the decisions. For these reasons, many projects have formally established change control boards responsible for reviewing and analyzing change requests in accordance with the change management plan for the project. The CCB then approves, postpones, or rejects the changes. The results of the board's 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 all projects have change control boards.

Process for Making Changes The exam has many situational questions that deal with how to make changes. For example:

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

Or

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 to all aspects of the project (e.g., 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)

The process of handling changes is often tested on the exam. Note in the previous steps that changes are always evaluated first. In most cases, "evaluate" involves considering all of the project constraints. "Options" are created based on crashing, fast tracking, reestimating, and playing "what if" using project management software. (See the Time Management chapter for questions about 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?

Now 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 "What is the best thing to do?" about a change to depend on how the question is written and the situation involved. 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.

In the second question, evaluation has been done. The answer would be to look for options and then meet with the sponsor or change control board to discuss the change and its lack of impact to the project constraints. After informing the sponsor or change control board, the project manager may inform the customer according to the process defined in the communications management plan.



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, but proactively eliminate the need for changes.
2. **Identify 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. **Look at 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 time 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, the contract, charter, statement 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. Wait! Did you catch that? Many project managers have never really thought about this. Is the change beneficial to the project? Is it needed? If the answer to any of these questions is no, the change should not be approved. Also note that any change that already had a reserve created for it (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 Direct and Manage Project Work rather than integrated change control.
 - b. **Look for options** Options include actions to decrease threats further, increase opportunities, compress the schedule through crashing or fast tracking, change how the work is performed, adjust quality, or cut scope so that the effect of the change will be minimized. Be careful—it is not wise to decrease the impact of every change. In doing so, the project manager could decrease the overall probability of success on the project. Sometimes an additional two weeks' worth of scope added to the project should receive a two-week extension of time to the project, if the work occurs on the critical path. (See the Time Management chapter for a discussion of the critical path.)
 - c. **The change is approved or rejected** 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. The approved changes are then implemented in the Direct and Manage Project Work process.
 - 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 also 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 affect the way the project manager will manage the project, and the 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 (e.g., the activity list, human resource plan and other resource documentation, schedule, budget, risk register, etc.) 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**

Exercise Test yourself! Describe common changes on projects, and determine what you would do to handle each. An example is provided. Because of the wide variety of possible changes, this exercise does not have an “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	<p>Make sure you know what the specific scope is and why it is necessary. Make sure all the data needed 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. Look at the impact of the change. Look for options. Have the change reviewed by the change control board if necessary.</p>

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Common Change	How to Handle It

Close Project or Phase PAGE 100

Process: Close Project or Phase
Process Group: Closing
Knowledge Area: Integration Management

(See also the Project Management Processes chapter of this book for a discussion of the closing process group.)

Many of the high-level concepts of closing have already been discussed in the Project Management Processes chapter. In terms of the Close Project or Phase process, you need to understand that this effort finalizes all activities across all process groups to formally close out the project or project phase.



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 is one part of project closing. The other part is the Close Procurements process, described in the Procurement Management chapter. Together, these two processes are addressed in about 14 questions on the exam.



Watch out; people with limited project management training and experience often have difficulty with this section on the exam. Many do not seem to understand the significance of closure and what it does for both the project manager and the project. 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 included in Rita's Process Chart? Make sure you become

familiar with all the concepts here and imagine completing these activities in the real world on large projects if you do not currently do this for your projects.

**TRICKS
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TRADE**

Be sure to remember for the exam 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 presented in Rita's Process Chart. (This list includes efforts in both the Close Project or Phase and Close Procurements processes.)

- Confirm work is done to requirements.
- Complete procurement closure.
- Gain final acceptance of the product.
- Complete financial closure.
- Hand off completed product.
- Solicit feedback from the customer 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 many 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 knowledge areas? How about the example of indexing and archiving project records? Wouldn't you need to do so for records from all the knowledge areas? Take some time to think about project closing and how it applies to proper project management for large projects before you take the exam.

Practice Exam

1. The need for ____ is one of the major driving forces for communication in 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. When it comes to changes, the project manager's attention is BEST focused on:
 - 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 of 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.

7. A project is plagued by 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

8. Effective project integration usually requires an emphasis on:
 - A. The personal careers of the team members.
 - B. Timely updates to the project management plan.
 - C. Effective communication at key interface points.
 - D. Product control.
9. Integration is done by the:
 - A. Project manager.
 - B. Team.
 - C. Sponsor.
 - D. Stakeholders.
10. 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. Double declining balance is a form of:
 - A. Decelerated depreciation.
 - B. Straight line depreciation.
 - C. Accelerated depreciation.
 - D. Life cycle costing.
13. 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
14. Which of the following BEST describes a project management plan?
 - A. A printout from project management software
 - B. A bar chart
 - C. Risk, human resource, process improvement, and other management plans
 - D. The project scope

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15. Which of the following is TRUE about the development of a project charter?
 - A. The sponsor creates the project charter, and the project manager approves it.
 - B. The project team creates the project charter, and the PMO approves it.
 - C. The executive manager creates the project charter, and the functional manager approves it.
 - D. The project manager creates the project charter, and the sponsor approves it.
16. 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.
17. You are taking over a project during project planning and discover 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
18. 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
19. All of 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.

20. 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 team functioning throughout the project at a very high level, demonstrating creativity and commitment.
 - A team that initially experiences some amounts of confusion, but that after a period of time becomes a cohesive and effective unit.
 - A team that is not highly productive, but that stays together because of the work environment created by the project manager.
 - A team that is characterized by poor performance, low morale, high levels of conflict, and high turnover.
21. You are in the middle of executing a major modification to an existing product when you learn that the resources promised at the beginning of the project are not available. The BEST thing to do is to:
- Show how the resources were originally promised to your project.
 - Replan the project without the resources.
 - Explain the impact if the promised resources are not made available.
 - Crash the project.
22. The primary customer of a project has requested an application change during user testing. As project manager, how should you BEST address this issue?
- Develop a risk mitigation plan.
 - Create a formal change request.
 - Inform the project sponsor of changes to scope, cost, and schedule.
 - Ensure the scope change complies with all relevant contractual provisions.
23. The project manager has just received a change from the customer that does not affect the project schedule and is easy to complete. What should the project manager do FIRST?
- Make the change happen as soon as possible.
 - Contact the project sponsor for permission.
 - Go to the change control board.
 - Evaluate the impacts on other project constraints.
24. Your company just won a major new project. It will begin in three months and is valued at US \$2,000,000. You are the project manager for an existing project. What is the FIRST thing you should do once you hear of the new project?
- Ask management how the new project will use resources.
 - Resource level your project.
 - Crash your project.
 - Ask management how the new project will affect your project.

25. 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.
26. You are assigned as the project manager in the middle of the project. The project is within the baselines, but the customer is not happy with the performance of the project. What is the FIRST thing you should do?
 - A. Discuss it with the project team.
 - B. Recalculate baselines.
 - C. Renegotiate the contract.
 - D. Meet with the customer.
27. It is the middle of the project when 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 e-mails from a minor stakeholder and 14 e-mails from team members. While she is reading the e-mails, 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 e-mailing 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 e-mails, and review the process listed in the communications management plan for reporting concerns with the team member having the documentation problem.
28. 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.

29. During project executing, the project manager determines that a change is needed to material purchased for the project. The project manager calls a meeting of the team to plan how to make the change. This is an example of:
- Management by objectives.
 - Lack of a change management plan.
 - Good team relations.
 - Lack of a clear work breakdown structure.
30. The project was going well when all of a sudden there were changes to the project coming from multiple stakeholders. After all the changes were determined, the project manager spent time with all the stakeholders to find out why there were changes and to discover any more.
- The project work has quieted down when a team member casually mentions to the project manager that he added functionality to a product of the project. "Do not worry," he says, "I did not impact time, cost, or quality!" What should the project manager do FIRST?
- Ask the team member how the need for the functionality was determined.
 - Hold a meeting to review the team member's completed work.
 - Look for other added functionality.
 - Ask the team member how he knows there is no time, cost, or quality impact.
31. 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:
- Fixed costs.
 - Sunk costs.
 - Direct costs.
 - Variable costs.
32. Which of the following sequences represents straight line depreciation?
- \$100, \$100, \$100
 - \$100, \$120, \$140
 - \$100, \$120, \$160
 - \$160, \$140, \$120

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33. This 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. Look for 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.
34. 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
35. An output of the Close Project or Phase process is the creation of:
- A. Project archives.
 - B. A project charter.
 - C. A project management plan.
 - D. A risk management plan.
36. All of 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.
37. Which of the following is included in a project charter?
- A. A risk management strategy
 - B. Work package estimates
 - C. Detailed resource estimates
 - D. The business case for the project

38. A project manager is trying to convince management to use more formal project management procedures and has decided to start improving the company's project management by obtaining a project charter for each of his projects. Which of the following BEST describes why a project charter would help the project manager?
- A. It describes the details of what needs to be done.
 - B. It lists the names of all team members.
 - C. It gives the project manager authority.
 - D. It describes the history of similar or related projects.
39. Linear programming is an example of what type of project selection criteria?
- A. Constrained optimization
 - B. Comparative approach
 - C. Benefit measurement
 - D. Impact analysis
40. You have been involved in creating the project charter, but could not get it approved. Your manager and his boss have asked that the project begin immediately. Which of the following is the BEST thing to do?
- A. Set up an integrated change control process.
 - B. Show your manager the impact of proceeding without approval.
 - C. Focus on completing projects that have signed project charters.
 - D. Start work on only the critical path activities.
41. The engineering department has uncovered a problem with the cost accounting system and has asked the systems department to analyze what is wrong and fix the problem. You are a project manager working with the cost accounting programs on another project. Management has issued a change request to the change control board to add the new work to your project.
- Your existing project has a cost performance index (CPI) of 1.2 and a schedule performance index (SPI) of 1.3, so you have some room to add work without delaying your existing project or going over budget. However, you cannot see how the new work fits within the project charter for your existing project. After some analysis, you determine that the new work and existing work do not overlap and can be done concurrently. They also require different skill sets. Which of the following is the BEST thing to do?
- A. Develop a project charter.
 - B. Reestimate the project schedule with input from the engineering department.
 - C. Validate the scope of the new work with the help of the stakeholders.
 - D. Identify specific changes to the existing work.
42. All technical work is completed on the project. Which of the following remains to be done?
- A. Validate Scope
 - B. Plan Risk Responses
 - C. Create a staffing management plan
 - D. Complete lessons learned

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43. 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

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 do not solve the problem—they just postpone dealing with 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 C**

Explanation The sponsor issues the project charter and so he or she should help the project manager control changes to the charter. The primary responsibility lies with the sponsor.

8. **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). In order 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.

9. **Answer A**

Explanation Integration is a key responsibility of the project manager.

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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 C**

Explanation Double declining balance is a form of depreciation. That eliminates the choice of life cycle costing. The choices of decelerated depreciation and straight line depreciation are also incorrect because double declining balance is a form of accelerated depreciation.

13. **Answer B**

Explanation One of the ways 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.

14. **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.

15. **Answer D**

Explanation The project manager may create the project charter, but it is approved and authorized by the project sponsor, giving the project manager authority to proceed with the project.

16. **Answer D**

Explanation If we were to rephrase the question, it would be asking, "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.

17. **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 added communications requirements, you should be concerned with competing needs and requirements impacting your efforts on configuration management.

18. **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.

19. **Answer D**

Explanation A WBS is created in project planning, but can be used to help manage the project during project executing. The wording here 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.

20. 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.

21. Answer C

Explanation Crashing and replanning are essentially delaying the situation. Instead, the project manager should try to prevent the situation by showing the consequences if the resources are not available. This is a more effective strategy than saying, “But you gave them to me.”

22. Answer B

Explanation Your first action is to formally document the requested change to the requirements, and then follow the integrated change control process.

23. Answer D

Explanation The other impacts to the project should be evaluated first. Such impacts include scope, cost, quality, risk, resources, and customer satisfaction. Once these are evaluated, the change control board, if one exists, can approve or deny the change.

24. 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.

25. Answer C

Explanation Before you can do anything else, you have to know what YOU are going to do. Developing the management strategy will provide the framework for all the rest of the choices presented and the other activities that need to be done.

26. Answer D

Explanation First, you need to find out why the customer is not happy. Then meet with the team and determine options.

27. Answer C

Explanation Notice how many situations are thrown at you in this question. It is important to practice reading through questions to discover what is important and what is just 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 and, thus, it is not on the critical path.) So is the issue the noncritical 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 smooth the team member’s issue with the accounting department.

28. 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.

29. Answer B

Explanation The project manager is asking how to make a change. Such a question cannot be resolved using management by objectives, team relations, or a work breakdown structure. The procedures, forms, sign-offs, and other similar requirements for handling changes should have already been determined in the change management plan. Because they were not, the project manager will waste valuable work time trying to figure it out after the fact.

30. Answer D

Explanation Notice that the first paragraph is extraneous. Also notice that the question states that the change has already been made. The project manager's actions would be different if the change had not been made. The project manager, with the help of others, must determine how a change impacts the project as a whole. Asking the team member how he knows there is no impact on time, cost, or quality is the best answer. This begins the project manager's analysis of the impacts to the project as a whole by finding out what analysis has already been done. This change minimally involves a change to the scope baseline, and likely other baselines. A change request must ultimately be submitted to integrated change control, but that is not listed as an option.

31. 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.

32. Answer A

Explanation Straight line depreciation uses the same amount each time period.

33. 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.

34. 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.

35. Answer A

Explanation The project charter is created in initiating. The project management plan and risk management plan are outputs of project planning. Project records are archived in the Close Project or Phase process.

36. 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.

37. Answer D

Explanation A risk management strategy and work package estimates are not created until project planning, but the project charter is created in initiating. A project charter may include the names of some resources (the project manager, for example), but not detailed resource estimates. Of the choices given, only the business case for the project is included in the project charter.

38. Answer C

Explanation The exam will ask questions like this to make sure you know the benefits you should be getting out of the processes and tools of project management. The details of what needs to be done are found in the WBS dictionary. The names of team members are included in the responsibility assignment matrix and other documents. Project history is found in the lessons learned and other historical records. A major benefit of a project charter is that it documents the authority given to the project manager.

39. Answer A

Explanation Constrained optimization uses mathematical models. Linear programming is a mathematical model.

40. Answer B

Explanation The best thing to do would be to show the impact. This is the only choice that prevents future problems—always the best choice. The other choices just pretend the problem does not exist.

41. Answer A

Explanation How long did it take you to read this question? Expect long-winded questions on the exam. Take another look at the choices before you continue reading. Did you notice that each of the choices occurs during a different part of the project management process?

This question is essentially asking if the new work should be added to the existing project. There may be many business reasons to try to do this, but from a project management perspective, major additions to the project are generally discouraged. In this case, the new work is a self-contained unit of work, has no overlap with the existing work, does not fit within the project charter, and needs a different skill set. Therefore, it is best to make it a new project.

The first step to answering this question is to realize that the work should be a separate project. The second step is to look at the choices and see which relates to initiating a new project.

Reestimating the project sounds like the best choice only if you did not realize that the new work should be a separate project. Validating scope is done during project monitoring and controlling, and does not relate to the decision of whether to add work to the project. Identifying scope changes also implies that the new work has been accepted as an addition to the existing project. Developing a project charter is among the first steps of initiating a new project, and the best choice in this situation.

42. Answer D

Explanation Did you pick Validate Scope? Then you may have forgotten that the Validate Scope process is done during project monitoring and controlling, not project closing. Planning the risk responses and creating the staffing management plan are done earlier in the project. The lessons learned can only be completed after the work is completed.

Integration Management F O U R

43. 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. He or she needs to find the root cause, so future changes may be avoided.

Scope Management

FIVE

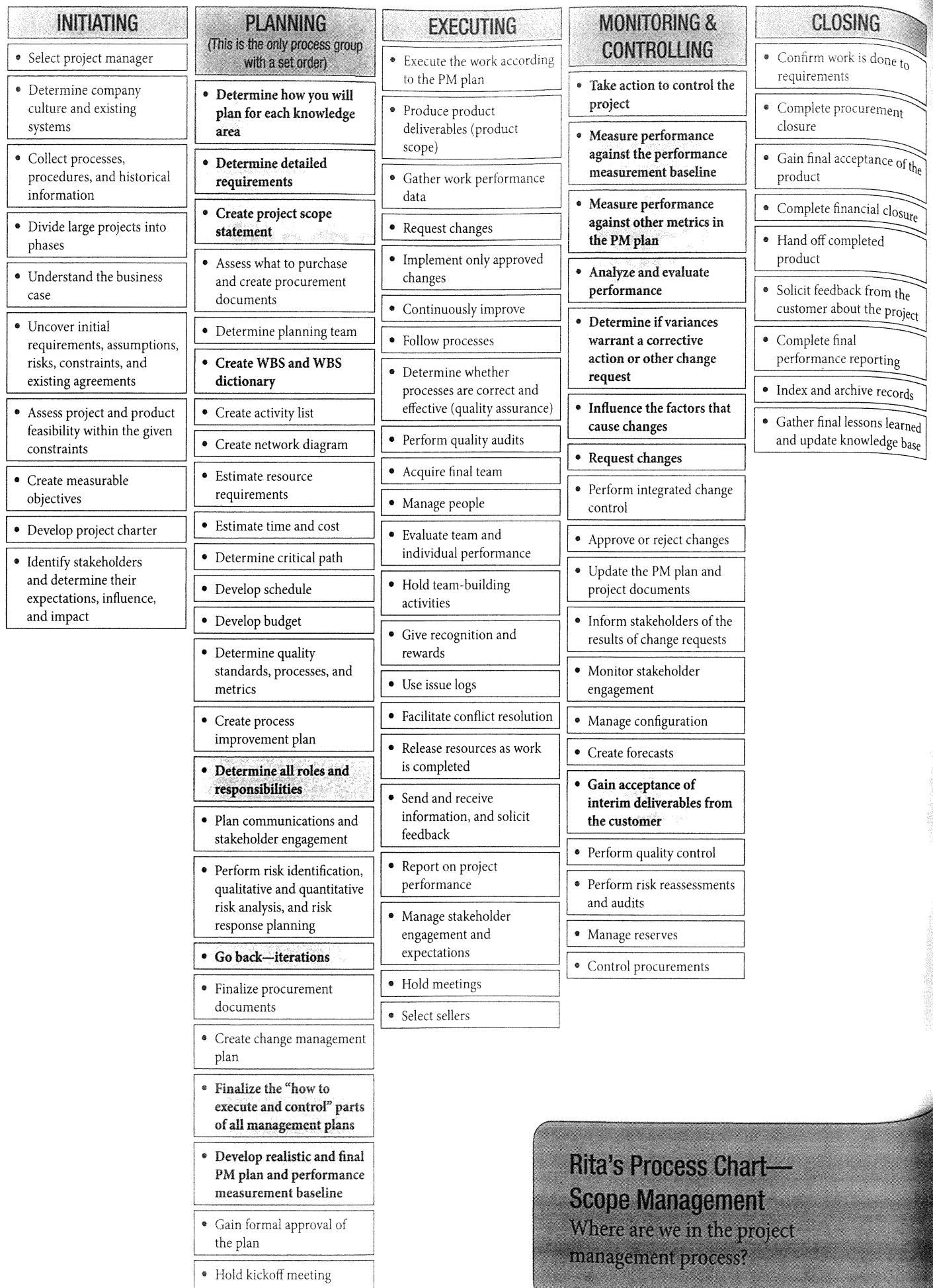
Scope management is the process of defining what work is required and then making sure all of that work—and only that work—is done. This is generally an easy topic, but we all have gaps in our knowledge, even regarding things like scope management, that we deal with daily. The following are gaps that many people do not know they have. Read through this list, and see if it helps you uncover any gaps in your knowledge.

TRICKS OF THE TRADE Things to Know about Scope Management for the Exam

- You must plan, in advance, 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.
- Requirements are gathered from all the stakeholders, not just the person who assigned the project.
- Requirements gathering can take a substantial amount of time, especially on large projects that may involve obtaining requirements from hundreds of people.
- 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) is used on all projects. Using this tool enables you to clarify identified scope as well as find additional scope.
- While the project is being completed, you must check to make sure you are doing all the work, but only the work included in the project management plan.
- Gold plating a project (adding extras) is not allowed.

QUICKTEST

- Scope management process
- Scope baseline
- Work breakdown structure (WBS)
- Project scope statement
- WBS dictionary
- Requirements documentation
- Requirements traceability matrix
- How to create a WBS
- Benefits of a WBS
- Uses of a WBS
- Requirements management plan
- Scope management plan
- Work package
- Activity
- Product scope
- Project scope
- Decomposition
- Control account
- Product analysis
- Verified deliverables
- Data collection techniques
 - Interviews
 - Focus groups
 - Facilitated workshops
- Brainstorming
- Nominal group technique
- Multi-criteria decision analysis
- Context diagrams
- Delphi technique
- Mind maps
- Affinity diagrams
- Questionnaires and surveys
- Observation
- Prototypes
- Benchmarking
- Group decision-making (unanimous, dictatorship, majority, plurality, consensus)
- Requirements categories
 - Business requirements
 - Stakeholder requirements
 - Solution requirements
 - » Functional
 - » Nonfunctional
 - Transition requirements
 - Project requirements
 - Quality requirements
 - Technical requirements



Rita's Process Chart—Scope Management

Where are we in the project management process?

- Any change to scope must be evaluated for its effect on time, cost, risk, quality, resources, and customer satisfaction.
- No changes to scope are allowed without an approved change request.
- Scope changes should not be approved if they relate to work that does not fit within the project charter.
- You need to continuously determine what is and is not included in the project.

Please note that creating a WBS is a REQUIRED part of project management. A WBS is not a list! If you have never created one or do not currently use a WBS on your projects, this chapter will help you understand how highly beneficial this tool is and what it can do for you. Remember, the exam asks questions from an expert level and assumes you have experience using the various tools of project management. Therefore, you need to know how the WBS can help you clearly define requirements, plan how you will manage scope, and control scope.

The following should help you understand how each part of scope management fits into the overall project management process:

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

You should understand the following concepts for the exam:

Product Scope PAGE 105 Product scope is another way to say “requirements that relate to the product 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 project to determine product scope, or you may define the requirements as part of your project.

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 are recorded in the requirements documentation and the project scope statement for the project.

Project Scope PAGE 105 The project scope is the work the project 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 management plan, which is part of the project management plan. To determine if the project scope has been successfully completed, the work accomplished is measured against the scope baseline in the project management plan.

The Scope Management Process To avoid the risk that you will read the rest of this chapter and miss an important issue, let's make this point clear right away: the way PMI says scope should be managed and the way you manage it in the real world might be different. 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 projects. But if you're unfamiliar with PMI's perspective on scope management, you could get questions wrong on the exam. The *PMBOK® Guide* describes the scope management process as:

1. Develop a plan for how you will plan, manage, 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 the 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 that the completed scope of work is acceptable to the customer.
6. Measure scope performance, and adjust as needed.

Again, this may not be what you do in the real world. For example, many organizations establish a separate project to handle the requirements gathering and evaluation process and determine what the project will be. This is especially true for work that demands a large requirements-gathering effort and when the people involved in determining requirements are different from those who will perform the work. In the real world, the decision of whether to gather requirements as a separate project should be made based on the needs of the project and the organization.



While taking the exam, assume that you will need to determine requirements as part of the project.

If you work as a seller, your process might begin with the receipt of a large technical description (possibly 300 pages) of what the customer wants. Since the product requirements are supplied in such cases, the requirements step is more about clarifying product requirements than determining them. However, the project requirements would still need to be determined.



Assume that you are the project manager for the BUYER for all questions on the exam that involve procurement, unless the question specifically states otherwise.

Here is something else to notice about PMI's scope management process. Do you realize what the phrase "making sure all requirements support the project's business case, as described in the project charter" means in the real world? It means that no one can request or add work that is not related to the reason documented in the charter for initiating the project. Yet, in your real world, do you see people who want work done and try to attach it to any project they can to get the work accomplished? Do you see scope on projects that does not support the company's business objectives? It happens all the time. Therefore, a project manager must be assertive. This is also the attitude you should have when you take the exam. You must be able to say no and not allow such activities to take place on your project. Unnecessary scope adds time, cost, and risk to the project that you just do not need. You have to be able to say, "That sounds like it is its own project. It should go through the project approval process, instead of being added to my project." Understanding this attitude that a project manager needs to properly plan and protect the project is essential for passing the exam.

Now let's look in more detail at PMI's process.

Plan Scope Management PAGE 107

Process: Plan Scope Management
Process Group: Planning
Knowledge Area: Scope Management

Each of the project management knowledge areas has a management plan. For scope, there are actually two—a scope management plan and a requirements management plan. Let's look at each of these in more detail:

Scope Management Plan PAGE 109 The scope management plan essentially contains three parts: how scope will be planned, executed, and controlled. It defines the following:

- How to achieve the scope
- What tools to use to plan how the project will accomplish the scope
- How to create the WBS
- What enterprise environmental factors and organizational process assets (described in the Project Management Framework chapter) come into play
- How scope will be managed and controlled to the project management plan
- How to obtain acceptance of deliverables

Although very few companies have templates, forms, or standards for scope management, these are valuable assets to have on a project. 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. Once completed, the scope management plan becomes part of the project management plan, and the project manager uses it to guide the project until closing.

The scope management plan can be developed in stages, or iterated, during project planning. The first step is to determine how scope will be defined. Once the rest of the project is planned, the project manager will have enough information to decide how the scope will be executed 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.

Stop—do not just read on! Instead, read this section over again. Notice that you need a good understanding of the project scope in order to create a scope management plan. The idea behind the creation of this and all management plans is, “If you cannot plan it, you cannot do it.” (Even for a change-driven project, you need to plan some level of scope before work begins.) Yet many people make the mistake of starting to work on a project before the product and project scope are defined and before they have properly planned how they will manage scope. Do you? As we've previously explained, you need to assume proper project management is being done on the project when you take the exam, unless the question says otherwise. Remember, creating a scope management plan is a required part of project management.

Requirements Management Plan PAGE 110 Like the scope management plan, the requirements management plan falls under the PMI-ism of “plan before you do.” In addition to describing the methods you intend to use to identify requirements, the plan should answer the following questions: “Once I have all the requirements, what will I do to analyze, prioritize, manage, and track changes to them? What should I include in the requirements traceability matrix?” (The requirements traceability matrix is described later in this chapter.)

The scope management and requirements management plans are the outputs of the Plan Scope Management process, and they become part of the project management plan. The next process, Collect Requirements, begins to put these plans into action.

Collect Requirements PAGE 110

Process: Collect Requirements
Process Group: Planning
Knowledge Area: Scope Management

Requirements are what stakeholders need from a project or product. Work should not be included in a project just because someone wants it. Instead, the requirements should relate to solving problems or achieving the objectives outlined in the charter. Requirements may include requests about how the work is managed (“You cannot shut down our systems on a Friday”) or capabilities stakeholders would like to see in the product (“The new software should allow multiple users to access it at the same time”). They also may be related to quality (“There can be no more than one day of unexpected down time”), business processes (“You must track and report the project’s expenses in this way”), compliance (“By law, we have to meet this safety standard”), or even project management (“We require risk management procedure X to be used on the project”). The Collect Requirements process looks for all requirements, not just those related to the product of the project.

The high-level project and product description should have already been defined in the project charter during initiating. The Collect Requirements process involves gathering more detailed input on what’s required and any related assumptions and expectations from all stakeholders. This process is critical to project success, as a missed requirement could mean significant changes and conflict throughout the remainder of the project, and even project failure.

So how do you collect requirements? First, know who your stakeholders are. This information is recorded in the stakeholder register and stakeholder management plan. Then get the stakeholders to give you requirements! It may sound simple, but it is not. For 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 expensive and time-consuming and cause other problems later, a concerted effort must be made to find as many of the requirements as possible before work starts on a project or development phase. This includes eliciting stakeholders’ expectations—their beliefs or mental pictures about how the project will turn out—and translating those expectations into requirements as necessary. This effort to collect requirements may involve reviewing lessons learned and other historical records and using various data-gathering techniques (described next). The project manager needs to choose the techniques that are most appropriate for the project and the stakeholders. Many of these techniques can also be used as part of other data-gathering efforts, such as identifying risks during the risk management process.

Reviewing Historical Records Historical records and lessons learned can indicate what the requirements were on similar projects and help identify relevant processes and expectations. For example, historical records may provide data about reporting requirements, project management requirements, system compatibility requirements, compliance requirements, etc. Lessons learned from other projects may also identify commonly overlooked areas of scope to help ensure such requirements are not missed on the current project.

Interviews This technique may also be referred to as “expert interviews” on the exam. 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 e-mail, phone calls, or virtual collaboration tools.

Focus Groups The focus group technique helps get a specific set of stakeholders’ or subject matter experts’ opinions and requirements for the product or an aspect of the project. Members of the focus group are usually selected from a specific demographic group of customers. They can discuss their ideas with each other, and the conversation is directed by a moderator.

Facilitated Workshops Facilitated requirements workshops bring together stakeholders with different perspectives (e.g., product designers and end users) to talk about the product and, ultimately, define requirements. Stakeholders may develop user stories as part of these workshops. User stories describe functionality or features the stakeholders hope to see and 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."

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 individual thoughts as 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. After all the ideas have been captured, the group can evaluate and rank them through the nominal group technique or multi-criteria decision analysis, as described in the following sections.

As with any group technique, the results of brainstorming sessions vary depending on who the participants are. It can be highly beneficial to include people with different perspectives or backgrounds. The participants may be internal or external to the project or the organization.

Nominal Group Technique¹ This technique is usually, but not always, done during the same meeting as brainstorming. The meeting participants rank the most useful ideas generated during the brainstorming session.

Multi-criteria Decision Analysis² Another way to rank ideas is through multi-criteria 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.

Mind Maps³ A mind map is a diagram of ideas or notes to help generate, classify, or record information. It looks like several trees radiating out of a central core word or words (see figure 5.1). Colors, pictures, and notations can be used to make the diagram more readable.

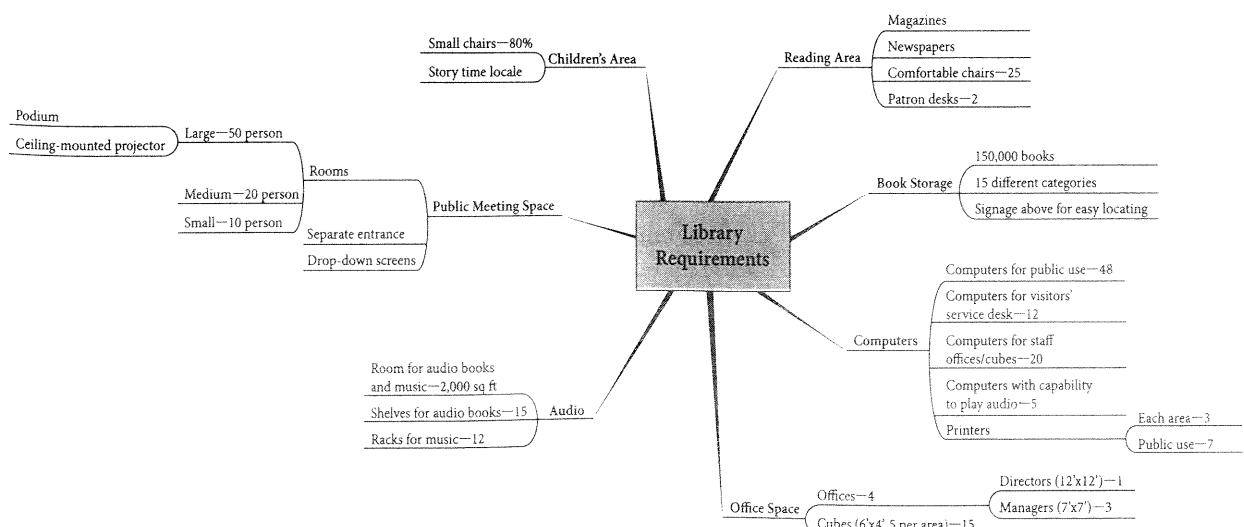


Figure 5.1: Mind Map

Scope Management

FIVE

Affinity Diagrams⁴ 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 (or risks) that have not been identified.

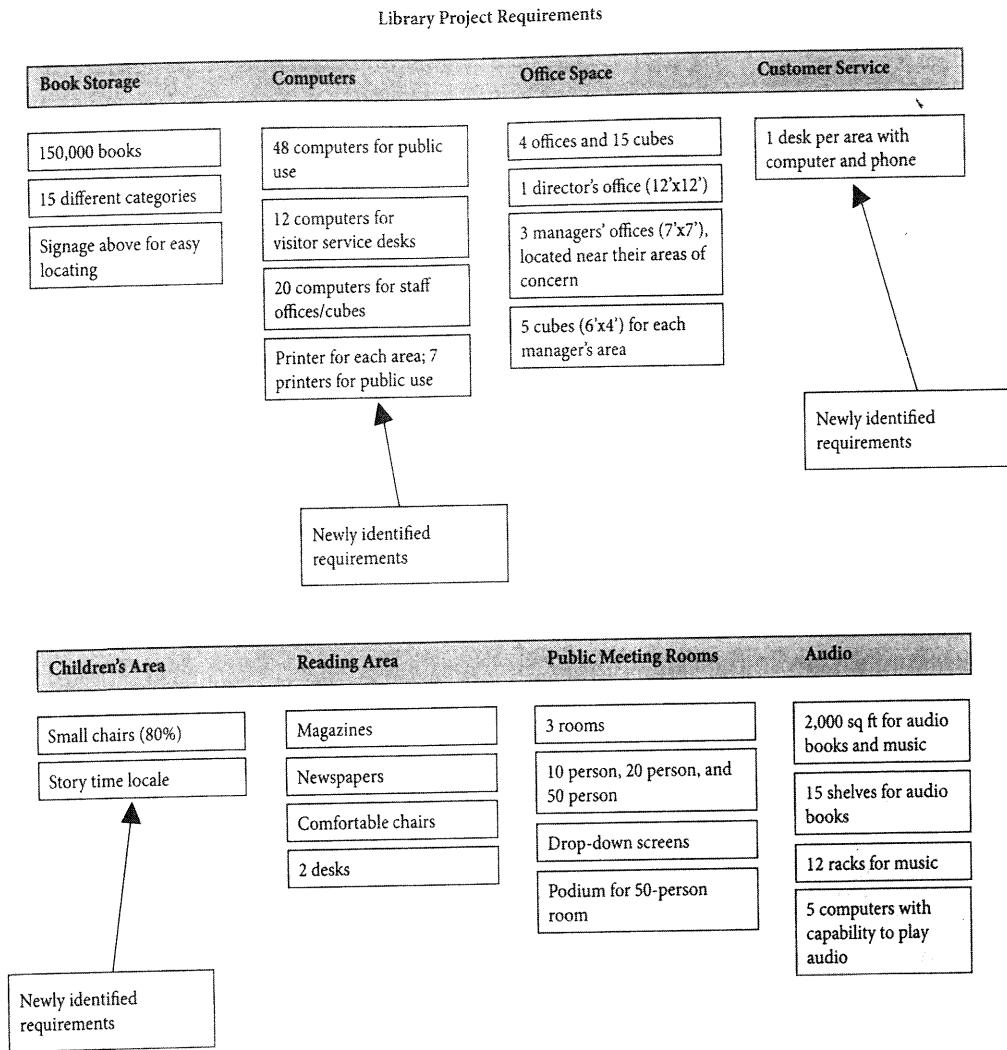


Figure 5.2: Affinity Diagram

Affinity diagrams can also be organized by requirement 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 expect from and 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** What are the expectations for how the project should be initiated, planned, executed, controlled, and closed?
- **Quality requirements** What quality measures does the product need to meet? What designates a deliverable as successfully complete?
- **Technical requirements** How will the product be built? What are the product specifications?

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.

Observation Observation is a great way to learn about business processes and get a feel for the work environment of your 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.

Prototypes A prototype is a model of the proposed product. In this technique, the prototype is presented to stakeholders for feedback. The prototype may be updated multiple times to incorporate the feedback until the requirements have been solidified for the product.

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 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 developing new, innovative ideas.

Context Diagrams⁵ 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 second project charter in the previous chapter.

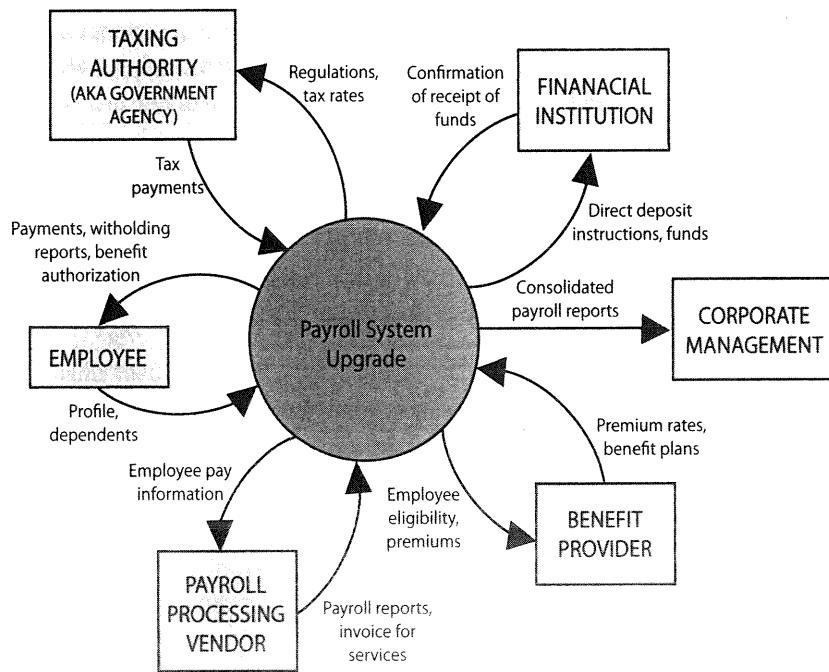


Figure 5.3: Context Diagram

Group Decision Making Soliciting input on requirements from different stakeholders often results in conflicting requirements. It's essential to resolve these conflicts and review, analyze, accept or reject, and prioritize requirements before recording them in project documents. There are different

ways to make decisions in a group setting. If the group agrees on a requirement unanimously (i.e., everyone agrees), the decision is easy. One way to achieve unanimous agreement is through the Delphi technique (described next). The decision-making process can also be easy if a single person is assigned to make the decision for the entire group. This technique, known as the dictatorship technique, can have negative impacts on the project if the stakeholders do not buy into the decision, however.

When there are conflicting opinions, groups may take a majority approach. With this technique, 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 technique. The final technique is the consensus approach, which achieves general agreement about a decision; those who would prefer another option are willing to accept the decision that most members of the group support.

Delphi Technique⁶

With this group-decision-making technique, a request for information is sent to experts who participate anonymously. Their responses are compiled, and the results are sent back to the experts for further review until they reach agreement.

Requirements Documentation After the 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 make sure the requirements are clear and unambiguous.

The requirements documentation can contain various types of information, but there is one thing you should be sure to include. You will have a lot of requirements that could easily be misunderstood. Therefore, one of the great questions to ask stakeholders is, “How will we know if the work we do will meet this requirement?” The answer to this question is often referred to as acceptance criteria. Not only is this a great way to make sure you understand the stakeholder’s requirement, but it also helps ensure the work being done will be acceptable.

Balancing Stakeholders’ Requirements This effort is an important aspect of the Collect Requirements process. Part of balancing stakeholders’ requirements 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. Balancing stakeholders’ requirements also involves prioritizing requirements and resolving any conflicts between them.

There is a need to balance stakeholders’ requirements beyond the Collect Requirements process. It may only become apparent later in the project that some stakeholders’ requirements do not match those of the project or those of other stakeholders. Whenever this occurs, you need to balance the requirements against the interests of the project and resolve any conflicts.

Balancing stakeholders’ requirements is never easy or fast, but it can become an impossible effort if you do not have clear project objectives and if you do not identify and prioritize ALL the requirements from ALL the stakeholders during the Collect Requirements process. Do you make the effort in your real world to get as close to final requirements as possible? Are your requirements ranked by order of importance? If not, think about how such actions could improve your real-world projects. When you take the exam, assume the project manager has expended the effort necessary to determine all the requirements and that those requirements are ranked by order of importance.

Exercise This exercise outlines some of the key actions involved in balancing stakeholders' requirements. It goes beyond the Collect Requirements process and looks at this effort throughout the project life cycle. Spend some time thinking about balancing stakeholders' requirements while getting ready for the exam. This exercise will help you determine if you really understand the process summarized here. Go through each topic and put a checkmark next to the ones you understand. Put an X next to the ones you are able to apply in the real world. Then spend time thinking about the unmarked topics.

ACTION	Understand ✓	Can Do X
Identify all the stakeholders on the project, and understand their needs, wants, assumptions, and expectations related to the project.		
Work to get the requirements as clear and complete as possible before starting the project work.		
Use information about stakeholders and their requirements to resolve competing requirements while the work is being done on the project.		
Look for competing interests during project planning; don't just wait for them to show up during project executing.		
Look for possible options to resolve competing interests and alternative ways of completing the project activities. This may involve using techniques like brainstorming, schedule compression, reestimating, and other project management and management-related practices.		
Resolve stakeholders' competing requirements based on how the requirements affect the project. (See the guidelines listed in the following discussion.)		
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.)		
Use quality management to ensure the project will satisfy the needs for which it was undertaken.		
Deal with problems and conflicts as soon as they arise through the use of team-building, problem-solving, and conflict-management techniques.		
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.)		
Call on management to help resolve competing interests when the project manager and the team cannot come up with a fair and equitable solution.		
Fix the project when the project starts to deviate from the requirements, rather than changing or lowering the requirements to meet the results of the project.		

ACTION	Understand ✓	Can Do X
Work toward fair resolution of disputes that consider all stakeholders' interests as well as the needs of the project.		
Hold meetings, interviews, and discussions to facilitate the resolution of competing requirements.		
Use negotiation techniques to resolve disputes between stakeholders.		
Plan and implement effective communication. (Do not just read this item and move on! Take some time to think about what effective communication is.)		
Gather, assess, and integrate information into the project.		

Resolving Competing Requirements Many project managers have no idea how to prioritize competing requirements. What if the engineering department wants the project to focus on decreasing defects and the accounting department wants the project costs to be lower? Can both needs be met? What if the engineering department is the primary stakeholder or even the sponsor of the project? Do that department's needs outweigh the needs of the accounting department? What if the needs of the engineering department actually hurt 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. One trick is to walk through the following list for each requirement.

You should help resolve competing requirements by accepting those that best comply with following:

- The business case stating the reason the project was initiated (market demand, legal requirement, etc.)
- The project charter
- The project scope statement (if this is available at the time of the conflict)
- The project constraints

So 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 need to be brought to the sponsor's attention for approval. When considering constraints, if the most important constraint is schedule, then any requirements that would delay the schedule would not likely be accepted. Those that enhance the schedule (without serious impact on the other project constraints) would more likely be accepted. Requests that do not fall within these guidelines could become part of a future project instead.

Requirements Traceability Matrix⁷ Have you ever worked on a project in which some requirements got lost in the details? The process of determining requirements (especially on large projects) can easily involve one requirement leading to more refined requirements and clarifications. It can be difficult to remember where a requirement came from and its significance 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 the 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.

Objectives	Reading Area			Book Storage		Public Meeting Space	Children's Area	Audio	Office Space	Computers												
	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	

Figure 5.4: Requirements Traceability Matrix

Information like requirement identification numbers, the source of each requirement, who is assigned to manage the requirement, and the status of the requirement should also be recorded. The *PMBOK® Guide* suggests documenting this information 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 requirement attributes (i.e., identification numbers, source, status, etc.) also need to be documented.

Did you notice in the previous paragraph that each requirement is assigned to someone to manage, or “own”? This concept is similar to that of risk owners, described in the Risk Management chapter. An owner helps ensure the customer receives what they asked for and 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 beyond their efforts to produce the product.

Define Scope PAGE 120

Process: Define Scope
Process Group: Planning
Knowledge Area: Scope Management

The Define Scope process is primarily concerned with what is and is not included in the project and its deliverables. This process uses the scope management plan, the requirements documentation created in the Collect Requirements process, the project charter, and any additional information about project risks, assumptions, and constraints to define the project and product scope.

Remember that planning is iterative. When the requirements have been determined and the scope defined, the project manager follows the project management planning process outlined in Rita's Process Chart 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 the budget, schedule, and other constraints in the project. The iteration process involves coming up with options for meeting the scope, time, and cost objectives of the project and presenting those options 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-to scope.

The Define Scope process is discussed throughout this book. The following are two key reasons this process is important on the exam:

- Many project managers complain about unrealistic schedules, but for the exam, you need to understand that unrealistic schedules are the project managers' 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 other project constraints to resolve the problem before work begins.
- Project managers spend a large portion of their time, while the work is being done, looking for options to adjust the project and still meet the project schedule or budget. Therefore, all the tools used in planning to come up with a realistic schedule and budget, such as negotiating scope and fast tracking, are also major activities while the work is being done.

The process of Define Scope will continue as the project progresses, and will be iterated. Regardless of when this process is performed, its purpose is always to determine what scope is and is not in the project.

Product Analysis As noted at the beginning of this section, part of defining scope is determining what the deliverables of the project are. The purpose of product analysis is to analyze the objectives and description of the product stated by the customer or sponsor and turn them into tangible deliverables. 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 Statement⁸ 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 "Here is the approved project and product scope for this 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. 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:

- Product scope
- Project scope
- Deliverables (for the product and the project)
- Acceptance criteria
- What is not part of the project
- Assumptions and constraints

Create Work Breakdown Structure (WBS)⁹ PAGE 125 & THROUGHOUT

Process: Create Work Breakdown Structure
Process Group: Planning
Knowledge Area: Scope Management

Before you go any further, ask yourself, “What is a WBS?” It is essential to correctly understand this project management tool before taking the exam.

Exercise Test yourself! What is a WBS?

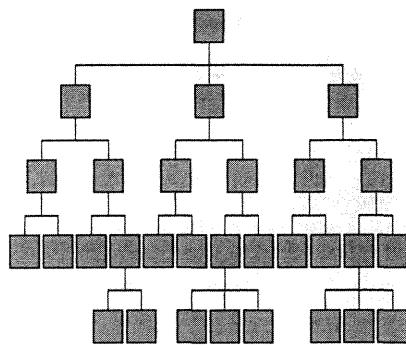
Answer This question should be easy if you currently use WBSs on your projects. You may have trouble on the exam if you do not create these in the real world, however. Why? The WBS is a required element in project management. This organizational tool shows all the scope on the project, broken down into manageable deliverables. Without a WBS, the project will take longer, elements will slip through the cracks, and the project will be negatively impacted. So there is no choice. All projects, even small ones, need a WBS. Read the rest of this section to learn more about what a WBS is and how it adds value to the project.

Questions on the exam are designed to identify those who know what WBSs are but who do not use them in the real world. What if a question described details of a project to you and then asked, “You are in the middle of planning this project and creating a WBS. Which of the following would you most likely need to worry about?” It is difficult to answer such questions with only academic knowledge. You need to have been there! You need experience using this tool.

Scope Management

Let's work through the topic of the WBS together. Try the following exercise.

Exercise Many people simply make a list of things to do as their method of defining the activities on a project. This is a mistake; there are enormous advantages to using a WBS instead. Test yourself. Can you explain why the image on the right side (a list) is not as good as the diagram on the left (a WBS)?



- Agenda for visits
- Evaluation criteria
- Team preparation
- Visit schedule
- Report on visits
- Vendor scores
- Finalist list

Answer Here are just a few answers to why a WBS is better than a list:

- The way a list, the method on the right, is created and the way it displays information make it easy to overlook some deliverables. In contrast, the construction of the WBS chart on the left provides a structured vision for the project and helps to ensure that nothing slips through the cracks (i.e., no deliverables are forgotten).
- A list can be cumbersome and does not allow you to clearly break down a large project into small enough pieces. With a WBS, you can easily break down the work into work packages, and the WBS shows how the work packages are derived.
- A list is usually created by one person, whereas the WBS is created with input from the team and stakeholders. Involving the team and stakeholders helps gain their buy-in, and increased buy-in leads to improved performance. In contrast, a list often makes people wary of the project because they do not understand the project by looking at the list, nor do they know how it was created.
- The process of creating a WBS allows the team to walk through the project in their minds and thus improves the project plan. The execution of the project is typically easier and less risky as a result.
- Being involved in the creation of the WBS helps people better understand the project and makes it feel more achievable.
- A WBS shows a complete hierarchy of the project, making it easier to see how one deliverable relates to another. A list is just a list.

So will this be on the exam? Not directly, but you will need to fully understand a WBS, and this discussion describes aspects of using a WBS that many people do not understand.

Figure 5.5 is a sample WBS:

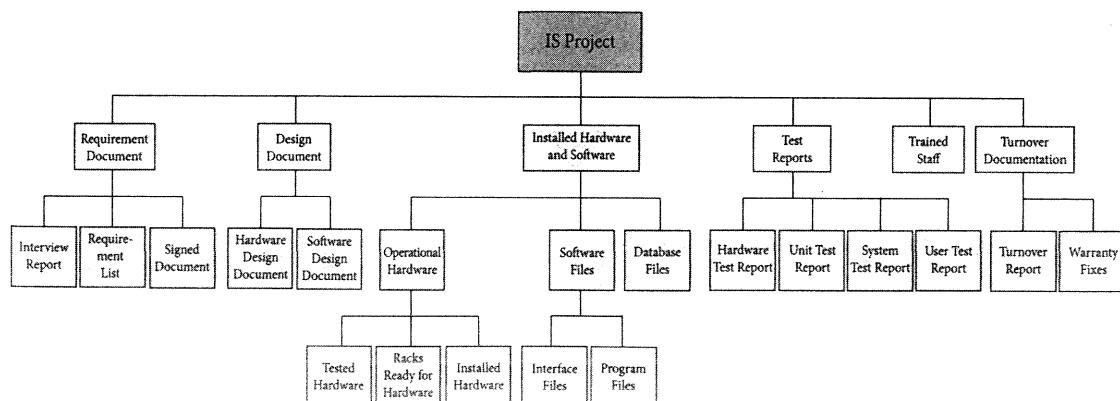


Figure 5.5: A WBS (on a Summary Level) for a Hardware/Software Creation and Installation Project

Most commonly, the project name goes at the top of the WBS. The next level is typically the same as the project life cycle (for example, for the IS project shown in figure 5.5: requirements documentation, design, installation, testing, training, turnover). The later levels break the project into smaller pieces. Such decomposition continues until reaching the level appropriate to manage the project.

Although the WBS may look like a corporate organizational chart, it is not! It serves a different function. The WBS allows you to break down a seemingly overwhelming project into pieces you can plan, organize, manage, and control. The creation of the WBS is an effort to decompose the deliverables into smaller pieces called work packages. Decomposition can be done using a top-down approach (starting with the high-level pieces of the 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, rather than actions. A WBS is deliverable-oriented. This does not mean that only customer deliverables are included in the WBS. The complete scope of the project, including product scope, project scope, and project management efforts, are included.

TRICKS OF THE TRADE Watch out for the word “task.” What many people refer to as a “task” in the real world (and in some project management software) is often called an “activity” on the exam. PMI considers an activity to be a particular piece of work scheduled for the project. Tasks can be smaller components of work that make up that activity, but PMI only expects you to manage to the activity level.

Understand that there are few set rules for creating a WBS. WBSs created by two people for the same project will look different. That is fine, as long as these rules are followed:

- The WBS is created with the help of the team.
- Each level of the WBS is a smaller piece of the previous level.
- The entire project is included in each of the highest levels of the WBS. Eventually some levels will be broken down further than others.
- The WBS includes only deliverables that are required for the project.
- Deliverables not in the WBS are not part of the project.

The team breaks down the WBS until work packages are reached. This occurs when the deliverables:

- Can be realistically and confidently estimated
- Can be completed quickly
- Can be completed without interruption (without the need for more information)
- May be outsourced or contracted out

Once they are determined, you might enter the work packages—the items at the lowest level of the WBS—into project scheduling software. You would not try to derive the list of work packages by using this software, however. That list comes from the creation of the WBS.

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 5.6 provides an example:

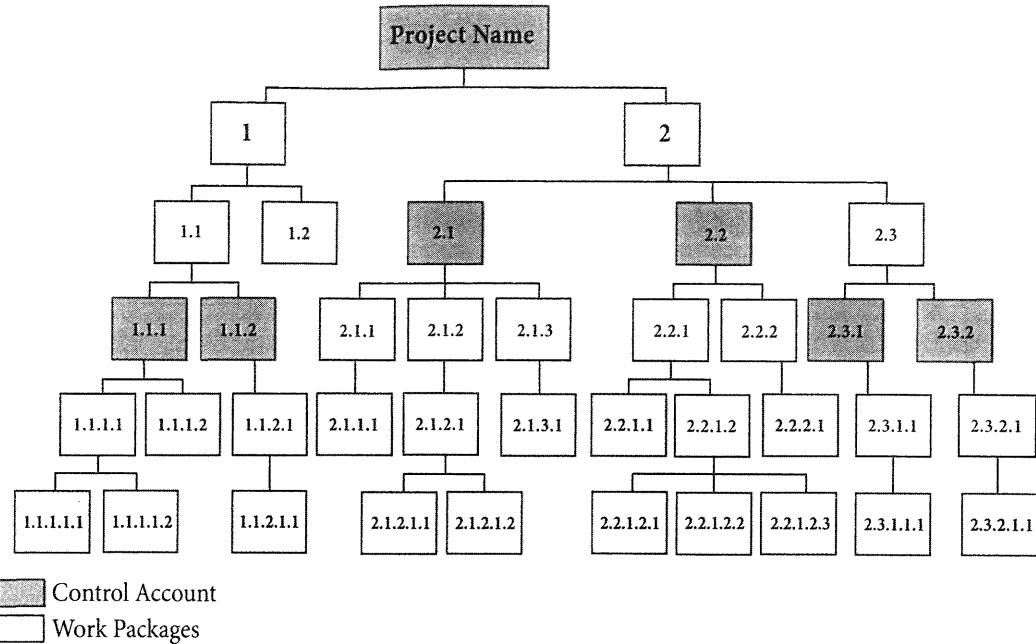


Figure 5.6: Sample WBS Numbering System

You may see the term “control account”¹⁰ on the exam. Sometimes depicted at higher levels on the WBS (as shown in figure 5.6), a control account is a tool that allows for the aggregation and analysis of work performance data regarding costs, schedule, and scope. Control accounts 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 would be assigned to only one control account.

As the planning process 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 time 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.

On small projects, the WBS is often broken down into work packages that involve from 4 to 40 hours of work. Medium-size projects may have work packages with anywhere from 8 to 80 hours of work. On large projects, however, the work packages may be much larger than this; for example, they could involve 300 hours of work. Therefore, the Define Activities process is especially important on large projects. Can you imagine 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 the next. Therefore, the project management office should collect WBS examples and encourage the creation of templates.

Great project managers do not only see the value of the information provided in the WBS; they also recognize the value that the effort involved in creating the WBS adds to the project. Do you really understand what a WBS is? Try the next exercise. If you miss many of the answers, review this section again and rethink your knowledge of WBSs before taking the exam.

Scope Management FIVE

Exercise Test yourself! What are the benefits of using a WBS?

Answer This exercise may seem similar to the previous exercise, but it is important to clearly understand the value of the WBS for the exam. The following are benefits of using a WBS:

- Helps prevent work from slipping through the cracks
 - Provides the project team members with an understanding of where their pieces fit into the overall project management plan and gives them 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 stakeholders' expectations regarding the deliverables
 - Helps identify risks
 - Helps prevent changes
 - Focuses the 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, cost, and time
 - Provides PROOF of the need for resources, funds, and time
 - Helps with planning the control efforts and establishing acceptance criteria for the deliverables
 - Gets team buy-in and builds the team
 - Helps people get their minds around the project

The WBS is the foundation of the project. This means almost everything that occurs in planning after the creation of the WBS is related to the WBS. For example, project costs and time are estimated at the work package or activity level, not for the project as a whole. Risks are identified by work package, not just for the project as a whole. Work packages are assigned to individuals or parts of the performing organization, depending on the size of the project. Does figure 5.7 make sense to you? Are you getting the full value of the WBS on your projects?

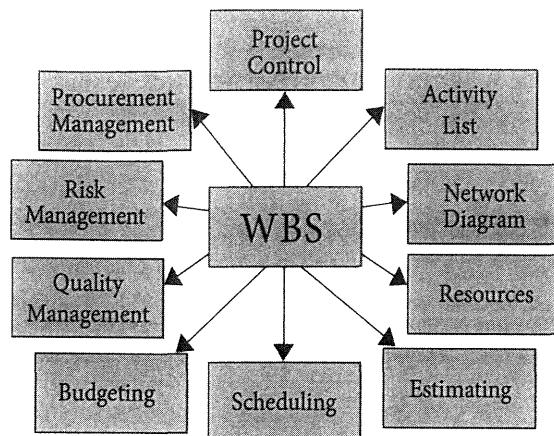


Figure 5.7: The WBS Is the Foundation of the Project

Let's think about the project control element in figure 5.7. Many people forget to use the project management tools from project planning while the work is being done. They may create a WBS as a required activity but then forget about it. As a result, they do not get all the tool's benefits. If the exam asks what you do with the WBS once you have created it, what will you answer?

Exercise What do you do with a WBS once you have created it?

If you were going to test someone's knowledge, would you test the basics like "What is a WBS?" or would you test knowledge about how a WBS helps better manage a project? The exam strongly weighs toward the latter. So take some time to really think about this question.

Answer

When completed, the WBS can be used any time the scope of the project needs to be reevaluated. For example, you can use a WBS:

- When there is a scope-related change request to the project; the WBS, along with the project scope statement, can help you see if the request is within the planned scope of the project
- As part of integrated change control to evaluate any impacts of other changes on scope
- As a way to control scope creep (i.e., scope increasing or varying from what was planned on the project) by reminding everyone what work is to be done
- As a communications tool
- To help new team members see their roles



There can be many references to the WBS on the exam. In short, remember the following. A WBS:

- Is a graphical picture of the hierarchy of the project
- Identifies all the deliverables to be completed (if it is not in the WBS, it is not part of the project)
- Is the foundation upon which the project is built
- Is VERY important
- Should exist for every project
- Forces you to think through all aspects of the project
- Can be reused for other projects
- Does NOT show dependencies



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 is that decomposition is what you are doing, and the WBS is the means to do it. In other words, you can decompose the project using a WBS.



The exam may use the term “deconstruction” instead of “decomposition.”¹¹ Both terms mean the same thing.

WBS Dictionary PAGE 132 Do you want to hear about a really great idea? Think about how a work package is identified in a WBS. It is usually described in a few words, such as “casing design” or “module XYZ code.” But giving such a brief description of the deliverable to a team member allows for too much possible variation from what the deliverable was intended to be. 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 helps make sure the resulting work better matches what is needed. Therefore, a project manager can use the WBS dictionary to prevent scope creep before work even starts on the project, rather than dealing with scope creep while the work is being done through the use of management skills and constant inspection.

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. The WBS dictionary describes the schedule milestones, the acceptance criteria, durations, interdependencies, and other information about the work package. You can also use it to control what work is done when, to prevent scope creep, and to increase stakeholders’ understanding of the effort required for each work package. The WBS dictionary essentially puts boundaries on what is included in the work package (similar to the way the project scope statement puts boundaries on what is included

in the project). NOTE: Some of the entries in the WBS dictionary are filled in during iterations, rather than when it is first drafted (e.g., durations, interdependencies, etc.).

A WBS dictionary may contain information similar to the example shown here in figure 5.8:

WBS Dictionary			
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			
Interdependencies			
Before this work package _____			
After this work package _____			
Approved By: Project Manager _____ Date: _____			

Figure 5.8: WBS Dictionary

Scope Baseline PAGE 131 Think about the word “baseline.” We discussed baselines in the Integration Management chapter and will continue to mention baselines throughout this book. Some people who do not currently use baselines to help control their projects have a hard time understanding this concept. Baselines are simply the final, approved version of certain pieces of the project

Scope Management FIVE

management plan. For scope, the baseline is the version of the WBS, WBS dictionary, and project scope statement that is approved at the end of planning, before the project work begins. As the work on the project progresses, the project manager looks at where the project is at compared to where the baseline says it should be. In other words, 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) then 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 (e.g., parts of the project management plan or project documents related to schedule, budget, resources, quality, risk, etc.).

A project's (and project manager's) measurements of success include whether the project has met the requirements and whether the scope baseline has been met. And 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 Scope PAGE 133

Process: Validate Scope
Process Group: Monitoring & Controlling
Knowledge Area: Scope Management

Many people are confused about what it means to validate scope. Are you one of them? If so, we can help you get up to five more questions right on the exam by clarifying this process.

TRICKS OF THE TRADE First, think about the name of the process. Many people think Validate Scope means confirming the validity and appropriateness of the scope 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.

Exercise What would you expect the inputs to Validate Scope to be? (Remember that the word "input" means, "What do I need before I can. . .?")

Answer

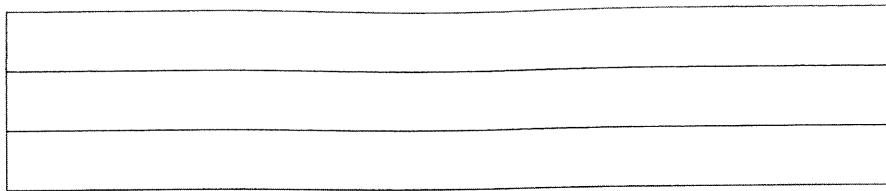
- Work must be completed and checked each time before you meet with the customer; therefore, you must have what are called **verified deliverables** from the Control Quality process. (Note that the *PMBOK® Guide* formerly called these *validated* deliverables but changed the term to *verified* deliverables in the fifth edition; nevertheless, the fifth edition of the *PMBOK® Guide* does occasionally revert back to this older term, so it's a good idea to be aware of both names.)
- 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 might also need the **requirements traceability matrix** for the meeting, so you can track where requirements came from and prove that requirements were achieved.
- In addition, you should have the **requirements documentation** to refresh your memory about the full details of the requirements.
- 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.
- 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.



Did you notice how we haven't just listed the inputs for the previous answers, but have actually described them in terms of how they will be used? Whenever you think about inputs for a project management process, make sure you can describe them and explain where they come from and what they can offer the process. Similarly, make sure you also 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 answer.

Can you see how important having experience working on projects is for the exam, and how you can use logic to answer many questions correctly, even input questions? Now let's try the dreaded outputs.

Exercise Name the outputs of Validate Scope. (Remember that output means, "What will I have when I am done with . . . ?")



Answer Another way of looking at an output is to think about why you are bothering doing this and what the results should be. 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 the 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:

- Work performance information
- Accepted deliverables
- Change requests
- Project document updates

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 in one project. 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, remember that 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.

TRICKS OF THE TRADE

The third tricky area is how Validate Scope relates to the Control Quality process. See the high-level diagram in figure 5.9.

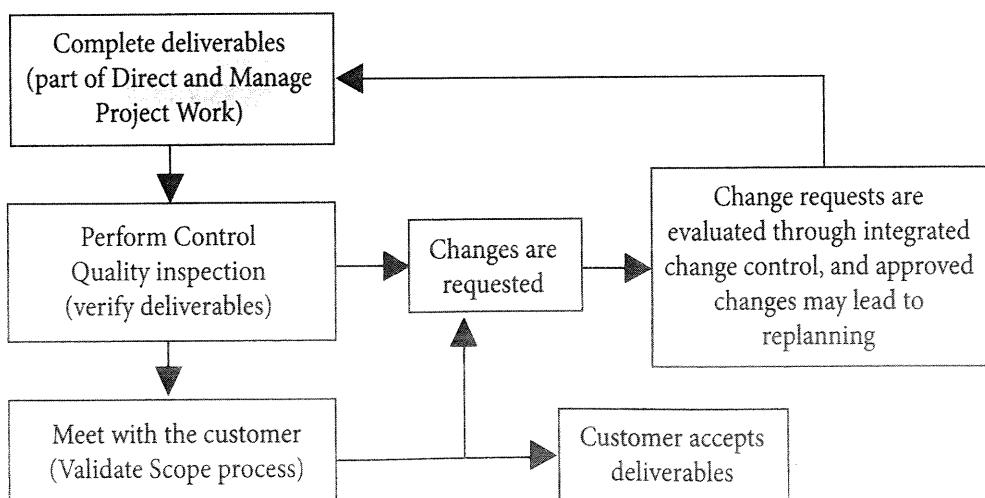


Figure 5.9: Relationship between Validate Scope and Control Quality

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 in that 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.

Control Scope PAGE 136

Process: Control Scope
Process Group: Monitoring & Controlling
Knowledge Area: Scope Management

Many project managers do not

really control their projects. If this is true for you, you might have some gaps in your knowledge of this process. Control Scope involves measuring and assessing work performance data against the scope baseline and managing scope baseline changes. How do you measure scope now? Are you doing it frequently, so that you are sure at any point in the project that the scope is being completed according to 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 what the scope should be (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 scope performance (the work completed) against the scope baseline to analyze any variances to see whether they warrant changes. (Your scope management and requirements management plans include information about how such analysis should be done.) 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. As a part of Control Scope and Perform Integrated Change Control for any approved changes, the output of the process is updates to or replanning of the baselines, parts of 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. If you properly use project management tools, techniques, and practices, it saves you from having to deal with unnecessary problems. As a result, you have time to do such analysis.

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 should not let others add scope or change scope without following the approved change management process and without the suggested changes being 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.

Practice Exam

1. A work breakdown structure numbering system allows the project team to:
 - A. Systematically estimate costs of work breakdown structure elements.
 - B. Provide project justification.
 - C. Identify the level at which individual elements are found.
 - D. Use it in project management software.
2. The work breakdown structure can BEST be thought of as an effective aid for _____ communications.
 - A. Team
 - B. Project manager
 - C. Customer
 - D. Stakeholder
3. 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. Improved schedule estimates
 - D. An improved project management information system
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
6. 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.

7. During a meeting with some of the project stakeholders, the project manager is asked to add work to the project scope. The project manager had access to correspondence about the project before the project charter was signed and remembers that the project sponsor specifically denied funding for the scope mentioned by these stakeholders. The BEST thing for the project manager to do is to:
 - A. Let the sponsor know of the stakeholders' request.
 - B. Evaluate the impact of adding the scope.
 - C. Tell the stakeholders the scope cannot be added.
 - D. Add the work if there is time available in the project schedule.
8. A new project manager is being mentored by a more experienced PMP-certified project manager. The new project manager is having difficulty finding enough time to manage the project because the project scope is being progressively elaborated. The PMP-certified project manager advises that the basic tools for project management, such as a work breakdown structure, can be used during project executing to assist the project manager. For which of the following can a work breakdown structure be used?
 - A. Communicating with the customer
 - B. Showing calendar dates for each work package
 - C. Showing the functional managers for each team member
 - D. Showing the business need for the project
9. During a project team meeting, a team member suggests an enhancement to the scope that is beyond the scope of the project charter. The project manager points out that the team needs to concentrate on completing all the work and only the work required. This is an example of:
 - A. Change management process.
 - B. Scope management.
 - C. Quality analysis.
 - D. Scope decomposition.
10. 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
11. 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.

Scope Management FIVE

12. 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 would be 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 only needed on large projects.
 - C. Work breakdown structures are required only if the project involves contracts.
 - D. Work breakdown structures are the only way to identify risks.
13. A new project manager has asked you for advice on creating a work breakdown structure. After you explain the process to her, she asks you what software she should use to create the WBS and what she should do with it when it is completed. You might respond that it is not the picture that is the most valuable result of creating a WBS. The most valuable result of a WBS is:
 - A. A bar chart.
 - B. Team buy-in.
 - C. Activities.
 - D. A list of risks.
14. 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
15. A project manager may use _____ to make sure the team members clearly know what work is included in each of their work packages.
 - A. The project scope statement
 - B. The product scope
 - C. The WBS dictionary
 - D. The schedule
16. The MAIN purpose of writing 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.
17. The construction phase of a new software product is near completion. 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 final phase?
 - A. Validate Scope
 - B. Control Quality
 - C. Manage Communications
 - D. Control Costs

18. You are managing a six-month project and have held bi-weekly 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 and Control Risks.
 - B. Control Schedule.
 - C. Define Scope.
 - D. Control Scope.
19. 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.
20. 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 there are any more changes 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 discovered during project planning.
21. During the completion of project work, the sponsor asks the project manager to report on how the project is going. In order to prepare the report, the project manager asks all the team members what percent complete their work is. There is one team member who has been hard to manage from the beginning. In response to being asked what percent complete he is, the team member asks, "Percent complete of what?" Being tired of such comments, the project manager reports to the team member's boss that the team member is not cooperating. Which of the following is MOST likely the real problem?
 - A. The project manager did not get buy-in from the manager for the resources on the project.
 - B. The project manager did not create an adequate reward system for team members to improve their cooperation.
 - C. The project manager should have had a meeting with the team member's boss the first time the team member caused trouble.
 - D. The project manager did not assign work packages.
22. 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 project expeditor.

Scope Management FIVE

23. 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
24. A scope change has been suggested by one of the stakeholders on the project. After careful consideration and a lot of arguing, the change control board has decided to reject the change. What should the project manager do?
 - A. Support the stakeholder by asking the board for the reason for the rejection.
 - B. Suggest to the stakeholder that the next change they request will be approved.
 - C. Document the outcome of the change request.
 - D. Advise the change control board to make sure they create approval processes before the next change is proposed.
25. 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 on the project 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
26. Validate Scope is closely related to:
 - A. Control Quality.
 - B. Sequence Activities.
 - C. Perform Quality Assurance.
 - D. Time Management.
27. Which of the following can create the MOST misinterpretation of the project scope statement?
 - A. Imprecise language
 - B. Poor pattern, structure, and chronological order
 - C. Small variations in size of work packages or detail of work
 - D. Too much detail
28. 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.

29. 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.
30. 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

Answers

1. **Answer C**

Explanation The numbering system allows team members to quickly identify the level in the work breakdown structure where the specific element is found. It also helps to locate the element in the WBS dictionary.

2. **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 (but does not need to be used) as a communications tool for all stakeholders to “see” what is included in the project.

3. **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.

4. **Answer A**

Explanation 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. The WBS dictionary defines each element in the WBS. Therefore, descriptions of the work packages are in the WBS dictionary.

5. **Answer B**

Explanation The project scope statement is an output of the Define Scope process, which occurs during project planning.

6. **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. For larger projects, it is more difficult to “catch” everything.

7. **Answer C**

Explanation Although one could let the sponsor know about the stakeholders’ request, the best choice listed would be to say no, as this was already considered. An even better choice would be to find the root cause of the problem, but that choice is not listed here.

8. **Answer A**

Explanation A WBS does not show dates or responsibility assignments. The business need is described in the project charter. In this situation, the project scope is being fine-tuned. It would save the project manager time in effectively managing progressive elaboration if the WBS was used as a communications tool. Using the WBS helps ensure everyone (including the customer) understands the scope of the work.

9. **Answer B**

Explanation The team member is suggesting an enhancement that is outside the scope of the project charter. Scope management involves focusing on doing the work and only the work in the project management plan that meets the objectives of the project charter. The project manager is performing scope management.

10. 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.

11. 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 he or she knows 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.

12. 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.

13. Answer B

Explanation The WBS is an input to all of these choices. However, team buy-in is a direct result of the WBS creation process, while the other choices use the WBS to assist in their completion. Involving the team in creating the WBS provides project team members with an understanding of where their pieces fit into the overall project management plan and gives them an indication of the impact of their work on the project as a whole.

14. 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.

15. 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.

16. 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 facilitated workshops or as part of other requirements-gathering methods.

17. 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.

Scope Management FIVE

18. Answer C

Explanation Monitor and Control 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 a part of project planning. Good planning reduces the likelihood of a situation like the one described, by including the right people and spending adequate time clarifying the project scope.

19. 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.

20. Answer B

Explanation Notice that there are many things the project manager could do listed in the choices. The question asks what is the BEST thing to 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 time and cost. 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 there are more changes expected.

21. Answer D

Explanation The project manager is not losing resources (which is implied by not getting the manager's buy-in). Although a reward system would help with cooperation, the real problem here is not cooperation. Meeting with the team member and his boss cannot be the answer because it also does not solve the problem at hand (the team member not knowing what he is to do). If you selected this choice, be very careful! You can get 10 to 20 questions wrong on the exam simply because you do not see the real problem! The whole discussion of the team member and his actions is a distracter. The real problem in this scenario is not that the team member is being uncooperative. He is asking a question that many team members want to ask in the real world. "How can I tell you how things are going if I do not know what work I am being asked to do?" The real problem is the lack of a WBS and work packages. If there were a WBS and work packages for the project, the team member would not have to ask such a question.

22. 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.

23. 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.

24. Answer C

Explanation There is no reason to think that the board's rejection would not contain an explanation already, since providing that information is commonly done. Suggesting a change process that circumvents the change control board's authority is not ethical. There is no reason to think that approval processes are not already in place. A rejected change should be recorded for historical purposes, in case the idea is resurrected later, and for other reasons.

25. **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.

26. **Answer A**

Explanation Control Quality checks for correctness, and Validate Scope checks for acceptance.

27. **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.

28. **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.

29. **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 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.

30. **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 Perform Quality Assurance process. Product analysis includes gaining a better understanding of the product of the project, in order to create the project scope statement.



Time Management

SIX

This chapter is often very difficult for those who do not realize that an unrealistic schedule is the project manager's fault. Yes, it's true! One of the key responsibilities of a project manager is to see if the needed end date for a project can be met and to create options to make it happen, all BEFORE project executing starts. If you know the many options for compressing a project schedule, and understand that a project schedule must be realistic before project executing begins, this chapter should not be difficult for you.

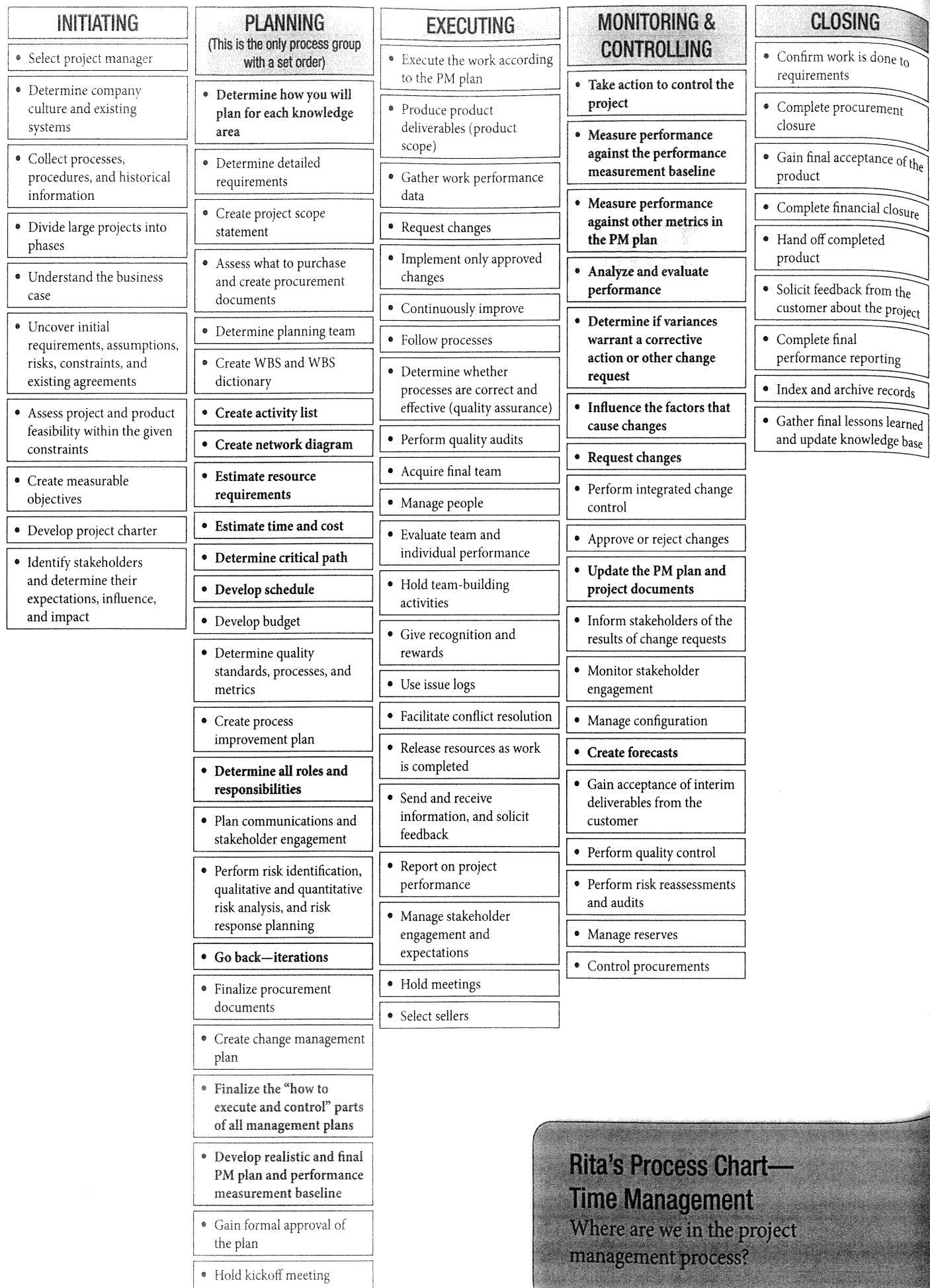
In order to answer time management questions correctly, you should thoroughly understand the process of scheduling a project. Although most project managers use some type of software to assist with scheduling, the exam has required test takers to manually draw network diagrams to answer questions about network diagrams and scheduling. Therefore, you need to know some things that normally go on behind the scenes when using "project management software."

Watch out! Although we just used the term "project management software," make sure you realize there is no such thing as true project management software. The software available can be extremely helpful for scheduling, analyzing "what if" scenarios, and performing status-reporting functions, but it does not tell you how to manage a project. You cannot simply follow the software; you must adapt it to your needs. Software cannot do a project manager's job.

Many existing software programs suggest planning a project in a way that does not conform to proper project management methods: first make a list of the activities, next assign them to calendar dates, and then the project management plan is finished. These programs do not address all aspects of project management and may have changed some of the basic components of the tools of project management

QUICKTEST

- Time management process
- Schedule baseline
- Schedule compression
 - Crashing
 - Fast tracking
- Activity list
- Network diagram
- Dependencies
 - Mandatory
 - Discretionary
 - External
 - Internal
- Precedence diagramming method (PDM)
- Critical path
- Float (Slack)
 - Total float
 - Free float
 - Project float
- Three-point estimating
 - Beta distribution
 - Triangular distribution
 - Beta activity standard deviation
- Monte Carlo analysis
- Bar charts
- Milestone charts
- Schedule model
- Schedule management plan
- Resource optimization
 - Resource leveling
 - Resource smoothing
- Critical path method
- Near-critical path
- Leads and lags
- Milestones, milestone list
- Resource breakdown structure (RBS)
- Reserve analysis
- Padding
- Analogous estimating
- Parametric estimating
- Heuristics
- Critical chain method
- Activity resource requirements
- Activity attributes
- Reestimating
- Rolling wave planning
- GERT



**Rita's Process Chart—
Time Management**
Where are we in the project management process?

(such as what is in a bar chart) in ways that could cause you to get questions wrong on the exam. Make sure you understand the full project management process and keep that process in mind for the exam.

Read this chapter carefully, and check your knowledge as you go.

The following should help you understand how each part of time management fits into the overall project management process:

The Time Management Process	Done During
Plan Schedule Management	Planning process group
Define Activities	Planning process group
Sequence Activities	Planning process group
Estimate Activity Resources	Planning process group
Estimate Activity Durations	Planning process group
Develop Schedule	Planning process group
Control Schedule	Monitoring and controlling process group

Plan Schedule Management PAGE 145

Process: Plan Schedule Management
Process Group: Planning
Knowledge Area: Time Management

The Plan Schedule Management process involves documenting how you will plan, manage, and control the project schedule. This process answers questions like: "Who will be involved, and what approach will we take to plan the schedule for the project?" "What processes and procedures will we use to create the schedule?" (Note that the processes, procedures, and tools approved for use within the organization may already be documented as part of organizational process assets.) You will also consider existing enterprise environmental factors: "Is there a work authorization system in place for the project to use?" "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?" This process should also answer the question: "How will I effectively manage and control the project to the schedule baseline, and manage schedule variances?"

Did you notice that this process requires you to think in advance about how you will manage and control the schedule? This is a concept that many project managers miss. Many project managers just work on the project and hope they meet the deadline. But proper schedule management requires you to measure 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 measure, how you will use the data to keep the project on track, and what you will do when variances occur.

To plan schedule management, you need to refer to the scope baseline and other pieces of the project management plan, in addition to the organizational process assets and enterprise environmental factors already discussed. The project charter will provide you with high-level milestones as well as information on who needs to approve your final schedule. You will also use expert judgment (yours and that of others) and various analysis techniques in planning how to arrive at a final schedule. You may also hold meetings to plan the schedule that include the project sponsor, team members, and other stakeholders.

Schedule Management Plan

PAGE 148 The key output of this process is a schedule management plan, which includes:

- The scheduling methodology and scheduling software to be used on the project
- Rules for how estimates should be stated. For example, should estimates be in hours, days, or weeks? Should estimators identify both the effort (the amount of labor involved in completing an activity; e.g., 12 hours) and duration (the amount of work periods the effort will span; e.g., 1.5 days) needed to complete an activity?
- Establishment of a schedule baseline for measuring against as part of project monitoring and controlling
- Identification of the performance measures that will be used on the project, to identify variances early
- Determination of what acceptable variance will be on this project
- Planning for how schedule variances will be identified and managed
- Identification of schedule change control procedures
- Reporting formats to be used

The schedule management plan can be formal or informal, but it is part of the project management plan. It helps make the schedule estimating process faster by providing guidelines on how estimates should be stated (e.g., in hours, days, or weeks) and within what range. The schedule management plan can specify the types of reports required on the project relating to schedule.

During monitoring and controlling, the schedule management plan can help determine if a variance is over the allowable threshold and therefore must be acted upon, and how the schedule model (described in the Develop Schedule section) will be updated to reflect progress and current status.

Define Activities

PAGE 149

Process: Define Activities
Process Group: Planning
Knowledge Area: Time Management

This process involves 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 in the next process, Sequence Activities. (Note that the creation of the work packages in the WBS is part of scope management, and the identification of activities is part of time management.)

Defining activities is not always done as a separate process. Many project managers combine this effort with creating a WBS and WBS dictionary; they take their WBS down one more level to show activities, rather than stopping at work packages.

TRICKS OF THE TRADE We also saw the term decomposition used in the Scope Management chapter, in the Create WBS process. Carefully read exam questions using the term. If the team is decomposing work into work packages (deliverables), they are creating a WBS (part of scope management). If they are decomposing work packages into the activities required to produce them, they are in the Define Activities process.

So what do you need in order to define activities? (That question is all there really is to the concept of inputs.) You need your schedule management plan, created in the previous process, and the scope baseline (scope statement, WBS, and WBS dictionary) from scope management. 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. Involving the team in the Define Activities process helps define the activities completely and accurately and therefore makes the estimates, created later in the planning process, more accurate.

Rolling Wave Planning¹ Have you ever felt a project had too many unknown components to adequately break down the work and schedule it? Be careful—when that is the case, you might really have more than one project (see the earlier discussion of the definition of a project in the Project Management Framework chapter). Or, you might just have found it better to not plan to the lowest detail in advance, but instead to plan to a higher level and then wait until the project work has begun and the work is clearer to plan the lower levels. This practice is called “rolling wave planning” and is a form of progressive elaboration. With this method, you plan activities to the detail needed to manage the work only when you start that phase of the project life cycle.

But remember—the options of rolling wave planning and planning to a higher level than a work package are not excuses for improperly planning a project or for not making sure all the scope that can be known is known before starting work!

When completed, the Define Activities process results in an activity list, which includes all activities required to complete the project, and documentation of the details of those activities (activity attributes). The Define Activities process also involves determining the milestones to use on the project.

Milestones Milestones are significant events within the project schedule. They are not work activities, and have no duration. For example, a completed design, certain deliverable due dates from the customer, or a company-required checkpoint could be milestones. The sponsor may impose milestones, and a summary of these milestones may be included in the project charter. The project manager can also impose additional milestones during the Sequence Activities or Develop Schedule processes, as checkpoints to help control the project. If a checkpoint 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 becomes part of the project scope documents that support the project schedule and baselines.

Sequence Activities PAGE 153

Process: Sequence Activities
Process Group: Planning
Knowledge Area: Time Management

The next process involves taking the activities and milestones and sequencing them in the order in which the work will be performed. The result is a network diagram (also referred to as a project schedule network diagram), which can look like the image in figure 6.1. Some people incorrectly call a network diagram a PERT chart. There are several exercises to help you draw and interpret network diagrams later in this chapter.

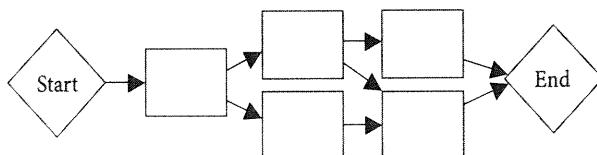


Figure 6.1: Network Diagram

For the exam, know that in its pure form, the network diagram shows just dependencies (logical relationships). If activity duration estimates (estimates) are added to the diagram, 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.

If you feel you need extra help understanding how to create and interpret network diagrams, please visit the website that accompanies the book www.rmcproject.com/extras.

Methods to Draw Network Diagrams² In the past, the Precedence Diagramming Method (PDM)³, the Arrow Diagramming Method (ADM)⁴, and the Graphical Evaluation and Review Technique (GERT)⁵ method were commonly used to draw network diagrams. Today most network diagrams are created using PDM.

Precedence Diagramming Method (PDM) or Activity-on-Node (AON)

In this method, nodes (or boxes) are used to represent activities, and arrows show activity dependencies, as follows:

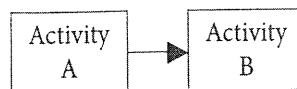


Figure 6.2: Precedence Diagramming Method

This type of drawing can have four types of logical relationships between activities:

- **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.

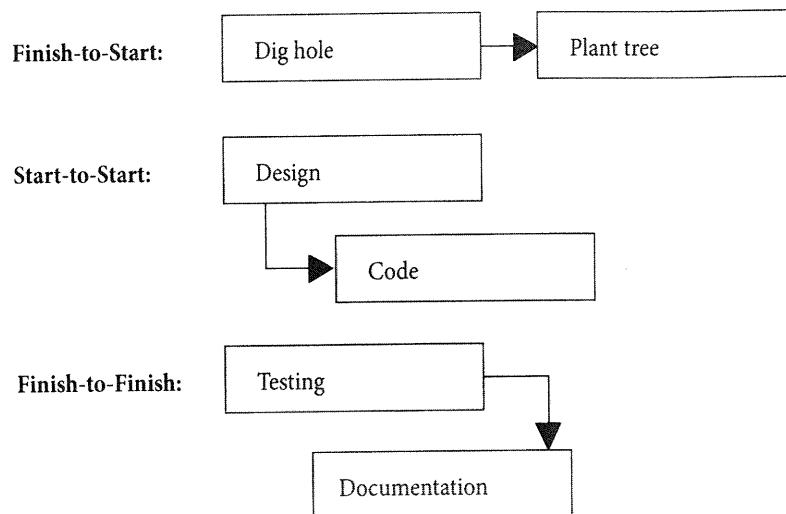


Figure 6.3: Finish-to-Start, Start-to-Start, and Finish-to-Finish Dependencies

Graphical Evaluation and Review Technique (GERT)

GERT is a modification to the network diagram drawing method. It is a computer simulation technique that allows loops between activities. The easiest example is when you have an activity to design a component and then test it. After testing, the component may or may not need to be redesigned. GERT is rarely on the exam, and when it does appear, it is most often just an incorrect answer choice.

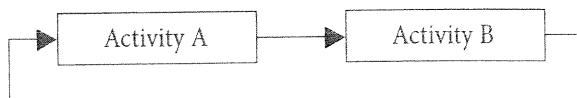


Figure 6.4: Activities Loop in GERT

Types of Dependencies The sequence of activities is determined based on the following dependencies:⁶

- **Mandatory Dependency (Hard Logic)** A mandatory dependency is inherent in the nature of the work (e.g., you must design before you can construct) or is required by the contract.
- **Discretionary Dependency (Preferred, Preferential, or Soft Logic)** This is the way an organization has chosen to have work performed in the organization. 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 (e.g., government or suppliers).
- **Internal Dependency** This dependency is based on the needs of the project and may be something the project team can control.

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.)

Leads and Lags PAGE 158 A lead may be used to indicate that an activity can start before its predecessor activity is completed. For example, coding might be able to start five days before the 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.

Project Schedule Network Diagrams Now it’s time to test your knowledge. Instead of just asking what a network diagram is, the exam will ask harder, more sophisticated questions like “How can the network diagram help you?” You need to have worked with network diagrams to accurately answer such questions. See how you do with the next exercise.

Exercise Describe how the network diagram can help you on the project.

Answer You should know that network diagrams 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.
- 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 (defined later in this chapter).
- Show project progress (when used for controlling the schedule and reporting).

Note that project schedule network diagrams may also be referred to as network diagrams or activity network diagrams.

In addition to a network diagram, the Sequence Activities process may result in updates to project documents such as the activity list, activity attributes, and the milestone list. Sequencing the activities can also reveal new risks, resulting in changes to the risk register.



Things to Know about Estimating for the Exam

The next two time management processes—Estimate Activity Resources and Estimate Activity Durations—and the Estimate Costs process (see the Cost Management chapter) all involve estimating. The following are important points to understand about time and cost estimating for the exam.

- Management plans provide the basis for estimating.
- Estimating should be based on a WBS to improve accuracy.
- Time and cost estimates are interrelated, as time estimates may impact cost, and vice versa.
- Identified risks must be considered when estimating time and cost of project work.
- Estimating should be done by the person doing the work whenever possible to improve accuracy.
- Historical information from past projects (part of organizational process assets) is key to improving estimates.
- Schedule, cost, and scope baselines should be kept and not changed except for approved project changes.
- The project schedule activities should be managed to the schedule baseline for the project.
- The project costs should be managed to the cost baseline for the project.
- Changes are approved in integrated change control.
- Estimates are more accurate if smaller-size work components are estimated.
- Changes should be requested when problems with schedule, cost, scope, quality, or resources occur and cannot be solved by using time and cost reserves.
- A project manager should never just accept constraints from management, but should instead analyze the needs of the project, come up with his or her own estimates (based on input from the team members doing the work when possible), and reconcile any differences to produce realistic objectives.
- The project manager may periodically recalculate the estimate to complete (ETC) for the project in order to make sure adequate time, funds, resources, etc., are available for the project.
- Plans should be revised during completion of the work as necessary with approved changes.
- There is a process for creating the most accurate estimate possible.
- Padding is not an acceptable project management practice.
- The project manager must meet any agreed-upon estimates.
- Estimates must be reviewed when they are received 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 decreased by reducing or eliminating risks.
 - A 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 and do not even know why.

Now let's look at an important topic related to estimating. Really try to answer the following question before reading on. It will help you assume the right perspective for studying this topic.

Exercise Why should you welcome management giving you an end date for the project or a total cost constraint?

Answer In the real world, many of us struggle with unrealistic schedules or budgets. As we have now stated a few times in this book, the project manager is responsible for making sure the schedule or budget is realistic. This is a difficult concept to get past for many people. Project managers often complain about unrealistic schedules and budgets and put the blame on senior management, but they do not realize that a major reason for having a project manager on a project is to make the schedule and budget realistic. So how do you go about achieving a realistic schedule or budget?

Let's think about the process logically. First, you look at the work needed to complete a project. You then estimate the time and cost of the work and come up with a calculated end date and budget for the project. You try to optimize that date and budget, and then compare your results to the end date and budget required by management. If there is a difference, you analyze the project and provide options on how to change it to meet management's time and cost requirements or negotiate a change to the end date or budget (in other words, you balance the constraints).

If you need more help with scheduling or handling unrealistic schedules, visit www.rmcproject.com for free tips and information about courses on these topics.

An unrealistic schedule or budget is the project manager's fault because he or she should be performing such activities in planning and while the project is underway to keep the project on track. This is an essential concept to understand for the exam. Do you follow the process we just described? If not, take some time now to truly understand it and think about how you can implement these practices in your real world.

So the quick answer to the question in this exercise is that you should welcome management providing an end date or total cost constraint because it gives you an opportunity to reconcile what management wants to what can be done BEFORE committing resources, wasting company time and money on projects that will not be successful, and damaging your reputation. As a project manager (especially as a PMP-certified project manager), you have a professional responsibility to properly manage the schedule.

Estimate Activity Resources PAGE 160

Process: Estimate Activity Resources

Process Group: Planning

Knowledge Area: Time Management

Once the activities are sequenced, the type and quantity of needed resources are determined. Remember that resources include equipment and materials, as well as people. The project manager must plan and coordinate resources in order to avoid common problems such as a lack of resources and resources being taken away from the project. This process results in defined activity resource requirements and a resource breakdown structure (RBS),⁷ which shows the resources to be used, organized by their category and type. The following exercise looks at the actions involved in the Estimate Activity Resources process.

Exercise Which of the following actions are involved in the Estimate Activity Resources process? Simply put a yes or no in the right-hand column. Then check your answers against the answer table. (Assume the full project management process is being used on a large project as you complete this exercise.)

	Action	Is It Part of Estimate Activity Resources?
1	Review schedule management plan.	
2	Review resource availability.	
3	Review activity cost estimates.	
4	Get one time estimate per activity.	
5	Complete an analysis of the reserves needed on the project.	
6	Create a company calendar identifying working and nonworking days.	
7	Create milestones.	
8	Review the WBS, activity list, and activity attributes.	
9	Review the risk register.	
10	Identify potentially available resources and their skill levels.	

	Action	Is It Part of Estimate Activity Resources?
11	Review historical information about the use of resources on similar projects.	
12	Review organizational policies on resource use.	
13	See how leads and lags affect the time estimate.	
14	Solicit expert judgment on what resources are needed and available.	
15	Analyze alternative equipment or methods to use in completing the work and whether different approaches help to better utilize resources.	
16	Show network dependencies per activity.	
17	Identify areas of the project that cannot be completed internally or would otherwise be more efficiently achieved through outsourcing (make-or-buy decisions).	
18	Crash the project.	
19	Break the activity down further if the activity is too complex to estimate resources (bottom-up estimating).	
20	Quantify resource requirements by activity.	
21	Create a hierarchical image that organizes the planned resources by their category and type (a resource breakdown structure).	
22	Fast track the project.	
23	Develop the schedule.	
24	Develop a plan as to what types of resources will be used.	
25	Update project documents.	

Answer The Estimate Activity Resources process involves:

	Action	Is It Part of Estimate Activity Resources?
1	Review schedule management plan.	Yes
2	Review resource availability.	Yes
3	Review activity cost estimates.	Yes
4	Get one time estimate per activity.	No
5	Complete an analysis of the reserves needed on the project.	No
6	Create a company calendar identifying working and nonworking days.	No
7	Create milestones.	No
8	Review the WBS, activity list, and activity attributes.	Yes

	Action	Is It Part of Estimate Activity Resources?
9	Review the risk register.	Yes
10	Identify potentially available resources and their skill levels.	Yes
11	Review historical information about the use of resources on similar projects.	Yes
12	Review organizational policies on resource use.	Yes
13	See how leads and lags affect the time estimate.	No
14	Solicit expert judgment on what resources are needed and available.	Yes
15	Analyze alternative equipment or methods to use in completing the work and whether different approaches help to better utilize resources.	Yes
16	Show network dependencies per activity.	No
17	Identify areas of the project that cannot be completed internally or would otherwise be more efficiently achieved through outsourcing (make-or-buy decisions).	Yes
18	Crash the project.	No
19	Break the activity down further if the activity is too complex to estimate resources (bottom-up estimating).	Yes
20	Quantify resource requirements by activity.	Yes
21	Create a hierarchical image that organizes the planned resources by their category and type (a resource breakdown structure).	Yes
22	Fast track the project.	No
23	Develop the schedule.	No
24	Develop a plan as to what types of resources will be used.	Yes
25	Update project documents.	Yes

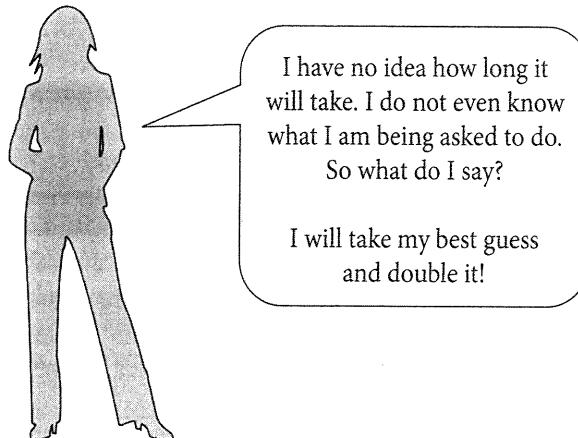
Estimate Activity Durations PAGE 165
Process: Estimate Activity Durations

Process Group: Planning

Knowledge Area: Time Management

Once the activities are defined and sequenced and the type and quantity of resources required for each activity are identified, the next step is to estimate how much time each activity will take. This is the Estimate Activity Durations process. The estimators should be those who will be doing the work, when possible; for large projects, however, the estimators are more often the members of the project 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 activity list and attributes, activity resource requirements, resource calendars, the resource breakdown structure (created in the previous process), organizational process assets (historical data and lessons learned about activity durations, past project calendars, and the defined scheduling methodology), and enterprise environmental factors (company culture and existing systems that the project will have to deal with or can make use of, such as estimating software and productivity metrics).

The risk register may include identified risks, assumptions, and/or constraints that should be reflected in the estimates. Now let's think about estimating in your real world 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. Shouldn't the project manager be providing that information? In cases where the estimator has many unknowns and the information is not available to clarify the unknowns, 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 cost. 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.

In a properly managed project, the estimators have a WBS and may even have helped create it. They also have a description for 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, and 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 Management chapter. You need to understand the difference between padding and creating reserves and 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.

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 be the ones creating the activity estimates. They may use techniques such as analogous estimating, parametric estimating, three-point estimating, group decision-making techniques (such as the Delphi technique), or reserve analysis, all of which we will describe next. But first 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 Management chapter).
- Make sure assumptions made during estimating are recorded for later review.

Now let's look at several different 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.

One-point estimating can have the following negative effects on the project:

- It can force people into padding their estimates.
- It hides important information about risks and uncertainties from the project manager that the project manager needs to better plan and control the project.
- It can result in a schedule that no one believes in, thus decreasing buy-in to the project management process.
- When a person estimates 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.
- It often results in the estimators working against the project manager to protect themselves, rather than with the project manager to help all involved in the project.

NOTE: You will frequently see a one-point estimate per activity used on the exam, as shown in the exercises later in this chapter. Although one-point estimating is often not the best method to use, it provides an easier way to improve your understanding of how to find critical paths and draw network diagrams. Using one-point estimates also allows for quick calculation on the exam and proof that you understand concepts such as the critical path.

Analogous Estimating (Top-down)⁸ PAGE 169

Applicable to both time and cost estimating, analogous estimating uses expert judgment and historical information to predict the future. It can be done at the project level (e.g., the last five projects similar to this one each took eight months, so this one should as well). Management or the sponsor might use analogous estimating to create the overall project estimate given to the project manager as the project is chartered. Analogous estimating can also be applied at the activity level, if the activity has been done on previous projects and there is substantial historical data to support the accuracy of such an estimate (e.g., 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 past history.

Parametric Estimating PAGE 170

Parametric estimating looks at the relationships between variables on an activity to calculate time or cost estimates. The data can come from historical records from previous projects, industry requirements, standard metrics, or other sources. For example, when estimating activity durations, the estimator may use measures like 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.)

There are two ways an estimator might create parametric estimates:

- **Regression analysis (scatter diagram)⁹** This diagram tracks two variables to see if they are related and creates a mathematical formula to use in future parametric estimating.
- **Learning curve** Example: The 100th room painted will take less time than the first room because of improved efficiency.

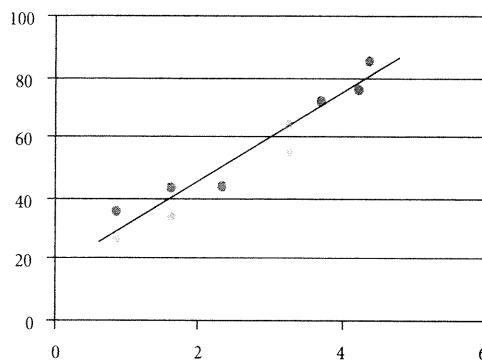


Figure 6.5: Regression Analysis (Scatter Diagram)

Heuristics¹⁰ A heuristic means a generally accepted rule, or best practice. An example of a heuristic is the 80/20 rule. This rule, applied to quality, suggests that 80 percent of quality problems are caused by 20 percent of potential sources of problems. 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 Estimating¹¹ PAGE 170

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 could go wrong (threats) can help estimators determine an expected range for each activity, and if they state this range using three time (or cost) estimates, the project manager can better understand the potential variation of the activity estimates and the overall project estimate. 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 the uncertainty of estimating and the risks associated with the activities.

Ultimately three-point estimates can be used to calculate a risk-based expected duration estimate by taking either a simple average or a weighted average of the three estimates. See the following information and formulas.

Triangular Distribution (Simple Average) A simple average of the three-point estimates can be done 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 Distribution¹² (Weighted Average) 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. The formula for beta distribution is $(P + 4M + O)/6$. Since the most likely estimate is multiplied by 4, it weights the average toward the most likely estimate. This has the advantage of taking into consideration 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 likely to occur because risk response plans have been developed to deal with identified opportunities and threats that have been factored into the pessimistic and optimistic estimates.



For the exam, it's important to know the formula for both triangular and beta distribution and understand that if you are being asked to calculate the activity (or cost) duration, you will need to read the situation carefully to determine which formula to use. Look for language like simple or straight (triangular), or PERT or weighted (beta) that might help you choose the correct formula.

You may be asked to perform calculations using the formulas or to analyze information to determine how best to deal with a situation. The exercises that follow can help you prepare for three-point estimating questions on the exam. But first, here are the formulas again, plus a new one for standard deviation:



You must MEMORIZE these formulas and remember that they can be used for both time and cost estimates.

Expected Activity Duration (Triangular Distribution) $\frac{P+M+O}{3}$	Expected Activity Duration (Beta Distribution) $\frac{P+4M+O}{6}$	Beta Activity Standard Deviation $\frac{P-O}{6}$
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Legend: P = Pessimistic, M = Most Likely, O = Optimistic

Figure 6.6: Formulas for Three-Point Estimating and Activity Standard Deviation

Activity standard deviation¹⁴ is the possible range for the estimate. For example, an activity estimate of 30 hours that has a standard deviation of +/- 2 could end up taking between 28 hours and 32 hours. We've listed the formula for beta activity standard deviation here. Although there is a standard deviation formula for triangular distribution, it's complicated and is unlikely to be on the exam. What you need to remember for the exam is that the greater the range created by the standard deviation calculation, the greater the risk.

The exam may ask you to calculate a range for an individual activity estimate using weighted (beta) averaging. To do this, 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. The second exercise in this section will give you a chance to practice these calculations. (Be aware that it is possible to calculate a range for individual activity estimates using simple [triangular] averaging, which would involve triangular EAD and the standard deviation formula for triangular distribution. But again, since the exam is unlikely to require you to perform this calculation, we haven't included it in our discussion.)

Exercise Calculate the expected activity duration using triangular distribution. It is best to calculate to three decimal places and round to two decimal places when you are ready to check your answers on the exam.

Activity	P	M	O	Expected Activity Duration (Triangular Distribution)
A	47	27	14	
B	89	60	41	
C	48	44	39	
D	42	37	29	

Answer

Activity	P	M	O	Expected Activity Duration (Triangular Distribution)
A	47	27	14	29.333
B	89	60	41	63.333
C	48	44	39	43.666
D	42	37	29	36

Exercise Complete the chart using the appropriate formulas. All estimates are in hours.

Activity	P	M	O	Expected Activity Duration (Beta Distribution)	Beta Activity Standard Deviation	Range of the Estimate
A	47	27	14			
B	89	60	41			
C	48	44	39			
D	42	37	29			

Answer

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

Please compare the answers in the “Expected Activity Duration (Beta Distribution)” column above to the answers in the “Expected Activity Duration (Triangular Distribution)” column from the previous exercise. Notice that the results are not hugely different. However, if you do not select the right formula for a question that requires the calculation of expected activity duration, you could end up picking the wrong answer.

Please note that 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.

Note that the formulas we've been discussing relate to activities, rather than the overall project, and that the exam concentrates on using three-point estimating to find ranges for activity duration and cost estimates. But as a project manager, you also use this information to calculate the overall project estimate and the project standard deviation to manage a project successfully. You need to consider how these ranges might affect the estimate of the overall project duration and cost. You can then 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 know the concept of three-point time (or cost) weighted estimates per activity as well as how to calculate simple and weighted average distributions. You may also see a beta or PERT total project duration used in questions not requiring calculation (e.g., the project duration is 35 months plus or minus 3 months) and need to evaluate the situation 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.

So why do project managers need to understand expected durations, range estimates, and standard deviations? The main purpose is to use these concepts to better control projects. These calculations help you know the potential variances on your project and determine appropriate courses of action.

For example, you can use estimate ranges and standard deviation to assess risk. Looking back at the answers for the second exercise 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 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 and wrong to 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 Management chapter for information about different types of contracts.)

Make sure you have a general understanding of these estimating concepts. If you are still struggling with this topic, review this section again.

Group 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. Examples of group decision-making techniques include brainstorming, the nominal group technique, and the Delphi technique, all of which were described in the Scope Management chapter of this book.

Reserve Analysis

We've discussed padding and how detrimental this practice is, and how three-point estimates for an activity (or a project) will have a wider range the more risk they have. Now let's connect the topics of estimating and risk management. Estimating will help identify more risks, and completing the risk management process will reduce the range of time and cost estimates and make them more accurate by addressing those risks. Risk management saves the project time and money!

Project managers have a professional responsibility to establish a reserve to accommodate the risks that remain in the project after the risk management planning processes have been 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 the Risk Management chapter describes, there can be two types of reserves added to the project schedule: contingency reserves (also called time reserves or buffers) and management reserves.¹⁵ The contingency reserves are for the identified schedule risks remaining after the Plan Risk Responses process. These reserves are included in the project schedule baseline. The management reserves are additional funds set aside to cover unforeseen risks that would impact the project's ability to meet the schedule. The management time reserves are not part of the schedule baseline. These reserves may not be applied at the project manager's discretion, but require obtaining approval of a formal change request. The Risk Management chapter explains how these reserves are calculated. You should understand for the exam 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 what additional time or funds the project may need, whereas with padding, team members arbitrarily determine how much of a pad they want to attach to their estimates.

When the Estimate Activity Durations process is completed, you will of course have estimates, including reserves. But also remember that you may update or change parts of the project documents as a result of this process.

Develop Schedule PAGE 172

PAGE 172

Process: Develop Schedule

Process Group: Planning

Knowledge Area: Time Management

Once a network diagram and activity duration estimates are completed, it is time to put the information into a schedule tool to create a schedule model.¹⁶ The schedule model consists of all the project data that will be used to calculate the schedule, such as the activities, dependencies, leads and lags, etc. The project schedule is the output of the schedule model—this refers to the final, printed dates that make up the schedule that becomes the baseline and part of the project management plan. The schedule model provides a vehicle to show various presentations of the schedule.

The schedule is calendar-based, approved, and realistic as it relates to all of the other activities and resources that are needed to complete the work of the project. Think about what is involved in creating a schedule and complete the following exercises.

Exercise Let's start at the beginning. What do you need before you can develop a schedule for your project?

Answer In order to develop a schedule, you need to have:

- Historical records of previous, similar projects (if available)
 - An understanding of the work required on the project, including the project assumptions, milestones, and constraints (project scope statement)
 - Defined activities (activity list and attributes)
 - The order of how the work will be done (network diagram)
 - An estimate of the duration of each activity (activity duration estimates)
 - An estimate of the resources needed (activity resource requirements)
 - 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 staff assignments)
 - A list of risks that could impact the schedule

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 finalized schedule?

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.
 - Meet with managers to negotiate for resources.
 - 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 (e.g., change the WBS because of planned risk responses).
 - Input the data into a scheduling tool (project management software) and perform calculations to determine the optimum schedule.
 - Simulate the project using Monte Carlo analysis 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 might have estimated an activity, but they should also look at 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 schedule is a major output of the time management process. Think carefully about all that is involved in creating the project schedule before you continue reading. Then review the list of actions for the Develop Project Management Plan process in the Integration Management chapter. Many of those actions are also performed as part of the Develop Schedule process.

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). A schedule is one of the outputs of project management that virtually every project manager has real-world experience using. However, the Develop Schedule process is a source of problems on the exam for many project managers. Read this entire section carefully. The exam will test you as an expert in handling schedule development during project planning and whenever there are changes to the project.

Schedule Network Analysis Once you have an initial schedule model, you begin schedule network analysis to create the final schedule. This analysis may use one or more of the following techniques:

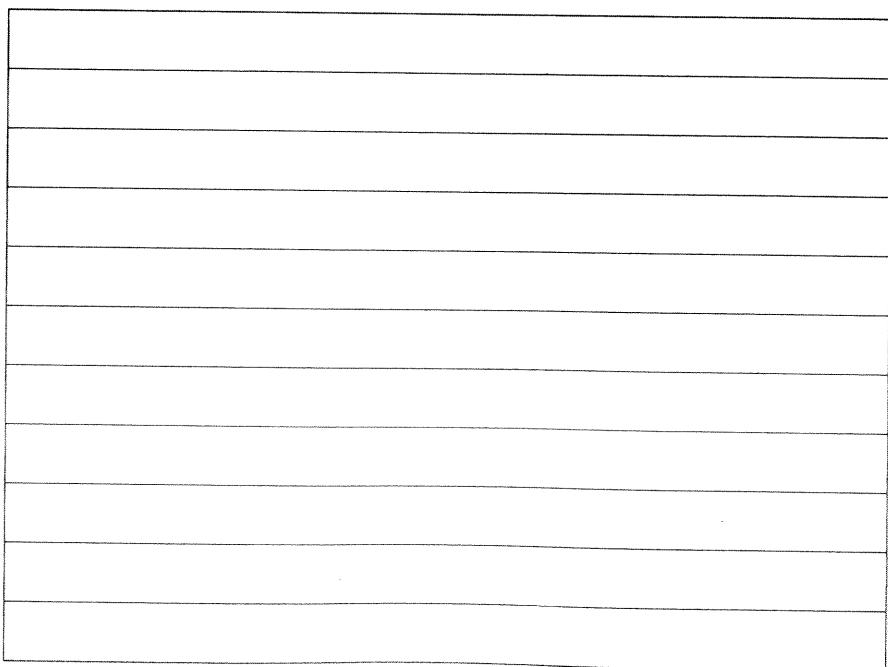
- Critical path method
- Schedule compression
- Modeling
- Resource optimization
- Critical chain method

Critical Path Method¹⁷

The critical path method involves determining the longest path through the network diagram (the critical path), 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 determines the shortest time it could take to complete the project.

Exercise Test yourself! How does the critical path help you as a project manager?



Answer The critical path:

- Helps prove how long the project will take
- Helps you determine where to focus your project management efforts
- Helps determine if an issue needs immediate attention
- Provides a vehicle to compress the schedule during project planning and whenever there are changes
- Shows which activities have float and can therefore be delayed without delaying 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. People will commonly not identify all of the paths or not calculate the duration correctly and get questions wrong on the exam.

Near-Critical Path¹⁸ In addition to the critical path, you should be familiar with the concept of a near-critical path. This path is close 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 (Slack)¹⁹ You should understand float and be able to calculate it manually for the exam. Please note that the terms “float” and “slack” mean the same thing. You may see either or both on the exam. The three types of float to know for the exam are:

- **Total float (slack)** 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 (slack)** This 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 (slack)** Project 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 dictated dates can result in negative float.

Float is an asset on a project. If you know where you have float, you can use it to help organize and manage the project. Do you do this in your real world? If not, study this section carefully.

How is float an asset? Once you know the critical path and any near-critical paths, you can use float as a way to focus your management on 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 him (assuming he has the skill set) to work on the activity with the most float. This gives you some level of security; even if his activity takes longer, the project is less likely to be delayed.

Knowing 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: $\text{Float} = \text{Late Start (LS)} - \text{Early Start (ES)}$, or $\text{Float} = \text{Late Finish (LF)} - \text{Early Finish (EF)}$. Either formula gets you the same answer. Do you want to remember them without any further study? Just know the following:



"There is a start formula and a finish formula, and we always begin late." Notice that the formula uses either two starts or two finishes and each begins with late.

Start Formula	Finish Formula
$\text{Float} = \text{LS} - \text{ES}$	$\text{Float} = \text{LF} - \text{EF}$

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 subtract $30 - 18$ to get 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 6.7 as an example:

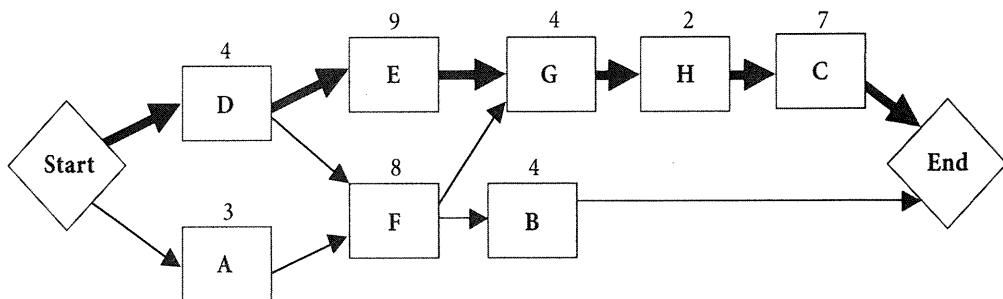


Figure 6.7: Critical Path Method

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.

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 6.8. This example uses zero as the early start for the first activities.

You can also access free tricks and tools, including an article about calculating the forward and backward passes in a network diagram (starting with zero or one), at www.rmcproject.com.

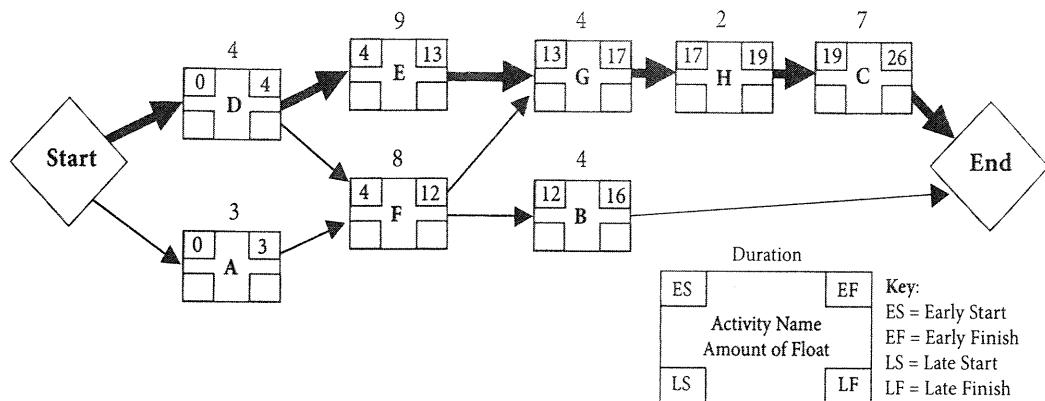


Figure 6.8: Forward Pass through Network Diagram

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 6.8). 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 6.8). 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 early finish of the last activity or activities in the network. See figure 6.9 for the late start and late finish data.

If you want additional practice, there are more questions on float and critical path in RMC's PM FASTrack® exam simulation software.

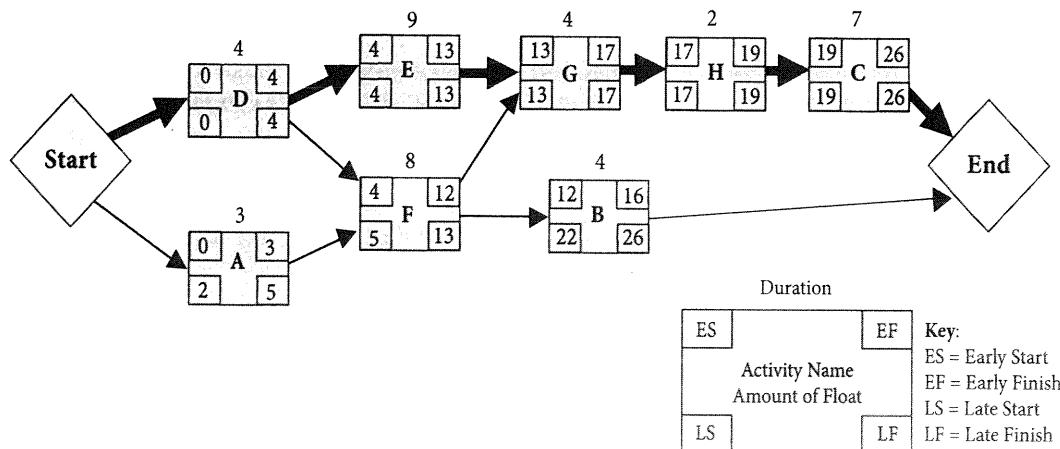


Figure 6.9: Backward Pass through Network Diagram

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).

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	Finish Formula
$\text{Float} = \text{LS} - \text{ES}$	$\text{Float} = \text{LF} - \text{EF}$

The activities with zero float are on the critical path (identified by the bold arrows). See figure 6.10 for the float of each activity:

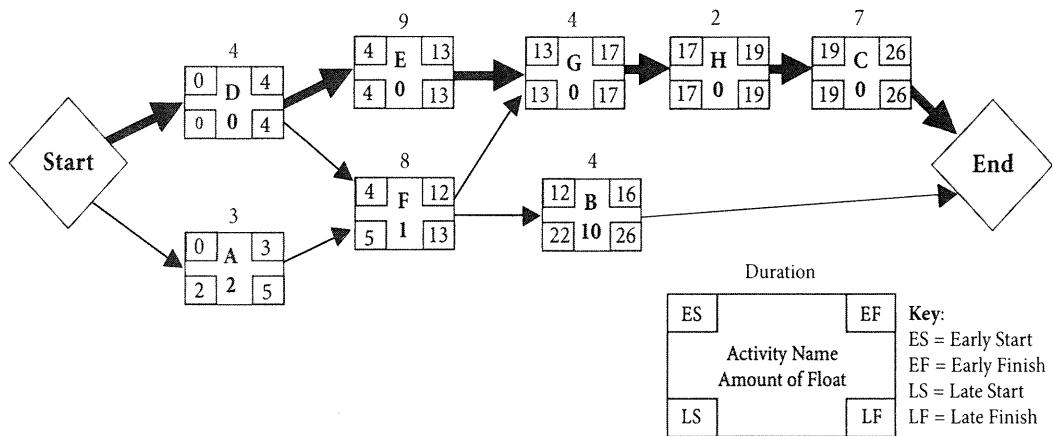


Figure 6.10: Float of Activities on Network Diagram

The next few exercises should help you better understand these concepts. As you do the exercises, think about how knowing float helps you in managing your real-world projects.

Exam questions may be substantially similar to the following exercises, or they may be more situational and wordy, without requiring you to draw a network diagram. Be prepared for both types.

Exercise Test yourself. Draw a network diagram, and answer the following questions.

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?

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.

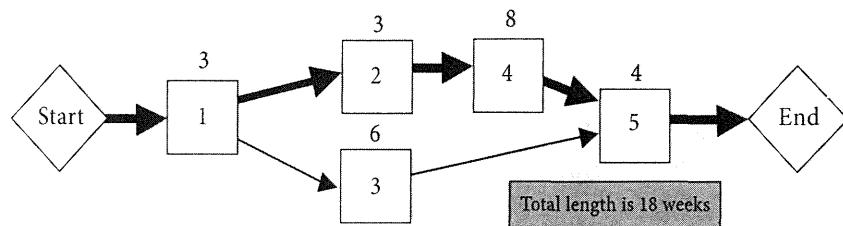
7. Based on the information in question 6, how much longer will the project take?

Time Management S I X

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.

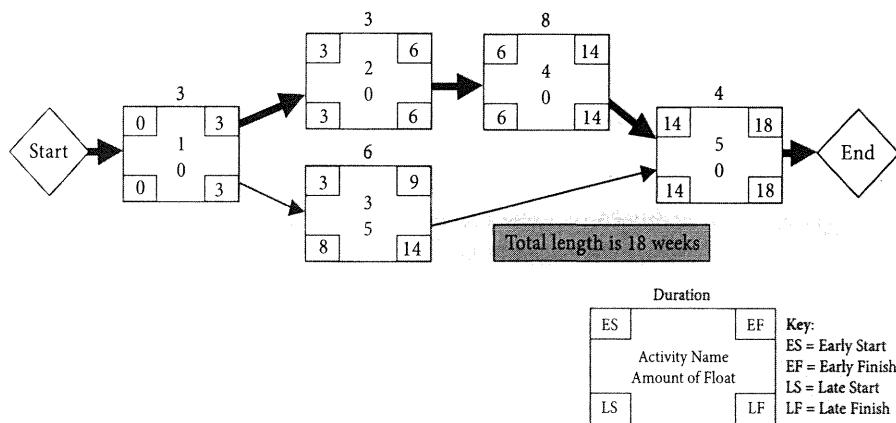
- The length of the critical path is 18. There are two paths here:

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 previous 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.

- The float is 5 weeks, per the following diagram. This diagram shows how to calculate float using the forward and backward pass.

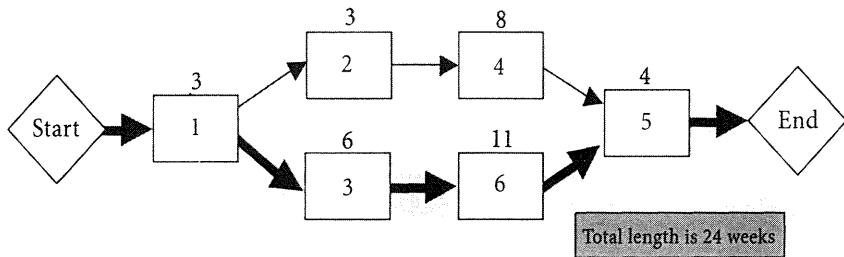


You can use either float formula to compute float. Late Finish – Early Finish = 14 – 9 = 5, or Late Start – Early Start = 8 – 3 = 5.

- The float is zero; it is on the critical path. An activity on the critical path generally has no float.
- The 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.
- It 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 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.



Exercise Use the data in this table to answer the questions that follow:

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?

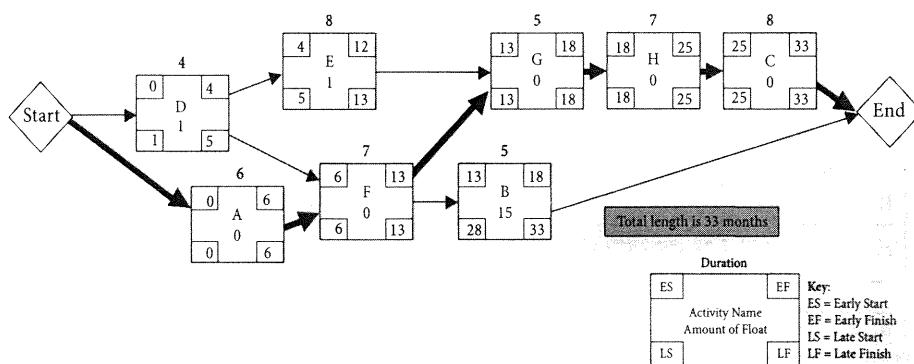
5. To shorten the length of the project, the sponsor has offered to remove the work of activity E from the project, making activity D the predecessor to activities G and F. What will be the effect?

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 is 15 months, per the following diagram.



3. The float 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 $13 - 12 = 1$.

4. The float is one month; just look at the network diagram.

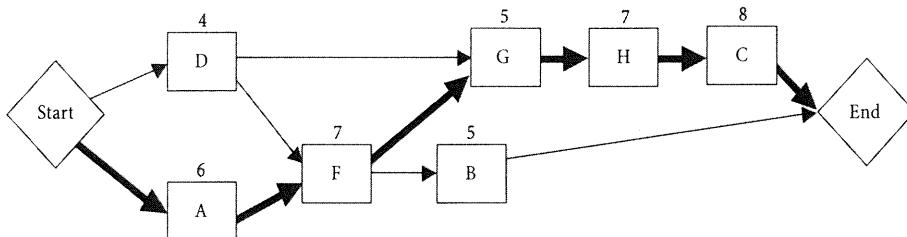
Now let's look at using a calculation to get the float for activity D. The project must be completed by the end of month 33. Activity D must be completed before activities E, F, G, H, C, and B can start. Looking backward through the dependencies, the late finish is $33 - 8 - 7 - 5$, but then we run into 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. There is 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
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, etc.:

- **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; it 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 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 actions 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 you encounter multiple questions on the exam that require you to draw a network diagram, you may be able to reuse the same network diagram to answer more than one question. Look to see if this is true before you spend time redrawing the diagram.

Schedule Compression²⁰ PAGE 181

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 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 like schedule compression.

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. This technique is also used during integrated change control to look at the impacts that changes to other parts of the project (i.e., cost, scope, risk, resources, quality, etc.) have on the schedule. The objective is to compress the schedule without changing project scope.

Fast Tracking This technique involves taking critical path activities that were originally planned in a series and doing them instead in parallel for some or all of their duration (see figure 6.11). Fast tracking often results in rework, usually increases risk, and requires more attention to communication.

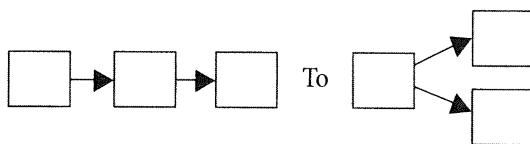


Figure 6.11: Fast Tracking

For example, which activity in figure 6.12 would you fast track to shorten the project length?

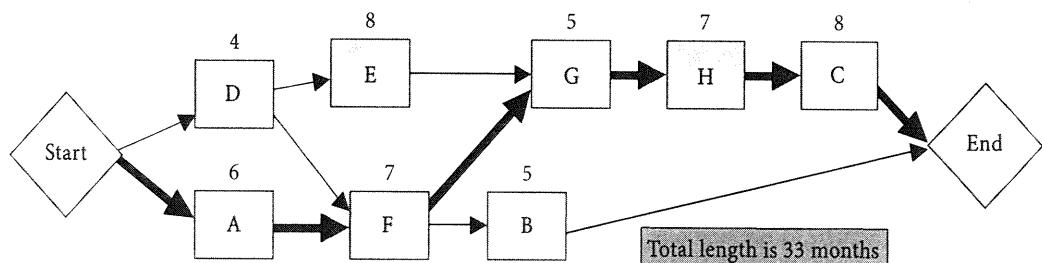


Figure 6.12: Which Activity Would You Fast Track?

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.

Crashing²¹ 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 6.12, 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.

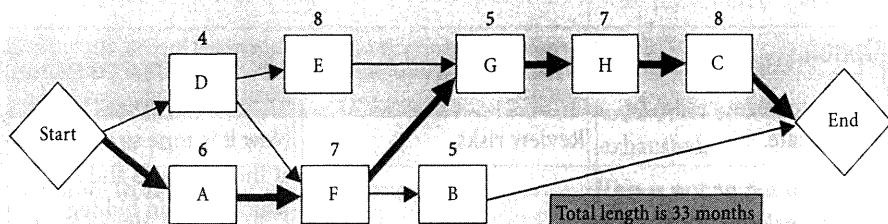
If you have negative project float (meaning the estimated completion date is after the desired date), would your first choice be to tell the customer the date cannot be met and to ask for more time? No; the first choice would be to analyze what could be done about the negative float by compressing the 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 operation of the project and to make adjustments when changes occur. You should expect this to be reflected on the exam by the number of questions on network diagrams, calculations, and "What do you do in this situation?" type of questions.

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 try an exercise.

Exercise During project planning, the project duration is estimated to be 33 months. However, you have been given a completion date of 30 months. Using the following network diagram, identify options for shortening the schedule to 30 months.

This is a general exercise with little detail. Make any assumptions you need to make in order to come up with as many options as possible.



Option	How to Achieve It	Explanation (Including Assumptions Made)

Time Management

SIX

Option	How to Achieve It	Explanation (Including Assumptions Made)

Answer Did this situation make sense? If it did, you are in good shape. If not, you should study a little more. Notice how this effort allows the project manager to proactively deal with the reality of the project and take action to be sure the project completion date can be met. The following are possible options for shortening the schedule.

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.

Option	How to Achieve It	Explanation (Including Assumptions Made)
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.	Though not the first choice, as it likely will affect the customer, reducing scope should be considered an option.
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 (i.e., activities G, H, or C).	Compress the schedule compression.	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 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 to 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? If you have not realized overtime should be one of the last choices, you have a large gap in your knowledge. Most organizations are working at close to 100 percent capacity. Your project working 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 first and possibly 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!

Let's look at these concepts again with a few more exercises.

Exercise What are the impacts of the schedule-shortening options listed in the following table?

Option	General Impacts to the Project
Fast track	
Crash	
Reduce scope	
Cut quality	

Answer

Option	General Impacts to the Project
Fast track	<ul style="list-style-type: none">• Always adds risk• May add management time for the project manager
Crash	<ul style="list-style-type: none">• Always adds cost• May add management time for the project manager• May add risk
Reduce scope	<ul style="list-style-type: none">• May save cost, resources, and time• May negatively impact customer satisfaction
Cut quality	<ul style="list-style-type: none">• May save cost, resources, and time• May increase risk• Requires good metrics• May negatively impact customer satisfaction

Exercise Here is another chance to test yourself on schedule compression.

Activity	Original Duration (in Months)	Crash Duration (in Months)	Time Savings	Original Cost (in Dollars)	Crash Cost (in Dollars)	Extra Cost (in 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

- Imagine that this project has a project float of -3 months. Which activity or activities presented above would you crash to save 3 months on the project, assuming that the activities listed above represent critical path activities?

- How much would it cost to crash this project?

Answer

- The options to save 3 months are:

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 there is nothing in the question to eliminate it, so the choice of 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.

- 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 distracter; 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.

Exercise

Consider the following:

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, inform management of the impact of the change.

The exam will ask many such questions requiring you to know that a project manager needs to analyze first and then let management, the sponsor, the customer, or other parties know the impact of their requests (see the four-step process for handling changes in the Integration Management chapter). A project manager does NOT just say yes! Instead, after analyzing the change for its impact to all areas of the project (cost, risk, resources, etc.), he or she could say something like, “Yes, I would be happy to make the change, BUT the project will be delayed two weeks, I will need two more resources, or the project will cost \$25,000 more.”



WARNING: 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.

Modeling PAGE 180

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, or model, the effect of these changes is through a Monte Carlo analysis.

Monte Carlo Analysis²² 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
- 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 6.13).

Monte Carlo analysis is also used as a risk management tool to quantitatively analyze risks (see the Risk Management chapter).

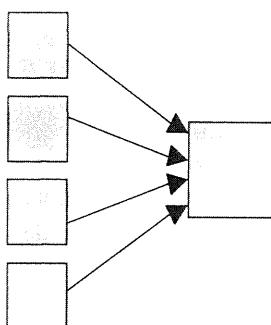


Figure 6.13: Path Convergence

Resource Optimization²³ PAGE 179

Resource optimization refers to finding ways to adjust the use of resources. There are two techniques that can achieve this outcome.

Resource Leveling²⁴ Resource leveling is used to produce a resource-limited schedule. Leveling lengthens the schedule and increases cost in order to deal with a limited amount 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 an acceptable use of resources. Leveling could also be used if you did not have 15 resources available and preferred to lengthen the project (which would be a result of leveling) instead of hiring more resources.

Resource Smoothing²⁵ 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.

Critical Chain Method²⁶ PAGE 178

The critical chain method is another way to develop a bought-into, approved, realistic, and formal schedule. Unlike the other schedule network analysis techniques, it takes into account both activity and resource dependencies. There are many variations of this method, so be careful here.

The critical chain method uses a network diagram and critical path to develop a schedule by assigning each activity to occur as late as possible to still meet the end date. You add resource dependencies to the schedule, and then calculate the critical chain. Starting at the end date, you build buffers for resource limitations and risks into the chain at critical milestones (think of this as your time reserves from risk response planning). These reserves, spread throughout the project, provide cushions for delays in the scheduled activities. You manage these buffers so that you meet each individual milestone date and thus the project milestone completion date as well.

For more exercises that involve network diagrams, visit www.rmcproject.com/extras or use RMC's PM FASTrack® exam simulation software.

Note that buffers are not the same as padding. They are planned and inserted to minimize known risks.

Do not get carried away with studying this technique; it should not be mentioned on the exam more than three times. And remember, this does not necessarily mean there are three questions about it—it could just be an incorrect choice in a question.

Project Schedule PAGE 182 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 and becomes part of the project management plan.

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 Charts²⁷

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 may include “requirements are complete” or “design is finished” and are part of the inputs to the Sequence Activities process. Milestone charts are good tools for reporting to management and to the customer.

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 6.14: Milestone Chart

Bar Charts (also called Gantt Charts)²⁸

Bar charts are weak planning tools, but they are effective for progress reporting and control. They are not project management plans. Figure 6.15 shows a sample bar chart:

ID	Activity Name	Duration	Start	Finish			September				October
					8/18	8/25	9/1	9/8	9/15	9/22	9/29
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 9/9							
5	E	8 days	Fri 8/30	Tue 9/10							
6	G	5 days	Wed 9/12	Wed 9/17							
7	B	5 days	Wed 9/12	Wed 9/17							
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 6.15: Bar Chart

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 diagram 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.

Exercise Test yourself! Answer the following questions in the spaces provided.

Under what circumstances would you use a network diagram instead of a bar chart?	
Under what circumstances would you use a milestone chart instead of a bar chart?	
Under what circumstances would you use a bar chart instead of a network diagram?	

Answer See the answers in the following table.

Under what circumstances would you use a network diagram instead of a bar chart?	To show interdependencies between activities
Under what circumstances would you use a milestone chart instead of a bar chart?	To report to senior management
Under what circumstances would you use a bar chart instead of a network diagram?	To track progress To report to the team

Schedule Baseline PAGE 181 The schedule baseline is the version of the schedule model used to manage the project and that 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 called project float.

The process of creating a final and realistic schedule could cause changes to project documents, including the activity resource requirements and activity attributes, as well as the risk register.

Control Schedule PAGE 185

Process: Control Schedule
Process Group: Monitoring & Controlling
Knowledge Area: Time Management

Controlling the project was discussed in the Project Management Processes chapter, but we will spend a little more time talking about it here. Control means measure, which means 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 now in your real world? If not, pay particular attention to the concept of control 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 questions state otherwise. On properly managed projects, a project manager does not have to spend all of his or her time dealing with problems, because most of those problems were prevented through risk management. Project managers are measuring, measuring, measuring against the plan and taking action as needed to control the project.

The project (and the project manager) will be considered a failure if the schedule baseline—the end date agreed to in planning and adjusted for approved changes—is not met. So control 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 effort.

Schedule control also means looking for the things that are causing changes and influencing the sources 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 (the schedule baseline), 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 higher-ups 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 someone 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 someone who is 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 involved in controlling the schedule:

- Review current work performance data.
- 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 Management chapter).
- Perform trend analysis of project performance.
- Adjust future parts of the project to deal with delays, rather than asking for a time extension.
- Consider optimizing resources.
- Continue to use modeling techniques to better optimize the schedule.
- Adjust metrics that are not giving the project manager the information needed to properly manage the project.
- Adjust progress reports and reporting as needed to capture the information necessary to control and manage the project (see the Progress Reporting discussion in the Cost Management 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 such as agile include:

- Comparing work actually completed to what was predicted to be complete within a given work cycle duration
- Holding lessons learned sessions 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. Realize that the project was estimated while in planning and, although you might have done your best to understand the project well enough to estimate it accurately, it is extremely difficult to estimate well. Therefore, it is standard practice to reestimate the entire remaining part of the project at least once during the life of the project to make sure you can still meet the end date, budget, and other project objectives 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, changes to the schedule baseline or schedule management plan, and changes to any other part of the project. 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 Management chapter and realize the exam assumes that you perform it as part of your basic project management activities.

Practice Exam

1. To control the schedule, a project manager is reanalyzing the project to predict project duration. She does 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 dependency requiring that design be completed before manufacturing can start is an example of a(n):
 - A. Discretionary dependency.
 - B. External dependency.
 - C. Mandatory dependency.
 - D. Scope dependency.
3. 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. If the optimistic estimate for an activity is 12 days, and the pessimistic estimate is 18 days, what is the standard deviation of this activity?
 - A. 1
 - B. 1.3
 - C. 6
 - D. 3
5. A heuristic is BEST described as a:
 - A. Control tool.
 - B. Scheduling method.
 - C. Planning tool.
 - D. Generally accepted rule.
6. 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.

7. Which of the following is the BEST project management tool to use to determine the longest time the project will take?
 - A. Work breakdown structure
 - B. Network diagram
 - C. Bar chart
 - D. Project charter
8. 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.
9. What is the duration of a milestone?
 - 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. The float of an activity is determined by:
 - A. Performing a Monte Carlo analysis.
 - B. Determining the waiting time between activities.
 - C. Determining lag.
 - D. Determining the length of time the activity can be delayed without delaying the critical path.
12. A project has three critical paths. Which of the following BEST describes how this affects 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. 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.

Time Management

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14. When is a milestone chart used instead of a bar chart?
 - A. Project planning
 - B. Reporting to team members
 - C. Reporting to management
 - D. Risk analysis
15. 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.
16. 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 boss.
 - 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. 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. Boss's opinion of which activities to crash and in which order.
 - D. Project life cycle phase in which the activity is due to occur.
18. Which of the following processes includes asking team members about the time estimates for their activities and reaching agreement on the calendar date for each activity?
 - A. Sequence Activities
 - B. Develop Schedule
 - C. Define Scope
 - D. Develop Project Charter
19. A project manager is in the middle of executing a very 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 his recommended option.

20. During project planning, you estimate the time needed for each activity and then add up the estimates to create the project estimate. You commit to completing the project by this date. What is wrong with this scenario?
- The team did not create the estimate, and estimating takes too long using that method.
 - The team did not create the estimate, and a network diagram was not used.
 - The estimate is too long and should be created by management.
 - The project estimate should be the same as the customer's required completion date.
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, 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?
- Precedence diagramming method
 - Arrow diagramming method
 - Critical path method
 - Operational diagramming method
22. 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?
- Mandatory dependency
 - Discretionary dependency
 - External dependency
 - Heuristic
23. 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

- Activity B
- Activity D
- Activity H
- Activity C

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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. Change requests
 - B. Schedule change control system
 - C. Recommended corrective actions
 - 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. A project manager is using weighted average duration estimates to perform schedule network analysis. Which type of mathematical analysis is being used?
- A. Critical path method
 - B. Beta distribution
 - C. Monte Carlo
 - D. Resource leveling
28. 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.
29. A new product development project has four levels in the work breakdown structure and has been sequenced using the precedence diagramming method. The activity duration estimates have been received. What should be done NEXT?
- A. Create an activity list.
 - B. Begin the work breakdown structure.
 - C. Finalize the schedule.
 - D. Compress the schedule.

30. 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 time management activity should you do NEXT?
- A. Control Schedule.
 - B. Estimate Activity Resources.
 - C. Analogously estimate the schedule.
 - D. Gain approval.
31. A team member from research and development tells you that her work is too creative to provide you with a fixed single estimate for the activity. You both decide to use the average labor hours to develop a prototype (from past projects). This is an example of which of the following?
- A. Parametric estimating
 - B. Three-point estimating
 - C. Analogous estimating
 - D. Monte Carlo analysis
32. An activity 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. The activity:
- A. Is on the critical path.
 - B. Has a lag.
 - C. Is progressing well.
 - D. Is not on the critical path.
33. 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.
34. A project manager for a small construction company has a project that was budgeted for US \$130,000 over a six-week period. According to her schedule, the project should have cost US \$60,000 to date. However, it has cost US \$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

Time Management SIX

35. 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
36. Rearranging resources so that a constant number of resources is used each month is called:
 - A. Crashing.
 - B. Floating.
 - C. Leveling.
 - D. Fast tracking.
37. Which of the following is a benefit of an analogous project estimate?
 - A. It will be closer to what the work will actually require.
 - B. It is based on a detailed understanding of what the work requires.
 - C. It gives the project team an understanding of management's expectations.
 - D. It helps the project manager determine if the project will meet the schedule.
38. During project executing, a large number of changes are made to the project. The project manager should:
 - A. Wait until all changes are known and print out a new schedule.
 - B. Make approved changes as needed, but retain the schedule baseline.
 - C. Make only the changes approved by management.
 - D. Talk to management before any changes are made.

Answers

1. Answer A

Explanation There are only two choices related to scheduling: critical path method and precedence diagramming. Precedence diagramming, however, 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 word in the question is “requiring.” 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 (or Gantt 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 A

Explanation The beta standard deviation is computed by $(P - O)/6$. Therefore, the answer is $(18 - 12)/6 = 6/6 = 1$.

5. Answer D

Explanation A heuristic is a generally accepted rule. Examples are cost per line of code, cost per square foot of floor space, etc.

6. 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.

7. 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 takes the activities from the activity list and adds dependencies. 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.

8. 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.

9. Answer C

Explanation A milestone represents the completion of a series of activities or work packages. Therefore, it takes no time of its own.

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 D**

Explanation The total float of an activity is the length of time the activity can be delayed without delaying the critical path.

12. **Answer B**

Explanation Though having three critical paths COULD require more people or cost more, the answer that is definitely and 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 Both types of charts are used in project planning. Team members need to see details and 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 scare 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.

15. **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 the fast tracking option, leaving crashing the project as the best answer.

16. **Answer C**

Explanation This is another question that asks about problem solving. Neither telling the boss nor waiting to see the status next month tries to solve 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 boss's input, but you will definitely need to include an analysis of risk.

18. **Answer B**

Explanation By the time this process is taking place, Develop Project Charter, Define Scope, and Sequence Activities would be completed. The process defined in the question is Develop Schedule.

19. Answer D

Explanation This question again 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 selected first. Determining options for schedule compression would have the least negative effect on the project.

20. 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.

21. Answer A

Explanation The question implies a finish-to-finish relationship between activities. The arrow diagramming method 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.

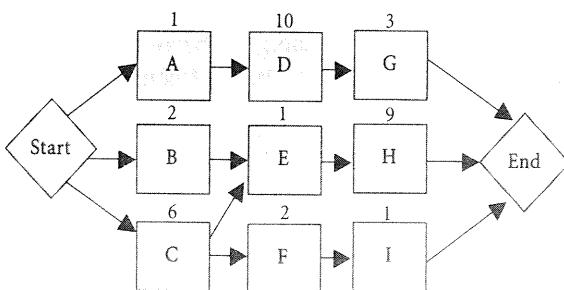
22. Answer B

Explanation The situation is neither mandatory nor driven by an external source. A heuristic is a general rule that can be used consistently. This situation is a unique occurrence for which a preferred method is being suggested. Therefore, this is a discretionary dependency.

23. 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

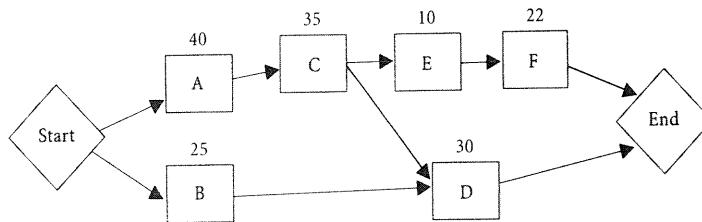


The critical path is 16 (Start, C, E, H, End). Many people immediately look for the longest duration activity on the project to cut. Here activity D is the longest, at 10 weeks. However, that activity is not on the critical path, and cutting it would not shorten the project's duration. You must change 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.

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.

27. **Answer B**

Explanation Beta distribution uses weighted averages to compute activity durations.

28. **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.

29. **Answer D**

Explanation The question is really asking, “What is done after the Estimate Activity Durations process?” The work breakdown structure and activity list are done before Estimate Activity Durations. The schedule is not finalized until after schedule compression. Therefore compressing the schedule is done next.

30. Answer D

Explanation Notice how this question and the previous one seem very similar. This is intended to prepare you for similar questions on the exam. Estimating activity resources and analogously estimating the schedule should have already been completed. The situation described is within the Develop Schedule process of time management. Control Schedule is the next time 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.

31. Answer A

Explanation Monte Carlo analysis is a modeling, or simulation, technique. Three-point estimating uses three time estimates per activity. One could use data from past projects to come up with the estimate (analogous estimating), but the best answer is parametric estimating because past history is being used to calculate an estimate.

32. 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.

33. 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 since 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.

34. 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.

35. 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.

36. Answer C

Explanation The key to this question is the phrase “constant number used each month.” Only leveling has such an effect on the schedule.

37. Answer C

Explanation Remember that analogous project estimates are considered to be top-down, high-level estimates. Therefore, they are not based on a detailed understanding of what the work will require. The project manager needs more than an analogous (high-level) estimate to determine whether or not the project will meet the schedule. The benefit of an analogous project estimate is that it is management’s expectations of how long the project will take. Any differences between the analogous estimate and the detailed bottom-up estimate can be reconciled in the planning processes.

38. 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.

Cost Management

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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.

Many people are nervous about questions relating to earned value. This chapter should help ease your mind. There have typically been about 13 questions on earned value on the exam, and only about seven of these questions have required earned value calculations. With a little study, such questions should be easy.

There is a strong connection between cost management and time management on the exam. Some topics (including planning, estimating, and monitoring and controlling) covered here in the Cost Management chapter also apply to the Time Management chapter. Earned value management is a good example of a tool that can be used for both time and cost.

The Time Management chapter talks about the decomposition of work packages into smaller components, or activities. For many projects, activities are used to create cost estimates. On some large projects, however, it might be more practical to estimate and control costs at a different level. This level is called a control account. It is higher than the work package level in the WBS. (See the Scope Management chapter for more on control accounts.)

QUICKTEST

- Cost management process
- Earned value measurement
 - 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 estimate
- Definitive estimate
- Budget estimate
- Reserve analysis
- Contingency reserves
- Management reserves
- Cost risk
- Variable/fixed costs
- Direct/indirect costs
- Life cycle costing
- Value analysis
- Control thresholds
- Progress reporting
- Cost of quality
- Project management software
- Return on investment (ROI)
- Discounted cash flow

INITIATING	PLANNING <i>(This is the only process group with a set order)</i>	EXECUTING	MONITORING & CONTROLLING	CLOSING
<ul style="list-style-type: none"> Select project manager Determine company culture and existing systems Collect processes, procedures, and historical information Divide large projects into phases Understand the business case Uncover initial requirements, assumptions, risks, constraints, and existing agreements Assess project and product feasibility within the given constraints Create measurable objectives Develop project charter Identify stakeholders and determine their expectations, influence, and impact 	<ul style="list-style-type: none"> Determine how you will plan for each knowledge area Determine detailed 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 time and cost Determine critical path Develop schedule Develop budget Determine quality standards, processes, and metrics Create process improvement plan Determine 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 documents Create change management plan Finalize the “how to execute and control” parts of all management plans Develop realistic and final PM plan and performance measurement baseline Gain formal approval of the plan Hold kickoff meeting 	<ul style="list-style-type: none"> Execute the work according to the PM plan Produce product deliverables (product scope) Gather work performance data Request changes Implement only approved changes Continuously improve Follow processes Determine whether processes are correct and effective (quality assurance) Perform quality audits Acquire final team Manage people Evaluate team and individual performance 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 Manage stakeholder engagement and expectations Hold meetings Select sellers 	<ul style="list-style-type: none"> Take action to control the project Measure performance against the performance measurement baseline Measure performance against other metrics in the PM plan Analyze and evaluate performance Determine if variances warrant a corrective action or other change request Influence the factors that cause changes Request changes Perform integrated change control Approve or reject changes Update the PM plan and project documents Inform stakeholders of the results of change requests Monitor stakeholder engagement Manage configuration Create forecasts Gain acceptance of interim deliverables from the customer Perform quality control Perform risk reassessments and audits Manage reserves Control procurements 	<ul style="list-style-type: none"> Confirm work is done to requirements Complete procurement closure Gain final acceptance of the product Complete financial closure Hand off completed product Solicit feedback from the customer about the project Complete final performance reporting Index and archive records Gather final lessons learned and update knowledge base

Rita's Process Chart—Cost Management
Where are we in the project management process?

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

You should be familiar with the following cost management concepts:

Life Cycle Costing¹ This concept involves looking at costs over the entire life of the product, not just the cost of the project to create the product. Would it be wise to design the project so that the project costs are low but the maintenance costs are higher than the project cost savings? For example, you plan the project to produce the product at a lower level of quality and save \$9,000. After the project is completed, the maintenance costs are \$100,000 over the product's life, instead of the \$20,000 in maintenance it could have cost had you built the product to a higher quality standard. Your \$9,000 project "savings" cost the company \$80,000 (or \$71,000 in additional cost). This is the concept of life cycle costing—looking at the cost of the whole life of the product, not just the cost of the project.

Value Analysis² This concept is sometimes referred to as value engineering. Its focus is to find a less costly way to do the same work. In other words, this technique asks, "How can we decrease cost on the project while maintaining the same scope?" When performing value analysis, you systematically identify the required project functions, assign values to these functions, and provide functions at the lowest overall cost without loss of performance.

Cost Risk³ Some topics cross the boundaries between knowledge areas. For example, the concept of cost risk involves risk, procurement, and cost management. This term means just what its name implies—cost-related risk. Since such topics cross knowledge areas, so do the questions on the exam about the topics. See the following example question:

Question Who has the cost risk in a fixed-price contract—the buyer or the seller?

Answer The seller

Plan Cost Management PAGE 195

Process: Plan Cost Management
Process Group: Planning
Knowledge Area: Cost Management

The Plan Cost Management process involves identifying how you're going to plan, manage, and control project costs. This process answers the questions, "How will I go about planning cost for the project?" and "How will I effectively manage the project to the cost baseline, control costs, and manage cost variances?"

In some organizations, the Plan Cost Management process can involve determining whether the project will be paid for with the organization's existing funds or will be funded through equity or debt. It could also include decisions about how to finance project resources, such as choosing whether to purchase or lease equipment. Existing organizational policies may help determine what analytical techniques to use to make these decisions; possible techniques include net present value, payback period, and internal rate

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of return. Do you remember these techniques from the Integration Management chapter? If not, you may want to return to that chapter now and review them. Two additional techniques to be aware of are:

- **Return on investment (ROI)** A technique to measure the potential profitability of an investment by calculating the benefits received in relation to the cost
- **Discounted cash flow** A technique to estimate the attractiveness of an investment by predicting how much money will be received in the future and discounting it to its current value

Can you see how decisions about funding and financing resources might affect project risks and the 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 funding and financing decisions could impact the rest of the project. As you read through this chapter, don't just focus on memorizing the formulas for earned value measurement. 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.

Cost Management Plan PAGE 198 The output of this process is the cost management plan, which could also be called the "budget management plan" or "budget plan" on the exam. The cost management plan is similar to other management plans (a PMI-ism). It can be formal or informal, but it is part of the project management plan. Once again, you can see that such a plan requires thinking in advance about how you will manage costs. This is a concept that many project managers miss.

The cost management plan may include:

- Specifications for how estimates should be stated (in what currency)
- The level of accuracy needed for estimates
- Reporting formats to be used
- Rules for measuring cost performance
- Whether costs will include both direct costs (those costs directly attributable to the project) and indirect costs (costs not directly attributable to any one project, such as overhead costs)
- Guidelines for the establishment of a cost baseline for measuring against as part of project monitoring and controlling (the cost baseline will ultimately be established in Determine Budget)
- Control thresholds
- Cost change control procedures
- Information on control accounts
- Information about how the Estimate Costs, Determine Budget, and Control Costs processes will be conducted
- 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. The creation of the cost management plan (like any other management plan in project management) requires thinking ahead about how you will control costs. If an actual cost comes in higher than expected, will you need to take action? What if it's a two dollar difference? Control thresholds are the amount of variation allowed before you need to take action. You determine these thresholds in planning while creating the cost management plan.

Estimate Costs PAGE 200

Process: Estimate Costs
Process Group: Planning
Knowledge Area: Cost Management

This process involves coming up with cost estimates for each activity. These estimates will ultimately be combined into one time-phased spending plan (the cost budget) in the next process, Determine Budget.

In the Time Management chapter, we discussed “Things to Know about Estimating for the Exam.” As noted in that chapter, these concepts apply to both time and cost estimating. Take some time now to review that discussion. It is helpful to have those concepts fresh in your mind before continuing to read about the Estimate Costs process.

So what costs should you estimate? To put it simply, the costs involved in all the efforts needed to complete the project. This could include:

- Costs of quality efforts
- Costs of risk efforts
- Costs of the project manager’s time
- Costs of project management activities
- Costs directly associated with the project, including labor, materials, training for the project, computers, etc.
- Expenses for physical office spaces used directly for the project
- Profit, when applicable
- Overhead costs, such as management salaries and general office expenses

Types of Cost There are several ways to look at costs when creating an estimate. In the past, the exam has only asked a few questions regarding types of cost. The following information should help you answer such questions.

A cost can be either variable or fixed:

- **Variable Costs** These costs change with the amount of production or the amount of work. Examples include the cost of material, supplies, and wages.
- **Fixed Costs** These costs do not change as production changes. Examples include the cost of set-up, rent, utilities, etc.

A cost can be either direct or indirect:

- **Direct Costs** These costs are directly attributable to the work on the project. Examples are team travel, team wages, recognition, and costs of material used on the project.
- **Indirect Costs** 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 (or “What do you need before you estimate costs?”)

These inputs help you create estimates more quickly and accurately. For example, imagine having access to a repository that contains 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. So read through the following list of inputs (do not just skim over this list!), and think through why each might help you in estimating costs.

- **The cost management plan** This plan developed in the Plan Cost Management process documents the methods you’ll use to estimate costs, as well as the level of accuracy required for estimates.
- **The scope baseline** In order to create an estimate, you need to know the details of what you are estimating; this includes knowing what is out of scope and what constraints have been placed on

the project. This information can be found by looking at all the components of the scope baseline (the project scope statement, WBS, and WBS dictionary).

- **Project schedule** This is one of the key inputs to estimating, as the schedule includes the activities, the resources needed to complete the work, and information about when the work will occur. Keep in mind that you need a schedule before you can come up with a budget. There are two reasons for this: First, the timing of when you buy something affects its cost. Second, you need to develop a time-phased spending plan to control project expenditures (a budget) so that you know how much money will be spent during specific periods of time (January, next month, etc.). But know that it goes both ways; costs will also affect the schedule. For example, the price of material or a piece of equipment may vary due to factors like availability, seasonal pricing fluctuations, new model releases, etc. If you know that something will be more expensive at the time it is scheduled to be purchased, you may want to change the schedule to be able to purchase the material or equipment at a different time, for a lower price. This is the process of iterative planning, as shown in Rita's Process Chart.
- **Human resource management plan** The human resource management plan lists the human resources (including the quantity of resources needed and their skills) intended to be used for the project. Of course, these resources have costs associated with them. The project manager should have access to the rates paid to everyone who works on the project. Is this different from your real world? If so, take note of this for the exam. Another part of the human resource management plan, reward systems can increase productivity and save money, but they are still a cost item and need to be estimated. The human resource management plan is discussed in more detail in the Human Resource Management chapter.
- **Risk register** Like reward systems, the risk management process can save time and money, but there are costs associated with the efforts to deal proactively with risks (both opportunities and threats). Risks are an input to this process because they influence how costs are estimated, but they can also be an output because our choices related to estimating costs have associated risks. Again, planning is iterative.
- **Policies and historical records related to estimating, templates, processes, procedures, lessons learned, and historical information (i.e., organizational process assets)** As noted earlier, historical records from past projects can be highly beneficial in creating estimates for a current project. Organizational policies and standardized templates related to estimating can also make this effort faster and easier.
- **Company culture and existing systems that the project will have to deal with or can use (i.e., enterprise environmental factors)** For cost estimating, this includes marketplace conditions and commercial cost databases. You might review the different sources from which supplies might be procured and at what costs as part of estimating.
- **Project management costs** It's important to understand that part of the expense of a project comes from the costs associated with project management activities. Although project management efforts save money on projects overall, they do incur costs and should be included in the project cost estimates. These include not only costs associated with the efforts of the project manager but also those associated with status reports, change analysis, etc.

Exercise Do you think you really understood the discussion of cost estimating inputs? Test yourself! Try to recreate the list of inputs to estimating in the space below. Spend some time thinking about any inputs you forgot, to make sure you really understand these inputs for the exam.

How Is Estimating Done? Costs can be estimated using the same techniques described in the Time Management chapter: one-point estimating, analogous estimating, parametric estimating, and three-point estimating. Costs can also be estimated using a bottom-up estimating technique.

Bottom-Up Estimating⁴ PAGE 205

This technique involves creating detailed estimates for each part of an activity (if available) or work package (if activities are not defined). To do this well requires an accurate WBS. The estimates are then rolled up into control accounts and finally into an overall project estimate.

Exercise Test yourself! See if you understand the differences between analogous and bottom-up estimating by identifying the advantages and disadvantages of each technique. (Analogous estimating was described in the Time Management chapter.)

What Are the Advantages of Analogous Estimating?	What Are the Disadvantages of Analogous Estimating?

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What Are the Advantages of Bottom-Up Estimating?	What Are the Disadvantages of Bottom-Up Estimating?

Answer There are many possible answers to these questions. The purpose of this exercise is to get you thinking about the differences so that you can answer any questions on the topic, no matter how they may be worded.

Advantages of Analogous Estimating	Disadvantages of Analogous Estimating
Quick	Less accurate
Activities need not be identified	Estimates are prepared with a limited amount of detailed information and understanding of the project
Less costly to create	Requires considerable experience to do well
Cost constraints created by management in project initiating give the project manager 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)	Extremely difficult for projects with uncertainty
	Does not take into account the differences between projects

Advantages of Bottom-up Estimating	Disadvantages of Bottom-up Estimating
More accurate	Takes time and expense to use this estimating technique
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 analysis of the project	Requires that the project be defined and well understood before estimating begins
Provides a basis for monitoring and controlling, performance measurement, and management	Requires time to break the project down into smaller pieces

The following are used in the process of creating estimates:

Project Management Software Remember there is no such thing as one software package to tell you how to manage a project. The software referred to here might be any software used for estimating. If a project has hundreds or thousands of activities, each of which has similar cost components added like overhead, software can significantly speed up the calculations.

Determining Resource Cost Rates Although many project managers do not have access to this information on their projects, the exam assumes that a project manager knows the actual cost of labor when performing detailed cost estimating. Remember that resources are not just internal human resources. This work might also involve estimating the work of consultants, vendors, and suppliers. When the project includes plans to outsource pieces of work, the Estimate Costs and Plan Procurement Management processes impact each other and require iterations as planning progresses. This same relationship exists between Plan Procurement Management and the other estimating processes (e.g., Estimate Activity Resources and Estimate Activity Durations). Planning is iterative.

Reserve Analysis Proper project management requires the use of reserves to cover the cost and time risk in a project estimate. This involves identifying which activities on the project have significant risks and determining how much time and money to set aside to account for the risks if they occur. There are two types of reserves that can be added to your estimates: contingency reserves and management reserves. Contingency reserves are used for known risks, which are specifically identified risks. A lump sum management reserve is used to accommodate unknown risks, or unidentified risks. See the Risk Management chapter to learn how these reserves are calculated. Reserve analysis should include making sure individual activity estimates are not padded.

Cost of Quality The cost of work added to the project to accommodate quality efforts should be included in the project estimate.

Group Decision Making As is the case with time estimates, involving team members in estimating costs improves accuracy because they are the ones most likely to understand what's involved in the effort. Examples of group decision-making techniques include brainstorming, the nominal group technique, and the Delphi technique, all of which were described in the Scope Management chapter of this book.

Accuracy of Estimates Think about someone walking into your office now 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?” Estimates made in the early part of the project will be less accurate than those made later, when more is known about the project. Estimates should be in a range, as it is very unlikely that an activity will be completed for exactly any particular amount of money. In the early part of the project, you typically provide wide-ranging estimates. Over time, as you determine more information about the project during planning, you can narrow the estimate range.

Organizations often have different standards for different ranges, from preliminary to conceptual to feasibility to order of magnitude to definitive estimates. The standard ranges of the order of magnitude estimate, budget estimate, and definitive estimate are shown below. Such ranges tell you how much time and effort need to go into estimating to make sure the actual cost is within the range of the estimate.



These ranges often show up on the exam. Make sure you memorize them.

- **Rough Order of Magnitude (ROM) Estimate⁵** This type of estimate is usually made during project initiating. A typical range for ROM estimates is -25 to +75 percent from actual, but this range can vary depending on how much is known about the project when creating the estimates.
- **Budget Estimate** This type of estimate is usually made during project planning and is in the range of -10 to +25 percent from actual.
- **Definitive Estimate** As the project progresses, the estimate will become more refined. Some project managers use the range of +/-10 percent from actual, while others use -5 to +10 percent from actual.

When completed, the Estimate Costs process results in activity cost estimates and an explanation of how those estimates were derived (known as the basis of estimates). It can also result in changes or updates to the risk register and other project documents.

Determine Budget PAGE 208

Process: Determine Budget
Process Group: Planning
Knowledge Area: Cost Management

In this part of cost management, the project manager calculates the total cost of the project in order to determine the amount of funds the organization needs to have available for the project. The result of this calculation is called the budget. The cost baseline is the portion of the budget the project manager will have control over. Meeting the cost baseline will be a measure of project success, so the budget should be in a form the project manager can use while the work is being done to control costs and, therefore, control the overall project.

Many of the inputs to the Estimate Costs process are used here as well: the cost management plan, the scope baseline, the project schedule, the risk register, and organizational process assets (existing policies on cost control and cost budgeting, for example). Two outputs from Estimate Costs—activity cost estimates and the basis of estimates—are also essential inputs to this process. You’ll also need information on the availability of resources (resource calendars) and any agreements about costs associated with the purchase of services or products for the project.

In estimating the total cost of a project (i.e., determining the project’s budget), a project manager MUST perform risk management activities and include reserves in that estimate! Make sure you note this for the exam if you do not formally manage risks on your real-world projects. Remember that contingency reserves address the cost impacts of the risks remaining during risk response planning. Management reserves are additional funds set aside to cover unforeseen risks to the project. The cost baseline includes the contingency reserves; it represents the funds the project manager has authority to manage.

and control. The cost budget is the cost baseline plus the management reserves. The cost budget is how much money the company should have available for the project.

To create a budget, activity costs are rolled up to work package costs. Work package costs are then rolled up to control account costs and finally to project costs. This process is called cost aggregation. Contingency reserves are added to determine the cost baseline (these can be added at the project level, as described here and depicted in figure 7.1, but note that it's also possible to add contingency reserves at the activity level). In the final step, the management reserves are added.

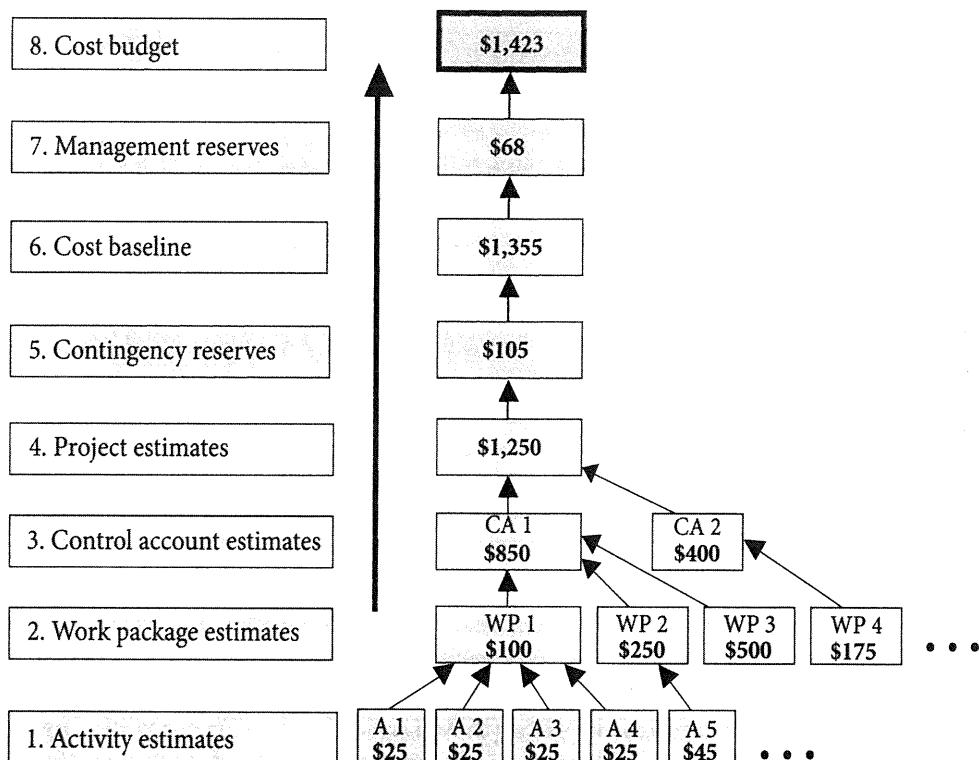


Figure 7.1: Creating a Budget

After the cost baseline and cost budget are estimated, the project manager may compare these numbers to parametric estimates, expert judgment, or historical records as a sanity check. 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 consider 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 correct.

The next thing to check is cash flow (part of funding limit reconciliation⁶). Funding may not be available when it is needed on the project, causing changes to the other parts of the project and iterations of the project documents or project management plan. 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 and may be shown as an S-curve.⁷

The project manager needs to perform another reconciliation before the proposed cost baseline and cost budget can become final: reconciliation with any cost constraints in the charter. If the project estimate exceeds the constraints, the project manager has to meet with management, explain why their cost cannot be met, and propose options to decrease costs. Pay particular attention to that last sentence.

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If such actions are a required part of project management, then an unrealistic budget is the project manager's fault! As with the schedule, project managers have a professional responsibility to reconcile the budget in this way. This reconciliation is done as part of integration management.

When the Determine Budget process is complete, the cost baseline, including all funding requirements, is established. As in the other processes we have discussed, the efforts involved in determining the budget may create the need for updates to other project documentation, including cost estimates, the risk register, and the project schedule.

Control Costs PAGE 215

Process: Control Costs
Process Group: Monitoring & Controlling
Knowledge Area: Cost Management

The Control Costs process is similar to the control part of any other knowledge area, with a focus on cost. That being said, complete the following exercise and imagine how this would work on real-world projects.

Exercise What ACTIONS should a project manager take to control costs? (This is an important topic, so really take the time to think about this question, even if you are tired of exercises!)

Answer Was one of your answers “follow the cost management plan”? This is an excellent answer! The cost management plan includes your plan for how you will control the costs of the project, such as meetings on cost, reports, measurements that will be made, and their frequency. The control part of the management plan is customized to the needs of the project.

If you understand the idea behind PMI-isms, you might also have answered something like “look at any organizational process assets that are available.” This is also a good answer. You need to consider any policies, procedures, tools, or reporting formats related to controlling costs that are available or required by your company.

Was another one of your answers “manage changes”? This is generally correct, but make sure you understand the complexity of this effort. What about preventing unnecessary changes and influencing the things that are causing costs to rise? What about letting people know which changes are approved and which are not so that everyone is working on the same project? You need to have an “attitude” of control. It is your project and your career. You must be assertive and make sure the project goes according to the plan. Oversight and CONTROL are essential for the success of both the project and your career as a project manager. It is important to understand that this attitude of control applies to all parts of the project, not just cost. Think of yourself as a detective looking for anything that can get in the way of project success, and you will choose the better answer choice for questions that seem to have more than one “correct” answer.

Also keep in mind that control means measure. When taking the exam, assume that the project manager is measuring, measuring, measuring on the project, even if you do not do this on your real-world projects. Measurement helps you see if there are any variances. You can then determine if those variances require changes, including corrective or preventive actions. The cost management plan should include what you will measure, when, and what amount of variation between planned and actual will require action (your control limits). In other words, you plan what you will do to control the project before you get started. Do you do this in your real world? Assume that you do, and assume that all proper project management is being done when you take the exam unless the question tells you (directly or indirectly) that proper project management was not done.

Progress Reporting PAGE 220 The project manager can use information about project progress to help control the schedule and costs and to assess whether the project is on track through earned value measurement (described later in this section). Some project managers use alternative means of determining progress that don’t rely on earned value measurement, such as asking team members for an estimate of percent complete for each work package or activity. On projects where work is not objectively measured, the estimate the team members provide is simply a guess. The method of asking for percent complete is time-consuming and generally a waste of time when the estimate is a guess, because it does not provide a realistic estimate of the project’s progress.

Another way to track progress without using earned value measurement is by accurately measuring deliverable completion (evaluating how much has been done to complete the deliverable based on the work package and the time and cost estimates). Typically with a WBS, 80 hours is a small enough increment of work to be able to track progress against and still have accurate data. For the exam, remember that projects planned using proper project management make use of a WBS, and the activities to produce the work package deliverable would be broken down to an appropriate level for monitoring and controlling. Because such work packages are completed relatively quickly and frequently, the project manager can monitor completion of work packages as a way to show progress on deliverables within the time and cost allotted to them in the plan.

Reserve Analysis PAGE 225 Remember the contingency reserves that get factored into the cost baseline to address known risks? Part of controlling costs involves analyzing whether those contingency reserves are still necessary or whether 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 that risk, should the need arise. If the risk does not occur and it is determined that the risk is no longer a threat, the contingency reserve can be removed from the cost baseline (and subsequently the cost budget). As another example, risk reassessment on a project may identify new risks, which could lead to a decision to increase the contingency reserves. Both of these examples result in a change request being submitted through

integrated change control. It may also be necessary to reassess the management reserves that were set aside to address unknown risks. Maybe too little or too much was set aside for management reserves in the cost management plan. Reserve analysis allows you to evaluate and incorporate those lessons learned into your project through the Control Costs process. Analysis of the management reserves may also indicate that too many unknown risk events are occurring, suggesting that the risk management efforts in planning were inadequate and need to be recalculated. Management reserves, if you recall, are separate from the cost baseline, so changes to them will change the cost budget. If an unknown risk event occurs, management reserves will pay for the workaround; a change request will be required to move those management reserve funds into the cost baseline and to add any additional funds required to complete the reestimated project work within the new parameters of the project. Reserve analysis is used to evaluate those estimated cost impacts to the entire project to keep project work moving forward.

Earned Value Measurement⁸ PAGE 217 Okay, let's pause for a moment. You already know earned value is on the exam. 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? These are the benefits of earned value. 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. And they may regularly result in the need to work overtime at the end of the project because of the lack of control along the way. Keep the benefits of earned value in mind as you read this section, and go through it slowly if it seems confusing. Make sure you "get it" the first time you read it.

Earned value is used in performance reviews to measure project performance against the scope, schedule, and cost baselines. Please note that the earned value technique uses a combination of these three baselines, known as the performance measurement baseline. The measurements resulting from an earned value analysis of the project indicate whether there are any potential deviations from the scope, schedule, and cost baselines (the performance measurement baseline). Many project managers manage their project's performance by comparing planned to actual results. With this method, however, you could easily be on time but overspend according to your plan. Using earned value measurement is better, because it integrates cost, time, and the work done (or scope) and can be used to forecast future performance and project completion dates and costs.

Using the work performance information gathered through earned value analysis, a project manager can create reports, including cost forecasts, and other communications related to the project's progress (see the Communications Management chapter for more on earned-value-related reports). Earned value measurements may also result in change requests to the project.

Here are the earned value terms you need to know.



Terms 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 budget)	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 following formulas. (NOTE: The ^C in the following table stands for "cumulative.")

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 (CPI) ⁹	$\frac{EV}{AC}$	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.

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Name	Formula	Interpretation
Estimate at Completion (EAC)		As of now, how much do we expect the total project to cost? \$ _____. (See the formulas to the left, below.)
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 on the project. Exam questions may require you to determine which EAC formula is appropriate; you will need to pay attention to the information provided in the question to decide which formula to use.	AC + Bottom-up ETC $\frac{BAC}{CPI^C}$ AC + (BAC – EV) AC + $\frac{(BAC - EV)}{(CPI^C \times SPI^C)}$	This formula calculates actual costs to date plus a new estimate for the remaining work. It is used when the original estimate was fundamentally flawed. This formula is used if no variances from the BAC have occurred or 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). 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. 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 work remaining to be done by the money remaining to do it. It answers the question “In order to stay within budget, what rate must we meet for the remaining work?” Greater than one is bad; less than 1 is good.
Estimate to Complete (ETC)	EAC – AC Reestimate	How much more will the project cost? 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?

The CPI in the previous table is a cumulative CPI because it is using costs to date. It could be written as $CPI^C = EV^C/AC^C$ with the C standing for cumulative. This cumulative formula is the same as that in the previous table, but it more clearly states that the data used is cumulative. CPI can also be calculated for costs incurred during a specific period of time (week, month, or quarter) rather than over all the time to date.



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. (Aren't you glad you purchased this book?)
- If it is a variance, the formula is EV minus something.
- If it is an index, the formula is EV divided by something.
- 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 that you spent more than planned (over budget). A -200 schedule variance means that you are behind schedule. This also applies to VAC.
- For indices interpretation: greater than one is good; less than one is bad. (Remember, this only applies to CPI and SPI; the opposite is true of TCPI!)

One type of earned value question people often answer incorrectly requires that you differentiate between EAC and ETC and the other terms. Figure 7.2 may help you understand this difference. 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 prior to this point) look backward at the project. Budget at completion (BAC), estimate to complete (ETC), and estimate at completion (EAC) look forward. BAC states 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 remaining part of the project will cost to complete. EAC indicates what the total project cost is forecasted to be.

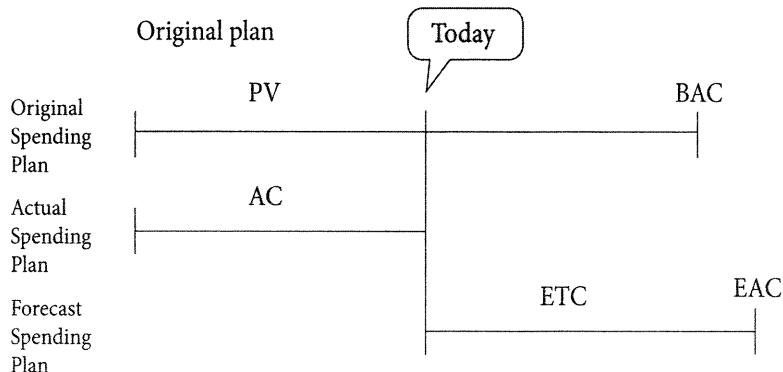


Figure 7.2: Understanding Earned Value Concepts by Looking Backward and Forward on a Project

Are you still worried about earned value? Not for long. Read the following pages and do the exercises; you might end up appreciating earned value questions over some of the more ambiguous and confusing questions on this exam.

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:

Ken, 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 that 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.”

“We could remove me from the project team and replace me with someone less expensive. I must be the most expensive team member,” Ashley says.

“Not only would it sadden me to lose you, but your suggestion would improve costs, not schedule. You are the company’s best network specialist. Someone else would not be as proficient as you in completing the work.”

“We could remove the purchase of the new computers from the project,” says Chris. “Or, we could just tell the customer the project will be two weeks late.”

“Canceling the new computers would save us money, not time. We need to focus on time,” Ken says. “Nor can we just change the project schedule baseline arbitrarily. That would be unethical.”

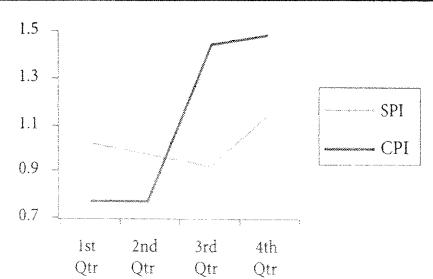
“Since we are doing well on cost, why don’t we bring in another programmer from the IT department to work on this project? We can get the next two activities completed faster,” Rose suggests.

“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,” Ken says.

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 for each question than these exercises.

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?



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.

Exercise The Fence #1



You have a project to build a new fence. The fence is four sided as shown at left. 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 following project status chart, calculate PV, EV, etc., in the spaces provided. Then check your answers. Interpretation is also important on the exam. Can you interpret what each answer means?

Do the calculations to three decimal place's on the exercises. 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.

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

	What Is:	Calculation	Answer	Interpretation of the Answer
1	PV			
2	EV			
3	AC			
4	BAC			
5	CV			
6	CPI			
7	SV			
8	SPI			

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	What Is:	Calculation	Answer	Interpretation of the Answer
9	EAC			
10	ETC			
11	VAC			

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 \$1,679 to finish the project.
11	VAC	\$4,000 minus \$4,479	-\$479	We currently expect to be \$479 over budget when the project is completed.

NOTE: If your answers differ, check your rounding. Again, it is best to calculate to three decimal places and then round to two decimal places when you are ready to compare your results against the choices provided on the exam.

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^c formula.

Exercise The Fence #2

You have a project to build a new fence. The fence is four sided as shown at left. 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, but 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 following project status chart, calculate PV, EV, etc., in the spaces provided. Then check your answers.

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

	What Is:	Calculation	Answer	Interpretation of the Answer
1	PV			
2	EV			
3	AC			
4	BAC			
5	CV			
6	CPI			
7	SV			
8	SPI			
9	EAC			
10	ETC			
11	VAC			

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.
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 \$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; thus, 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 that say things like, "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 this example, there are both cost and schedule problems.

You may also get questions on the exam that require you to perform multiple calculations (i.e., 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 this 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 that 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:

$$CV = EV - AC$$

$$CV + AC = EV - AC + AC$$

$$CV + AC = EV$$

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 like 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:

$$CPI = \frac{EV}{AC}$$

$$CPI \times AC = \frac{EV}{AC} \times AC$$

$$CPI \times AC = EV$$

You can also simply memorize the reverse formulas in the table below:

Original Formula	Reverse Formula to Determine EV
$CV = EV - AC$	$EV = CV + AC$
$SV = EV - PV$	$EV = SV + PV$
$CPI = \frac{EV}{AC}$	$EV = CPI \times AC$
$SPI = \frac{EV}{PV}$	$EV = SPI \times PV$

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.

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?

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 $EV = CPI \times AC$, or $EV = 1.1 \times \$10,000$, which works out to \$11,000. For this question, there was no need to use the SPI information.

Exercise What is your SPI if your CV is \$10,000, your SV is -\$3,000, and your PV is \$100,000?

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:

$$EV = SV + PV$$

$$EV = -\$3,000 + \$100,000$$

$$EV = \$97,000$$

We can then plug the PV and EV into the SPI formula as follows:

$$\text{SPI} = \frac{\text{EV}}{\text{PV}}$$

$$\text{SPI} = \frac{\$97,000}{\$100,000}$$

$$\text{SPI} = .97$$

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.

Exercise Using the information from the previous exercise, determine AC.

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 $\text{CV} = \text{EV} - \text{AC}$. To do this, we first plug the information we know into the formula:

$$\text{CV} = \text{EV} - \text{AC}$$

$$\$10,000 = \$97,000 - \text{AC}$$

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:

$$\$10,000 + \text{AC} = \$97,000 - \text{AC} + \text{AC}$$

$$\$10,000 + \text{AC} = \$97,000$$

The $-\text{AC}$ and $+\text{AC}$ 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:

$$\$10,000 + \text{AC} - \$10,000 = \$97,000 - \$10,000$$

$$\text{AC} = \$87,000$$

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?

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 $EV = SPI \times PV$ (this is the reverse formula for $SPI = EV/PV$).

$$EV = SPI \times PV$$

$$EV = 0.8 \times \$600,000$$

$$EV = \$480,000$$

Now we need AC, which we can get from the EV we just determined and the CPI given in the question (1.2).

$$\text{The formula is } CPI = \frac{EV}{AC} \text{ or } 1.2 = \frac{\$480,000}{AC}.$$

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:

$$1.2 \times AC = \$480,000$$

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:

$$CV = EV - AC$$

$$CV = \$480,000 - \$400,000$$

$$CV = \$80,000$$

The Control Costs process provides measurements that indicate how the work is progressing and that allow the project manager to create reliable forecasts and take action to control the project. This process also results in change requests, including recommended corrective or preventive actions, and updates to the project management plan and project documents. The project manager needs to make sure these changes and updates are communicated to stakeholders and the team to ensure they understand the revisions to the project and are implementing them correctly.

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. Estimate at completion (EAC) 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 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. 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.
6. All of 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.

7. The main focus of life cycle costing is to:
 - A. Estimate installation costs.
 - B. Estimate the cost of operations and maintenance.
 - C. Consider installation costs when planning the project costs.
 - D. Consider operations and maintenance costs in making project decisions.
8. 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 the 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
9. 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.
10. A schedule performance index (SPI) of 0.76 means:
 - A. You are over budget.
 - B. You are ahead of schedule.
 - C. You are progressing at 76 percent of the rate originally planned.
 - D. You are progressing at 24 percent of the rate originally planned.
11. 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
12. Which of the following is an example of a parametric estimate?
 - A. Dollars per module
 - B. Learning bend
 - C. Bottom-up
 - D. CPM
13. A rough order of magnitude estimate is made during which project management process group?
 - A. Planning
 - B. Closing
 - C. Executing
 - D. Initiating

Cost Management SEVEN

14. A cost baseline is an output of which cost management process?
 - A. Estimate Activity Resources
 - B. Estimate Costs
 - C. Determine Budget
 - D. Control Costs
15. During which project management process group are budget forecasts created?
 - A. Monitoring and controlling
 - B. Planning
 - C. Initiating
 - D. Executing
16. Which type of cost is team training?
 - A. Direct
 - B. NPV
 - C. Indirect
 - D. Fixed
17. Project setup costs are an example of:
 - A. Variable costs.
 - B. Fixed costs.
 - C. Overhead costs.
 - D. Opportunity costs.
18. 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.
19. Which estimating method tends to be MOST costly for creating a project cost estimate?
 - A. Bottom-up
 - B. Analogous
 - C. Parametric
 - D. 50/50
20. 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)

21. 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, specifications for how duration estimates should be stated
 - B. Specifications for how estimates should be stated, rules for measuring cost performance, the level of accuracy needed for estimates
 - C. Rules for measuring team performance, the level of accuracy needed for estimates, specifications for how estimates should be stated
 - D. Specifications for how estimates should be stated, the level of risk needed for estimates, rules for measuring cost performance
22. 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. Build 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.
23. 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 costs of the project to account for risks.
24. 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
25. Your cost forecast shows that 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.
26. 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.

Cost Management SEVEN

27. 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.
28. The project manager is allocating overall cost estimates to individual activities to establish a baseline for measuring project performance. What process is this?
 - A. Cost Management
 - B. Estimate Costs
 - C. Determine Budget
 - D. Control Costs
29. Monitoring cost expended to date in order to detect variances from the plan occurs during:
 - A. The creation of the cost change management plan.
 - B. Recommending corrective actions.
 - C. Updating the cost baseline.
 - D. Project performance reviews.
30. A 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.
31. 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 BEST 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.
32. 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.

33. Earned value measurement is an example of:
- Performance reporting.
 - Planning control.
 - Ishikawa diagrams.
 - Integrating the project components into a whole.
34. Identified risks are:
- An input to the Estimate Costs process.
 - An output of the Estimate Costs process.
 - Not related to the Estimate Costs process.
 - Both an input to and an output of the Estimate Costs process.
35. The difference between the cost baseline and the cost budget can be BEST described as:
- The management reserves.
 - The contingency reserves.
 - The project cost estimate.
 - The cost account.
36. 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?
- Start the project and constantly look for cost savings.
 - Tell all the team members to cut 15 percent from their estimates.
 - Inform the sponsor of the activities to be cut.
 - Add additional resources with low hourly rates.
37. Cost risk means:
- There are risks that will cost the project money.
 - The project is too risky from a cost perspective.
 - There is a risk that project costs could go higher than planned.
 - There is a risk that the cost of the project will be lower than planned.
38. A project manager needs to analyze the project costs to find ways to decrease costs. It would be BEST if the project manager looks at:
- Variable costs and fixed costs.
 - Fixed costs and indirect costs.
 - Direct costs and variable costs.
 - Indirect costs and direct costs.

Answers

1. **Answer D**

Explanation This formula for EAC is used if no variances from the BAC have occurred or you will continue at the same rate of spending (as calculated in your cumulative CPI). You have to remember the formula to get the answer correct.

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 $CV = -50$.

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 increase the budget.

5. **Answer C**

Explanation Analogous estimating is used most frequently during project planning, not project executing. Parametric estimating involves calculations based on historical records. Analogous estimating uses top-down estimating techniques.

6. **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 pick that option. Documentation of assumptions is referring to 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.

7. **Answer D**

Explanation Life cycle costing looks at operations and maintenance costs and balances them with the project costs to try to reduce the cost across the entire life of the project.

8. **Answer B**

Explanation Asking percent complete is not a best practice since it is usually a guess. Often the easiest work is done first on a project, throwing 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. Using earned value and other calculations is the best answer since this choice looks at the past and uses that information to estimate future costs.

9. **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.

10. Answer C

Explanation Earned value questions ask for a calculation or an interpretation of the results. In this case, the project is progressing at 76 percent of the rate planned.

11. 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 we identify 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 the estimates.

12. Answer A

Explanation Parametric estimates use a mathematical model to predict project cost or time.

13. Answer D

Explanation This estimate has a wide range. It is done during project initiating, when very little is known about the project.

14. Answer C

Explanation A cost baseline is an output of the Determine Budget process.

15. Answer A

Explanation Budget forecasts are an output of Control Costs, which is part of monitoring and controlling.

16. Answer A

Explanation You are training the team on skills required for the project. The cost is directly related to the project and thus a direct cost.

17. Answer B

Explanation Setup costs do not change as production on the project changes. Therefore, they are fixed costs.

18. Answer D

Explanation Notice that you need to know the definition of value analysis to answer this question. Also notice that the other choices could be considered correct by someone who does not know the definition. Value analysis seeks to decrease cost while maintaining the same scope.

19. Answer A

Explanation Because you need project details to estimate this way, the effort expended will be greater with bottom-up estimating.

20. 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.

21. Answer B

Explanation Notice how one item in each of the incorrect options makes the entire choice incorrect. Duration estimates are created during time management, and measuring team performance is a part of human 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.

Cost Management SEVEN

22. 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.

23. Answer D

Explanation Hiding the reserve is an inappropriate action. Adding cost to each activity will not shorten the critical path, and thus 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.

24. Answer A

Explanation Although all choices could cause difficulty, only inadequate scope definition makes estimating impossible.

25. 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. Cutting quality and decreasing scope always have negative effects. The choice with the least negative impact is to eliminate risks in estimates and reestimate.

26. 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. In order to pick the best answer, you need to realize that analogous estimating is a form of expert judgment.

27. 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.

28. 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.

29. 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.

30. Answer D

Explanation The exam will 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.

31. **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 it was not necessarily added to. If the change was to reduce the scope, it might also have reduced cost. Though 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 thus 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.

32. **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 best way to estimate is bottom-up. Such estimating would have improved the overall quality of the estimate.

33. **Answer A**

Explanation Earned value measurement is a great reporting tool. With it, you can show where you stand on budget and schedule, as well as provide forecasts for the rest of the project.

34. **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.

35. **Answer A**

Explanation Cost accounts are included in the project cost estimate, and the contingency reserves are added to that to come up with the cost baseline. Thereafter, the management reserves are added to come up with the cost budget. The management reserves make up the difference between the cost baseline and the cost budget.

36. **Answer C**

Explanation This question is full of choices that are not correct project management actions. 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 time or cost for the project is unrealistic. Did you notice the choice of adding additional resources? Even though they have low hourly rates, that would add cost. Evaluating, looking for alternatives, and then reporting the impact of the cost cutting to the sponsor is the best action to take.

37. **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 that the risk is too great to do the project. Cost risk is the risk that project costs could go higher than planned.

38. **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.

