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Exam Success

PMBOK® Guide – 3rd Edition Companion

A Concise Study Guide
for the Busy
Project Manager

CD-ROM
INCLUDED

Margaret Chu, PMP
Diane Altwies, PMP
Edward Walker, PMP

How to go to your page

In this eBook, each chapter has its own page numbering scheme, consisting of a chapter number and a page number, separated by a hyphen.

For example, to go to page 5 of Chapter 1, type 1-5 in the "page #" box at the top of the screen and click "Go." To go to page 5 of Chapter 2, type 2-5… and so forth.

ACHIEVE

PMP®

EXAM SUCCESS

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J.ROSS PUBLISHING

Achieve PMP® Exam Success:

A concise study guide for the busy project manager

BY
Margaret Chu, PMP
Diane Altwies, MBA, PMP
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J.ROSS
PUBLISHING

What a clever idea: to create a PMP examination study guide to be used alongside the PMBOK Guide! As a PMP who has helped hundreds of PMI members prepare to take the exam and as a leader within the PMI community for more than 10 years, I have frequently wished for such a source of valuable information to help PMP candidates achieve success.

Let's face it, we all know the PMBOK Guide is useful but no one ever said it was a quick read! The variety of material and the length and breadth of the PMP exam questions have stumped and intimidated many would-be candidates. As one who in a previous career was a university Reading and Study Skills Specialist, I know how helpful a study guide can be. It helps keep one awake while reading slow going material and ensures that the reader gets the critical information from his or her reading in the most effective manner possible.

This particular study guide is excellent. Chapter 1 provides the information that the project manager needs and wants to know right away — what will the exam be like? And how does one go about studying and preparing for it? Adults who have been out of college for a few years usually do not really know how to study or have forgotten how to take multiple choice exams. The study techniques in this guide are well-researched and proven. (I should know; I prepared the original recommendations for the PMI-LA chapter PMP preparation workshop many years ago!) Chapter 1 also includes a preassessment test of 40 sample questions, giving you, the reader, a taste of the nature and content of examination questions. The next 11 chapters follow the structure of the PMBOK Guide, with project management framework, the project management processes and the 9 knowledge areas. The 13th chapter covers the performance domain of professional responsibility, an important additional topic on the exam. Each of these chapters contains sample exam questions for practice and confirmation that learning has taken place. In addition, a real-life case study exercise provides additional learning of the key aspects of the topic. The book concludes with a postassessment exam of 60 questions. But that's not all; a CD ROM features over 400 additional sample exam questions. Wow!

Although this study guide is designed to help PMP candidates pass the exam, it provides background and knowledge to any busy project participant who wants to improve his or her skills. This study guide ensures that the reader gets the essential information in an efficient manner. Bravo Margaret, Diane and Edward! You've created a tool that we've all needed for years now. I wish this guide had been available when I was a PMP exam candidate; my study time could have been cut in half, by far.

Ida Harding, PMP

PMI Component Services Member Advisory Committee (2004 – 2005)
PMI Chapter LDEC Chair and Co-chair (2003 – 2004)
PMI Association of Chapter Presidents (ACP) VP (Coordinator for
    Regional Mentor Program) (2002 – 2003)
PMI Educational Foundation BOD (2002 – 2003)
PMI-LA Chapter Trustee (2001 – 2005)
PMI REP Advisory Committee (2001 – 2002)
PMI District Regional Advocate (Region 7, 2000 – 2001)
PMI Chapter President of the Year (PMI-LA Chapter, both 1999
    and 2000)
PMI Information Systems SIG, Co-chair Seminar Symposium Track
    (1997 and 1998)
PMI-LA Chapter, miscellaneous other positions (1993 – 1998)

As most project managers know, PMI updates the PMBOK Guide every 4 years. The most recent update, released in October of 2004, is officially called the PMBOK Guide, Third Edition, but is popularly know as the PMBOK Guide 2004. It takes approximately a year for the changes in the PMBOK Guide to be reflected in the PMP exam. For the 2004 Guide, the exam changes go into effect in September of 2005. In addition to new or changed questions reflecting the changes in the PMBOK Guide, PMI has significantly changed the exam itself. Although there are still 200 questions, PMI will be field testing 25 of those questions to see if they are appropriate. Those 25 trial questions will NOT count towards the pass/fail determination, so only 175 of the 200 questions count towards your score. In addition, PMI raised the pass line from 137 correct out of 200, or 68.5%, to 143 correct out of 175, or 81.7%!

For those who are have been using the PMBOK Guide 2000, the following paragraphs describe the major changes for PMBOK Guide 2004. If you have not used the 2000 Guide, skip the remainder of this Preface.

In PMBOK 2000, Chapter 3, Project Management Processes, was part of the framework section, but has now become its own new section called "The Standard for Project Management of a Project." It emphasizes the 5 process groups and the iterative nature of project management. New graphics help the reader understand the relationships between the process groups and how the various processes fit into those groups.

The integration chapter has been greatly expanded and includes processes from each of the initiating, planning, executing, monitoring and controlling and closing process groups.

PMI has expanded the discussion and clarifies the importance of the work breakdown structure (WBS) by adding a new process called "create WBS" in the scope section (Chapter 5).

The time management knowledge area has a new process called "activity resource estimating." It is basically the "resource planning" process from the cost chapter in PMBOK 2000. From your own experience you may have found that you need to know if and when the resources you require will be available before you can create your schedule. PMI agrees!

The quality management section has 2 processes with name changes: "quality assurance" became "perform quality assurance" and "quality control" became "perform quality control." In addition, the prominence of the quality activities within the overall monitoring and controlling process is emphasized. This has resulted in many changes to the inputs and outputs.

The project human resource management knowledge area changes include a new monitoring and controlling process called "manage project team" while renaming the other 3 processes to "human resource planning," "acquire project team" and "develop project team."   Some project management techniques have also been added, such as the use of virtual teams, ground rules and issues logs.

The communications management knowledge area has been updated to emphasize the importance of communication with stakeholders by the addition of the "manage stakeholders" process. The previous "administrative closure" process has been renamed the "close project" process and has been moved the the integration knowledge area (Chapter 4).

Risk management changes primarily emphasize the possibility of opportunities or positive risks versus solely threats or negative risks. There are no new processes or process name changes, however the inputs and outputs for each process have been streamlined significantly. A risk register has been added and there is closer integration with other knowledge area processes.

Procurement management updates emphasize the organization as being either the buyer or the seller of the product, service or result under a contract. There are still 6 processes but the names and content of many of these processes have changed. The words "procure," "solicit" and "solicitation" have been removed. In addition, the "contract administration" process has moved from the executing process group to the monitoring and controlling process group.

Margaret, Diane and Ed would like to recognize the hard work and contributions of the many individuals who helped us make this book a success:

Steve Buda and his team at J.Ross Publishing for their guidance and patience; Michael Graupner, PMP, for all his constructive feedback; Frank Reynolds, PMP, for support and guidance throughout the project and his many contributions to our collective project management knowledge; Norm Vitale for the design work and first conversion from rough Word documents to something that actually looked like a book; Ida Harding, PMP, for her support and encouragement throughout; Jessica Haile and Gene Miller for their sharp eyes as editors; Richard Reinertson, Scott McQuigg, David Jacobs, Lora Lockwood, Judith Berman and Robet Pettis for their assistance in developing our test-question CD.

Special thanks also to the PMI-Orange County Chapter PMP Preparation Workshop instructors and students for using our materials and providing invaluable feedback.

There are certainly others, whose names are not here but who contributed as participants in our workshops, challenging us to defend our statements and the answers to the PMP questions we wrote. Each course offering enhanced the material that became this book. To each and every one of you, a million thanks from the bottom of our hearts. We could not have done this without you.

A special thank you to our significant others, Robert, Bruce and Andrea, for their patience, support, love and encouragement during the many months of late night and weekend work it took to turn our dream into reality.

Congratulations! Your curiosity about the project management profession and what is involved in attaining the elite status of a certified Project Management Professional (PMP) will lead you to many achievements. As you may know, the guide to the Project Management Body of Knowledge (PMBOK Guide), which is published by the Project Management Institute (PMI), is revised every 4 years. The revision of the PMBOK Guide is followed by corresponding changes to the PMP certification exam questions. The current edition of the PMBOK Guide is the 2004 edition (Third Edition) and it is often referenced as the PMBOK Guide 2004. This study guide is closely related to the PMBOK Guide and has been revised to match the PMBOK Guide 2004. Before you begin, make sure you know what version of the PMBOK Guide you need to study and determine your target time for taking the PMP exam. However, if your purpose is simply to find out more about the project management disciplines and the exam process, then any version will provide you with valuable information.

Our purpose in creating this study guide is to provide you with a consolidated source of material that, used together with the material contained in the PMBOK Guide and your experiences as a project manager, should be all you need to pass the PMP exam. To help you succeed and to make effective use of your study time, the chapter topics match the chapters in the PMBOK Guide and include material on PMI's additional exam area, the Professional Responsibility Performance Domain. Each chapter contains a series of sample exam questions and, where appropriate, a hands on exercise or 2.

We have structured each of the chapters to present a list of the things you need to know to pass the exam. This list is based on 1) our personal experiences in preparing for and taking the exam, 2) our experiences in helping others prepare for the exam and 3) what our students and workshop participants have told us was useful in helping them prepare for and pass the exam.

We have NOT included in the study guide all the inputs, outputs, tools and techniques described in the PMBOK Guide. PMI has already done that and you MUST go through the PMBOK Guide in detail to become familiar with the deliverables, tools and techniques of the many processes.

Remember also that the exam tests your knowledge of generally accepted project management processes. Your particular industry and/or area of specialization will have different ways of doing the same thing, but PMI is administering the test so you need to know "the PMI way."

We have included an assessment test in Chapter 1 that you should take before you continue on to further chapters. It will help you focus on those areas of your knowledge and experience that are the weakest and save you time by allowing you to skim over the areas where you are already knowledgeable. These assessment questions may also help you decide if you need to take a course on project management principles or a PMP exam preparation course before attempting the exam. Chapter 14 is a final exam to help you confirm your understanding of the material.

PMI also administers a Certified Associate in Project Management (CAPM) exam. This is a shorter exam with less experience requirements for application approval. You may use this study guide to facilitate your understanding of the PMBOK Guide in preparing for the CAPM exam as well.

Finally, we would like to emphasize that you should by no means assume that studying this book replaces reading the PMBOK Guide. Instead, both books should be used together. We suggest the following method of study:

- Start by doing an overview of a chapter in the PMBOK Guide (paging through the chapter to get a big picture of what the chapter is about and how it is organized). This should take about 2 or 3 minutes.
- Do the same with the equivalent chapter in this study guide. Chapters 1 and 2 of the PMBOK Guide are combined into Chapter 2 of this study guide.
- Now, read the PMBOK Guide chapter carefully, asking yourself "What do I need to learn from what I am reading?"
- Next read the study guide chapter carefully to find the tips and important points to learn.

- Then reread the PMBOK Guide chapter in chunks, referring back to the study guide. Note concepts in the study guide that go beyond the PMBOK Guide.
- Make notes or flash cards to help you remember essential information. Use these notes later to test yourself so you can narrow your focus on the information you may need to revisit.
- Next, do the sample exam questions in the study guide. If there are any concepts that you are weak in, you may want to read up on them by accessing the related reference material and practicing with additional exam questions.
- Use the compact disk of exam questions to practice taking online tests.
- Finally, reread the PMBOK Guide chapter, this time very quickly, so you end with the overall picture rather than being buried in details.

Good studying and good luck with building your project management skills and knowledge. We look forward to hearing from you and celebrating your achievement. News of your success as well as any suggestions or comments on our study guide can be sent to us by email to training@outercoreinc.com.

Margaret Chu, Diane Altwies and Ed Walker

AUTHORS' INFORMATION

OuterCore Professional Development, LLC

In 2001 Diane Altwies, Margaret Chu and Ed Walker founded OuterCore Professional Development in Newport Beach, California. The partners realized that there was a need for low-cost assistance to improve the success rate of individuals taking the PMP certification exam. In addition, from their own experiences, Diane, Margaret and Ed saw an increased demand for well-trained project management professionals in every organization.

Margaret Chu, PMP

Over the last 20 years, Margaret has performed in many roles in IT software development teams. She is currently engaged in implementing process improvement at a large manufacturing firm utilizing SEI-CMMI as the model. Her previously published book, *Blissful Data: Wisdom and Strategies for Providing Accurate, Meaningful, Useful, and Accessible Data for All Employees,* discusses the importance overcoming people's resistance to change to ensure project success. Margaret is an active member of the Los Angeles chapter of PMI and a Competent Toast Master (CTM) of Toastmasters International.

Diane Altwies, MBA, PMP

Diane has been managing software development projects for over 20 years, primarily in the insurance, financial services and healthcare industries. She is currently the president of her own consulting practice and teaches project management courses through OuterCore Professional Development and the University of California, Irvine. She is a frequent speaker at professional meetings and symposia and is on the board of PMI's Orange County chapter.

Edward Walker, PMP

Ed is a seasoned project manager and trainer, bringing over 30 years of hands-on knowledge to his clients. He has worked in a variety of industries including insurance, aerospace and supply chain management. In addition to his project management training, Ed has been an instructor for leadership, consulting skills and information technology topics for over 20 years. Ed is an active member of the Orange County chapter of PMI and received their "PMI-OC Fellow" award for 2005.

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Downloads available for *Achieve PMP*® *Exam Success*
consist of a flashcard study aid of key terms and
concepts, a self-study exercise on understanding the
interdependencies of all 44 processes defined in the
PMBOK Guide and a side-by-side comparison of the
differences between the PMBOK 2000 Guide and the
PMBOK 2004 Guide.

CHAPTER 1 | **EXAM OVERVIEW &
ASSESSMENT EXAM**

1

1

WHAT IS A PROJECT MANAGEMENT PROFESSIONAL (PMP)?

A PMP is a project management practitioner who:
- Has demonstrated a professional level of project management knowledge and experience by supporting projects using project management tools, techniques and methodologies
- Has at least 4,500 hours of experience as a project manager
- Has completed 35 hours of formal project management training
- Has passed a computer-based exam administered by the Project Management Institute (PMI)

PMP EXAM SPECIFICS

The exam has the following characteristics:
- Assesses the knowledge and application of globally accepted project management concepts, techniques and procedures
- Covers the 6 performance domains detailed in the role delineation study (PMI, *Role Delineation Study*)
- Covers the 9 knowledge areas and the 5 process groups as detailed in the Project Management Body of Knowledge (PMBOK) Guide
- Contains 200 multiple choice questions
- Includes 25 questions that are "preexam" questions being field-tested by PMI that do not affect grading
- Requires 143 correct answers to get a passing grade, which is 81.7% of the 175 questions that count toward the grade
- Takes up to 4 hours

The exam questions are divided as follows:

Performance Domain	% of exam	# of questions
1. Initiating	11.6%	20
2. Planning	22.7%	40
3. Executing	27.5%	48
4. Monitoring & Controlling	21.0%	37
5. Closing	8.6%	15
6. Professional Responsibility	8.6%	15

1

STUDY TIPS

- Make a checklist of things you need to study.
- Plan your study sessions with time limitations.
- Vary tasks and topics during lengthy study periods.
- Find one special place for studying and use it only for that.
- Eliminate distractions.
  - If daydreaming, walk away.
  - Take brief breaks (5 to 10 minutes) after about 50 minutes of study.
- Continue to test yourself.
- Create your own exam.
- Restate, repeat and put in your own words.
- Understand the big concepts first.
- Memorize key terms and important people.
- Memorize formulas.
- Use memorizing methods such as:
  - Flip-charts
  - Diagrams
  - Mnemonics
  - Memory searches (relate to past experiences)
- Prepare for the exam day.
  - Get a good night's rest.
  - Avoid last-minute cramming.
  - Have a good breakfast.
  - Leave books at home.
  - Use the calculator on the system.
  - Go with a positive attitude.
  - Get to the exam site EARLY.

EXAM TIPS

- Relax before and during the exam.
  - Take deep breaths.
  - Stretch about every 40 minutes.
  - If you get nervous, try to relax.
  - Give yourself a goal and reward yourself.
- Read each question carefully.
- Be especially alert when double negatives are used.

1 - 2

- Reread ALL questions containing negative words such as "not," "least" or "except."
- If a question is long and complex, read the final sentence, look at the options and then look for the subject and verb.
- Check for qualifying words such as "all," "most," "some," "none," "highest-to-lowest" and "smallest-to-largest."
- Check for key words such as input, output, tool, technique, initiating, planning, executing, monitoring and controlling and closure.
- Decide in your mind what the answer should be, then look for the answer in the options.
- Reread the questions and eliminate options that are NOT correct.
- The correct answer will include a PMI term.
- Make sure you look at ALL the options.
- Mark questions to come back to.

TIME MANAGEMENT DURING THE EXAM

- Keep track of time (you have approximately 1 minute and 15 seconds for each question).
- Set up a time schedule for each question.
- Allow time for review of the exam.
- To stay relaxed, keep on schedule.
- Answer all questions in order without skipping or jumping around.
- If you are unsure, take a guess and mark the question to return to later; do not linger.
- If you have memorized any formulas, use the scratch paper provided to write them down before you start the exam.
- For questions involving problem solving:
  - Write down the formulas before solving.
  - If possible, recheck your work in a different way — for example, rationalize.
- Subsequent questions may stimulate your memory and you may want to reevaluate a previous answer.
- A lapse in memory is normal.

1 - 3

- You will not know all the answers.
- Take your time.
- Do not be in a rush to leave the exam.
- Before turning in the exam, verify that you have answered all questions.

FAQS ABOUT THE EXAM

- Can you bring materials with you?
  NO.
- What is the physical setting like?
  It is a small room or carrel with a computer, chair, desk and trash can.
- Can you take food or drink into the exam area?
  NO food or drink is allowed.
- Can you take breaks during the exam?
  YES. You can go to the restroom; your clock is ticking all the time. You need to determine if you have time and need to take a break to clear your mind.
- What are the time constraints?
  You have 4 hours (with an additional 15-minute tutorial and 15-minute survey).
- Are the exam questions grouped by knowledge area such as scope, time and cost?
  NO. The 200 questions are randomly scattered across the process groups and knowledge areas.
- Can you take paper and pen into the exam area?
  NO. Pencils and 6 sheets of paper (one at a time) are supplied.
- Can you see both the question and the answer on the same screen?
  YES.
- Is there a way to mark out or eliminate options that you immediately know are not correct?
  NO. You can work only on a piece of scratch paper.
- Is there a way to mark questions you are doubtful of?
  YES.

- When you are done, can you review the exam?
  YES.
- Can you review just the questions you marked
  as doubtful?
  YES.
- Do you get immediate exam results?
  YES, if you are taking an online exam. After you
  are done, hit the SEND button. The computer will
  ask if you are sure. After you hit SEND, you will fill
  out an online evaluation of the exam process
  consisting of about ten questions. A Prometric staff
  person will give you a detailed report of your results.

READING THE RESULTS PRINTOUT

- Results are broken down by process group and then
  by knowledge area.
- For each process group or knowledge area set, there
  are two columns: the number of questions in that
  set and how many you got right.

MEMORIZATION TIPS FOR PERFORMANCE DOMAINS, PROCESS GROUPS, KNOWLEDGE AREAS AND PROCESSES

As stated in the *Role Delineation Study*, PMI defines
the field of project management as consisting of 6
Performance Domains:
- Initiating
- Planning
- Executing
- Monitoring and Controlling
- Closing
- Professional Responsibility

In alignment with the first 5 performance domains are the 5
Process Groups. Each process group contains 2 or more

1

processes. The process groups with their corresponding process counts are:

- Initiating (2)
- Planning (21)
- Executing (7)
- Monitoring and Controlling (12)
- Closing (2)

This yields a total of 44 processes. The process groups are discussed in detail in Chapter 3 of this study guide.

There are 9 **Knowledge Areas**. Each of the processes, in addition to belonging to a process group, also belongs to a knowledge area. The knowledge areas with their corresponding process counts are:

- Integration (7)
- Scope (5)
- Time (6)
- Cost (3)
- Human Resources (4)
- Quality (3)
- Communications (4)
- Risk (6)
- Procurement (6)

The individual processes are discussed in the knowledge area Chapters 4 through 12.

Page 70 of the PMBOK Guide has a comprehensive chart that cross-references the individual processes, knowledge areas and process groups.

Many people like to use creative phrases that jog the memory to remember lists and sequences. Examples of memorable phrases follow for the 5 process groups and the 9 knowledge areas.

> **EXAM TIP**
>
> Come up with your own creative phrases to remember processes in each of the 9 knowledge areas.

Memorization Tip for the 5 Process Groups:
Henry **I**nitiated a committee named **PEMC**o to **C**lose down the railway line.
1. **I**nitiating
2. **P**lanning
3. **E**xecuting
4. **M**onitoring and **C**ontrolling
5. **C**losing

Memorization Tip for the 9 Knowledge Areas:
In**ST**antly a**CQ**uaint **H**en**R**y with scope **CR**ee**P**:
1. **I**ntegration
2. **S**cope
3. **T**ime
4. **C**ost
5. **Q**uality
6. **H**uman **R**esources
7. **C**ommunications
8. **R**isk
9. **P**rocurement

You may want to devise your own memorization tips for processes in each of the knowledge areas. Here is an example of a **Memorization Tip for the Project Scope Management Processes:**
With my tele**SCOPE**, I **Plan** to **Define** and **Create WeBS** of **Verifi**able **Control**led material.
1. **Scope Planning**
2. **Scope Definition**
3. **Create WBS**
4. **Scope Verification**
5. **Scope Control**

FORMULAS, EQUATIONS AND RULES

Some formulas, equations and techniques must be memorized to answer exam questions effectively. The most important items to remember are listed here. Most of these are discussed in more detail in the following chapters.

1. Project Network Schedules

Network schedules are created after duration estimates and the relationships between the work packages have been determined. Following the path(s) from left to right makes a forward pass.
- Forward Pass
  - Yields early start (ES) and early finish (EF) dates
  - Early finish = early start + duration
  - RULE: If there are multiple predecessors, use LATEST EF to determine successor ES.

After all paths have been given their forward path, they are traversed from right to left to make a backward pass.
- Backward Pass
  - Yields late start (LS) and late finish (LF) dates
  - Late start = late finish - duration
  - RULE: If there are multiple successors, use EARLIEST LS to determine predecessor LF.

Once the forward and backward passes have been completed, the total float for the node can be calculated by:
- Total float = late finish - early finish

2. Normal Distribution

The normal distribution, commonly known as the bell curve, is a symmetrical distribution, as shown in Figure 1-1. Each normal curve can be distinctly described using the mean and sum of the values. The possibility of achieving the project objective in the mean time or cost is 0%, with a 50% chance of exceeding the mean and a 50% chance of beating the mean. Adding one or more standard deviations (σ) to the mean increases the chances of falling within the range. The probability of falling within 1σ, 2σ or 3σ from the mean is:

- $1\sigma = 68.27\%$
- $2\sigma = 95.45\%$
- $3\sigma = 99.73\%$
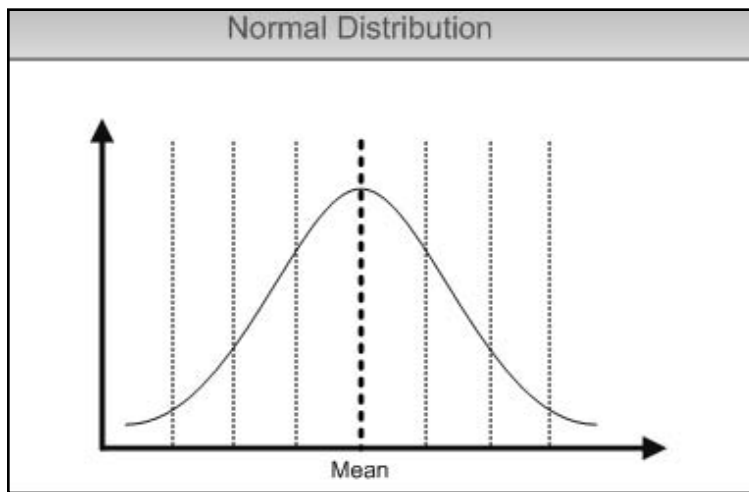
Figure 1-1
Normal
Distribution

1

3. Average or Triangular Distribution

When there are 3 possible values, each of which is equally likely, the distribution takes on the shape of a triangle, as shown in Figure 1-2.
- With a = lowest value, b = highest value and m = most likely value, variance for a task (V) (variance is not on the exam)
  - $V = [(a - b)^2 + (m - a)(m - b)]/18$
- Mean (μ)
  - $\mu = (a + m + b)/3$
- Standard deviation (σ)
  - $\sigma = \sqrt{V}$

Figure 1-2
Triangular
Distribution
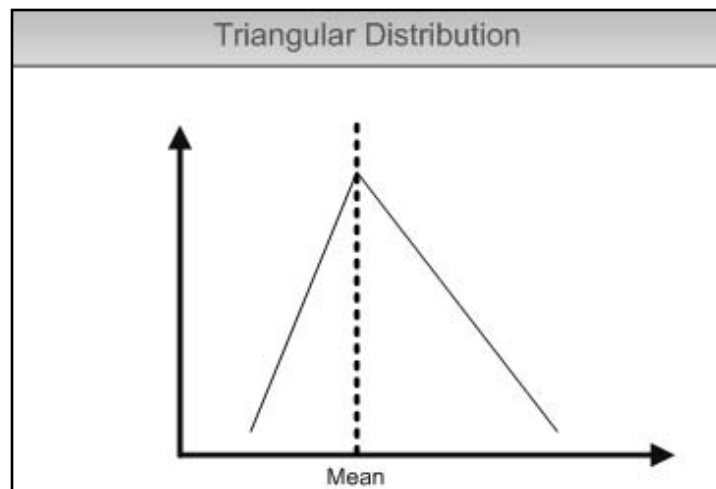
4. Weighted-Average or Beta Distribution

The beta distribution is like the triangular distribution except more weight is given to the most likely estimate. This may result in either a symmetrical or an asymmetrical (skewed right or skewed left) graph. A symmetrical graph is shown in Figure 1-3.
- Where O = optimistic estimate, ML = most likely estimate and P = pessimistic estimate, variance for a task (V)
  - $V = \sigma^2$
- Mean (μ)
  - $(\mu) = [O + 4(ML) + P]/6$
- Standard deviation (σ)
  - $\sigma = (P - O)/6$
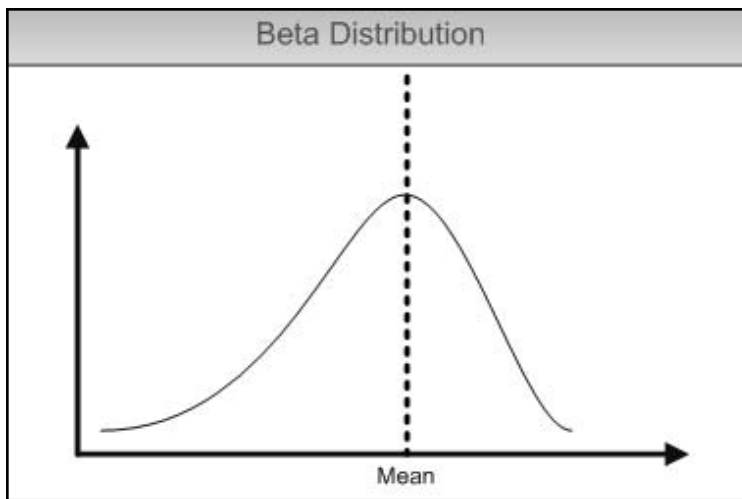
Figure 1-3
Weighted-Average
or Beta Distribution

5. Statistical Sums

- The project **Mean** is the sum of the means of the individual tasks: $\mu_p = \mu_1 + \mu_2 + \ldots + \mu_n$
- The project **Variance** is the sum of the variances of the individual tasks: $V_p = V_1 + V_2 + \ldots + V_n$
- The project **Standard Deviation** is the square root of the project variance: $\sigma_p = \sqrt{V_p}$

1 - 11

6. Earned Value Technique

The earned value technique is used to monitor the progress of a project and is a tool and technique of processes in the integration, time, cost and communication knowledge areas. It uses 3 independent variables:

- **Planned Value (PV):** PV is the budget or the portion of the approved cost estimate planned to be spent during a given period.
- **Actual Cost (AC):** AC is the total of direct and indirect costs incurred in accomplishing work during a given period.
- **Earned Value (EV):** EV is the budget for the work accomplished in a given period.

These 3 values are used in combination to provide measures of whether or not work is proceeding as planned. They combine to yield the following important formulas:

- **Cost Variance (CV)** = EV - AC
- **Schedule Variance (SV)** = EV - PV
- **Cost Performance Index (CPI)** = EV/AC
- **Schedule Performance Index (SPI)** = EV/PV

Positive CV indicates costs are below budget.
Positive SV indicates project is ahead of schedule.

Negative CV indicates cost overrun.
Negative SV indicates project is behind schedule.

CPI greater than 1.0 indicates costs are below budget.
SPI greater than 1.0 indicates project is ahead of schedule.

CPI less than 1.0 indicates costs are over budget.
SPI less than 1.0 indicates project is behind schedule.

A **Cumulative CPI (CPI^C)** is frequently used to forecast the total cost of a project at its completion. It is calculated by summing the EV for each period

(denoted by EV^C) divided by the cumulative actual costs for each period (AC^C).

- $CPI^C = EV^C/AC^C$

7. Estimate at Completion

The estimate at completion (EAC) is the amount the total project is expected to cost on completion and as of the data date (time now). There are 3 formulas listed in the PMBOK Guide for computing EAC. Each of these starts with AC^C and adds a slightly different formula for remaining work. The question of which formula to use will depend on the individual situation and the credibility of the actual work performed compared to budget up to that point. Note that budget at completion (BAC) and estimate to complete (ETC) are defined on the following 2 pages.

This formula is most applicable when future variances are projected to approximate the same level as current variances:

- $EAC = AC^C + ((BAC - EV)/CPI^C)$

This formula is most applicable when the actual performance to date shows that the original estimates were fundamentally flawed or when they are no longer accurate because of changes in conditions relating to the project:

- $EAC = AC^C + New\ ETC$

This formula is most applicable when actual variances to date are seen as being the exception and the expectations for the future are that the original estimates are more reliable than the actual work effort to date:

- $EAC = AC^C + BAC - EV$

This is another formula that might appear on the exam. It is similar to the first EAC formula but is not included in the PMBOK Guide. This formula is applicable when the project manager desires to make

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an adjustment to the budget based on the level of work variance to date:

- EAC = BAC/CPI^C
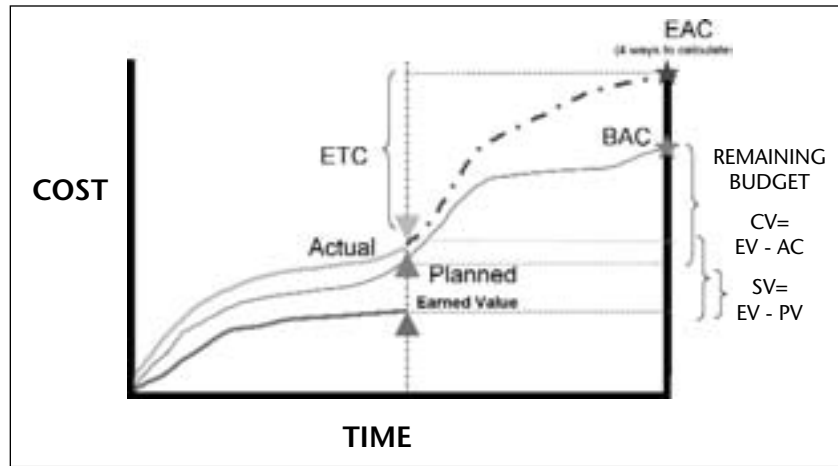
Figure 1-4
Earned Value
S-Curve

Formulas to be used with Figure 1-4 above include:

- CPI = EV/AC
- SPI = EV/PV
- % Complete = EV/BAC

8. Remaining Budget

- RB = Remaining PV
  or
- RB = BAC - EV

9. Budget at Completion

- BAC = the total budgeted cost of all approved activities

10. Estimate to Complete

The estimate to complete (ETC) is the estimate for completing the remaining work for a scheduled

activity. Like the EAC formulas above, there are 3 variations:
- ETC = an entirely new estimate
- ETC = (BAC - EV^C) when past variances are considered to be atypical
- ETC = (BAC - EV^C)/CPI^C when prior variances are considered to be typical of future variances

11. Percent Complete

- Percent Complete = EV/BAC

12. Communications Channels

- Channels = [n(n - 1)]/2
  where "n" = the number of people

13. Rule of Seven

In a control chart the "rule of seven" is a heuristic stating that if 7 or more observations occur in one direction either upward or downward, or a run of 7 observations occur either above or below the mean, even though they may be within the control lines, they should be investigated as if they had an assignable cause. The reason for this rule is that, if the process is operating normally, the observations will follow a random pattern and it is extremely unlikely that 7 observations in a row would occur in the same direction above or below the mean.

The probability of any given point going up or down or being above or below the mean is 50-50 (i.e., 50%). The probability of 7 observations being consecutively in one direction or above or below the mean would be calculated as 0.50^7, which equals 0.0078 (i.e., less than 1%).

SAMPLE STUDY SCHEDULE

Week/Day	Knowledge Area/ Domain	PMBOK Guide Chapter	Study Guide Chapter	Goals
1	Framework	1 and 2	1 and 2	40 questions
2	Processes	3	3	40 questions
3	Integration	4	4	40 questions
4	Scope	5	5	40 questions
5	Time	6	6	40 questions
6	Cost	7	7	40 questions
7	Communications	10	10	40 questions
8	Risk	11	11	40 questions
9	Human Resources	9	9	40 questions
10	Procurement	12	12	40 questions
11	Quality	8	8	40 questions
12	Professional Responsibility		13	40 questions
13	Review		2 to 13	100 questions
14	Review		1 to 13	100 questions

SAMPLE ASSESSMENT EXAM

Readers should give themselves 50 minutes to answer these 40 sample exam questions. This timing is similar to the average time per question used by PMI in the actual PMP exam. A passing score is 70% or 28 out of 40 correct answers.

1. Which of the following is not part of the project management plan?

   a) The staffing plan
   b) The WBS
   c) Performance measurement baselines for schedule and cost
   d) The project team members' contribution plan

2. Projects are typically initiated as a result of any of the following except:

   a) The project expeditor's need to practice creating a project plan
   b) The business need that will increase the organization's revenue
   c) A market demand for more technologically advanced products
   d) A social need identified by a feasibility study

3. Once the network diagram is laid out, the project manager will conduct a forward pass and a backward pass through the network. This will provide information on the _____ and identification of the _____.

   a) Slack for each activity, critical path
   b) Slack for each activity, high-risk activities
   c) Resource shortages, slack times
   d) High-risk activities, noncritical paths

Notes:
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4. The majority of firms utilizing project management may typically experience any of the following except:

   a) Better control and customer relations
   b) Improved coordination and a reduction in organizational complexity
   c) Additional costs in rework and warranties
   d) Greater adherence to organizational policy and procedures

5. The project manager reviews work results of completed project scope activities and measures these against the:

   a) Requirements
   b) Project management plan
   c) Scope management plan
   d) WBS

6. Of the 6 tools and techniques for cost control, which one integrates cost and schedule information as a key element of its approach?

   a) Performance reviews
   b) Variance analysis
   c) Trend analysis
   d) Performance measurement analysis

7. When one large project has several smaller projects within it, this is known as:

   a) Project or subproject
   b) Program or project
   c) Operation or project portfolio
   d) Project life cycle or product life cycle

Notes:

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8. One of the major problems facing project managers in acquiring staff is that functional managers are not willing to give up their best people, and even when they do, they do not give up controls such as salary and promotion over their people. This is a disadvantage of the _____ organizational structure.

   a) Weak matrix
   b) Projectized
   c) Virtual
   d) Functional

9. General management skills provide much of the foundation for building project management skills. However, managing a project requires which additional skill?

   a) Negotiating to acquire adequate resources
   b) Motivating and inspiring team members
   c) Effecting tradeoffs concerning project goals
   d) Understanding health and safety practices

10. The sequence of activities that cannot be delayed during the course of the project is referred to as the:

   a) Critical path
   b) Master schedule
   c) Slack line
   d) Action plan

11. Initial task(s) required to be performed by the project manager include all of the following except:

   a) Budget and schedule preparation
   b) Selection of people to serve on the project team
   c) Getting to know the project's client
   d) Contract administration

Notes:

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12. Cost of changes in requirements tends to:

   a) Increase as the project starts up and progresses
   b) Decrease as the project starts up and progresses
   c) Increase or decrease depending on the scope of the change
   d) Always require the project sponsor's approval

13. One purpose for risk management is:

   a) To make sure the schedule is met
   b) To increase the probability and impact of positive events
   c) Assessment
   d) Contingency planning

14. You are asked to take on a project that is in trouble. In replanning the project, you should place the highest priority on:

   a) Schedule, as the project is already behind schedule
   b) Quality, cost or schedule depending on the project objectives
   c) Cost, then schedule, then quality
   d) Quality, because with good quality, cost and schedule will come back in line

15. Why use risk management?

   a) Some businesses have minimal risk
   b) Planning only focuses on the past
   c) Uncertainty is often explicit and formal
   d) Projects contain too many surprises

16. To ensure control over the incidence and frequency of change requests, the project manager establishes a:

   a) WBS
   b) Change control system
   c) MBO chart
   d) Work procedure schedule

Notes:

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17. A project is an endeavor with a well-defined purpose that is:

   a) Ongoing and repetitive
   b) Unique and temporary
   c) A combination of interrelated activities
   d) Started and ended on certain days during each month

18. You have just been notified that your customer has money problems and will not be able to pay for the upcoming milestone deliverables. As project manager you should:

   a) Tell everyone to stop working
   b) Release 90% of the project team
   c) Reduce the scope and begin administrative closure
   d) Shift these deliverables to the next phase to give the customer additional time to obtain funds

19. When planning a project, the team should take into account:

   a) Technical training requirements
   b) The overall strategic goals of the organization
   c) Project requirements, resources and schedules only
   d) The project manager's experience

20. Which of the following is the proper sequence of planning activities for a project?
   I.   Status report description
   II. Detailed task description
   III. Project deliverables decomposition
   IV. Product acceptance criteria
   V.   Budgets and schedules

   a) III, V, I, II, IV
   b) III, V, I, IV, II
   c) IV, III, II, I, V
   d) IV, II, V, I, III

Notes:

1 - 21

21. During the closing phase of a project, employees are concerned about their next assignment in which type of organizational structure?

    a) Projectized
    b) Strong matrix
    c) Balanced matrix
    d) Functional

22. In a fixed price contract, who bears the greater burden of risk?

    a) The seller organization
    b) The buyer organization
    c) The project sponsor
    d) Both the buyer and the seller share the risk

23. The information from the WBS is used to derive all but which of the following:

    a) The project master schedule
    b) The project budget
    c) The project objectives
    d) Work package descriptions

24. A subcontractor is 2 weeks late in his deliverables and asks the project manager to accept these late deliverables in exchange for a reduction in his fee. This is an example of the _____ technique of conflict resolution.

    a) Forcing
    b) Problem solving
    c) Compromising
    d) Withdrawal

Notes:

25. As project manager, you notice that a team member is not performing well because he is inexperienced in the technology being utilized. What should be your best solution?

   a) Report the team member's bad performance to his functional manager
   b) Colocate the team member right next to your office so you can check on his work
   c) Discuss a reward mechanism with the team member to encourage him to work harder
   d) Arrange for the team member to get training in the required technology

26. Primary objectives of project management include:

   a) Profitability, competitive advantages and gaining a leadership position
   b) Meeting project requirements in performance, time and cost
   c) Upgrading the system, implementing new technology and facilitating operational change
   d) Solve business problems

27. Projects sometimes get authorized, even though they may not be profitable when fully costed, because the project serves:

   a) As a means to develop new technology
   b) To improve the organization's competitive position
   c) As a means to broaden a product line or a line of business
   d) All of the above

28. Cost estimating includes identifying and considering various costing alternatives; it requires you to use as inputs all of the following except:

   a) Cost of financing such as interest charges
   b) The WBS
   c) Resource rates
   d) Parametric modeling

Notes:

29. Good project objectives must be:

    a) General rather than specific
    b) Established without considering resource bounds
    c) Realistic and attainable
    d) Measurable, intangible and verifiable

30. A project is fully complete when:

    a) All work has been completed
    b) The customer has formally accepted the project results and deliverables
    c) Financial records for the project have been added to the project archives
    d) The project manager has arranged the project closure celebration

31. For effective communication, the message should be oriented to the _____.

    a) Sender
    b) Receiver
    c) Media
    d) Corporate culture

32. Slack or float is calculated by taking the difference between:

    a) LF and EF of an activity
    b) LF and duration of an activity
    c) ES and LF of an activity
    d) ES and LS of an activity

33. A work package is a:

    a) Deliverable at the lowest level of the WBS
    b) Task with a unique identifier
    c) Required level of reporting
    d) Task that can be assigned to one or more organizational units

Notes:

1 - 24

34. _____ is present in all projects.

    a) Knowledge
    b) Uncertainty
    c) Capital investment
    d) Contract closure

35. In the precedence diagramming method (PDM), common dependencies include:

    a) Start-to-node
    b) Finish-to-start
    c) Arrow-on-node
    d) Start-to-finish

36. Resource leveling shifts tasks within their slack allowances in order to minimize the period variations in resource use. It often results in:

    a) Project duration that is longer than the preliminary schedule
    b) Project duration that is shorter than the preliminary schedule
    c) No change to the project duration as the critical path is unchanged
    d) Fast tracking

37. Your project has fallen behind schedule and you are trying to get it back on track so you decide to crash some tasks. You will be most successful in completing the project on time and within budget by:

    a) Asking the customer which tasks could be crashed
    b) Crashing all tasks that are estimated to take more than 5 days
    c) Evaluating the risk impact of crashing tasks on the critical path
    d) Evaluating the cost and risk impact of crashing tasks with one or more days of float

Notes:

1 - 25

38. A critical resource used in project management that can neither be inventoried nor renewed is:

   a) Money
   b) People
   c) Data
   d) Time

39. The customer has asked for major changes that will incur significant costs. If the project is near completion, the project manager should:

   a) Ask the customer for a description of and reason for the changes
   b) Say no to the customer as the project is almost complete and less cost flexibility exists
   c) Meet with the project sponsor and determine if the changes should be made
   d) Meet with the project team to determine who can work overtime

40. Project management reports should be all of the following except:

   a) Problem solving
   b) Scorekeeping
   c) Attention getting
   d) Attention directing

SAMPLE ASSESSMENT EXAM ANSWERS
with explanations and references are in
Chapter 15, Appendix A.

Notes:

FRAMEWORK

CHAPTER 2 | FRAMEWORK

PROJECT MANAGEMENT FRAMEWORK

Chapters 1 and 2 of the PMBOK Guide provide a basic structure to the field of project management. These chapters provide an introduction to project management and the context or environment in which projects operate. Together, these 2 chapters describe the Project Management Framework. Framework itself is not a knowledge area or a performance domain but it contains many important definitions and concepts that must be understood before attempting the remaining chapters of the PMBOK Guide.

Framework questions on the PMP certification exam mainly cover definitions, concepts and approaches. You must be very familiar with PMI terminology. Projects, programs, project management, stakeholders, project and product life cycles, organizational structures and influences are among the topics covered.

> **EXAM TIP**
> Reference the Glossary of the PMBOK Guide frequently to learn PMI terminology.

Things to Know

1. **The Triple Constraint**
2. **Project Life Cycles**
3. **The Influence Curve**
4. **Forms of Organizational Structure**
5. **Management by Objective**

Key Definitions

Operation: ongoing work performed by people, constrained by resources, planned, executed, monitored and controlled. Unlike a project, operations are repetitive; e.g., the work performed to carry out the day-to-day business of an organization is operational work.

Portfolio: a collection of programs, projects and additional work managed together to facilitate the attainment of strategic business goals.

Product Life Cycle: the collection of stages that make up the life of a product. These stages are typically introduction, growth, maturity and decline.

2 - 1

2

Program: a group of related projects managed in a coordinated way; e.g., the design and creation of the prototype for a new airplane is a project, manufacturing 99 more airplanes of the same model is a program.

Project: work performed by people, constrained by resources, planned, executed, monitored and controlled. It has definite beginning and end points and creates a unique end result.

Project Life Cycle: the name given to the collection of various phases that make up a project. These phases make the project easier to control and integrate. The result of each phase is one or more deliverables that are needed and utilized in the next few phases. The work of each phase is accomplished through the iterative application of the initiating, planning, executing, monitoring and controlling and closing process groups.

Project Management: the ability to meet project requirements by using various knowledge, skills, tools and techniques to accomplish project work. Project work is completed through the iterative application of initiating, planning, executing, monitoring and controlling and closing process groups. Project management is challenged by competing and changing demands for scope (customer needs, expectations and requirements), resources (people, time and cost), risks (known and unknown) and quality (of the project and product).

Project Management System: the collection of tools, methodologies, techniques, standards and resources used to manage a project. These may be formal systems and strategies determined by the organization or informal methods utilized by project managers.

Stakeholders: individuals and organizations who are involved in or may be affected by project activities. Examples of stakeholders include the project manager, team members, the performing organization, the project

2 - 2

sponsor and the customer. PMI advocates that any discrepancies between stakeholder requirements should be resolved in favor of the customer. Therefore, the customer is one of the most important stakeholders in any project.

Subproject: a component of a project. Subprojects can be contracted out to an external enterprise or to another functional unit.

Tight Matrix: a project team that is colocated. This usually takes place in a strong matrix organizational structure. Colocation also characterizes projectized organizations without matrixed relationships.

Triple Constraint: the 3 demands of project scope, time, and cost that must be balanced to ensure project quality.

THE TRIPLE CONSTRAINT

Projects are often performed under many constraints that could impinge on the project's successful or nonsuccessful completion. In addition, these constraints interact and require tradeoffs or decisions that must be made to fulfill project objectives.

A common project tradeoff involves the competing demands of time vs. cost vs. scope (i.e., the project requirements). Increased performance in 1 area may adversely affect performance in another.

These 3 demands are so closely intertwined that they have come to be known as the **Triple Constraint.** They are depicted by a triangle, with the sides of the triangle representing each one of the constraints as in Figure 2-1. If any 1 side of the triangle is increased or decreased, at least 1 other side of the triangle must be increased or decreased for the triangle to stay whole.

For example, additional scope requirements will usually mean either more time to complete those requirements or more resources to work on these requirements, thereby increasing project cost.
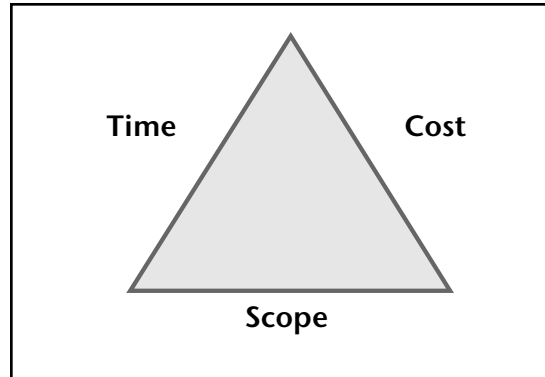
Figure 2-1
The Triple Constraint

PROJECT LIFE CYCLES

Project life cycles define:
- The phases that a project goes through from initiation to closure (The PMBOK Guide states that a project contains an initial phase, one or more intermediate phases and a final phase.)
- The technical work to be done in each phase
- The skills involved in each phase
- The deliverables and acceptance criteria for each phase
- How each phase will be monitored, controlled and approved before moving to the next phase

A typical project life cycle may contain the following 4 phases:
- **Concept Phase:** the problem to be solved is identified. Deliverables from this phase could be:
  - Feasibility studies that clarify the problem to be solved
  - Order of magnitude forecasts of cost
  - A project charter to grant permission for the project to proceed

2 - 4

2

- **Development and Planning Phase:** what needs to be done is identified. Deliverables created here include:
  - The scope statement
  - A WBS
  - A schedule baseline
  - A determination of budgetary costs and a developed budget
  - Identification of resources and team members with levels of responsibility
  - A risk assessment
  - A communications management plan
  - The project plan
  - Control systems and methods for handling change control

- **Implementation and Execution Phase**: actual work of the project is carried out. Deliverables include:
  - Execution results for work packages
  - Status reports and performance reporting
  - Procurement of goods and services
  - Managing, controlling and redirecting (if needed) of scope, quality, schedule and cost
  - Resolution of problems
  - Integration of the product into operations and the transferral of responsibility

- **Termination and Close Phase:** the product is finalized, evaluated and rejected or accepted. Deliverables include:
  - Formal acceptance
  - Documented results and lessons learned
  - Reassignment or release of resources

The concept phase is an initial phase of the project life cycle, the intermediate phases of the project life cycle are the development and planning and implementation and execution phases and termination and close is the final phase in the project life cycle.

2

Relationship of Project Life Cycles to Product Life Cycles

The life cycle of a project is only one aspect of the overall product life cycle. A project can be initiated to determine the feasibility of a product in the introductory stage of a product life cycle. There may be a second project to address the design and development of the product once the feasibility study has determined the viability of the product.

The number of projects initiated to support the product life cycle will vary from organization to organization and from product to product.

Project life cycle phases and product life cycle phases are often defined similarly. For example, a project life cycle may start with a feasibility phase to determine if the project can achieve its objectives while the first phase in a product life cycle might consist of a market study to determine if the product will meet the sales goals.

Phases of both project and product life cycles are generally performed in sequence. However, as one phase transitions to the next they will often overlap. That is, the next phase of the product life cycle is initiated before the closing of the previous phase. Similarly, the process groups are repeated within each phase of the project life cycle to guide the project to completion. This overlapping of process groups within phases can be seen in the PMBOK Guide's Figure 2-4.

THE INFLUENCE CURVE

The ability of a stakeholder to influence a change is high at the beginning of a project and decreases as the project progresses. Conversely, the impact or cost of a change is low at the beginning of a project and increases as the project progresses, as seen in Figure 2-2.
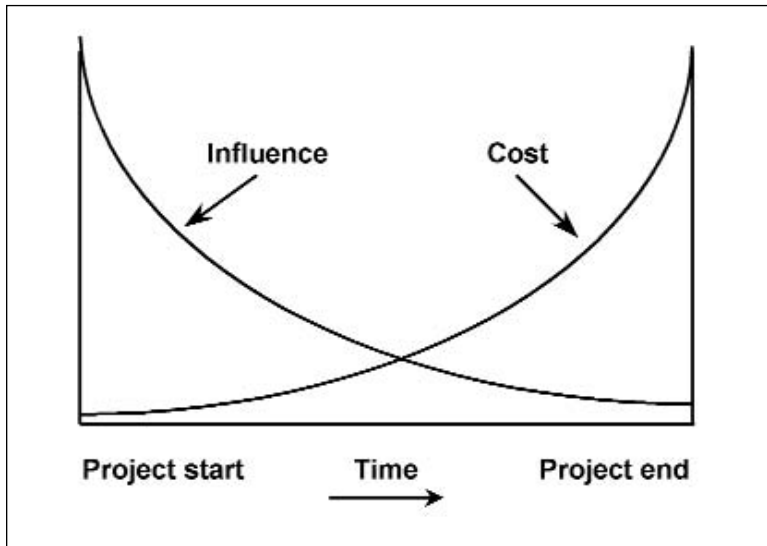
Figure 2-2
The Influence Curve

FORMS OF ORGANIZATIONAL STRUCTURE

PMI stresses the importance of organizational structures as the organizational structure will often constrain the availability of resources for a project. Become very familiar with Figure 2-6 in the PMBOK Guide, Organizational Structure Influences on Projects.

Functional Organization

In a functional organization, each employee is in a hierarchical structure with one clear superior. Staff is grouped by specialty, such as accounting, marketing or engineering. The pros and cons of a functional organization are shown in Figure 2-3. Included in a functional organization is the use of a project expeditor or a project coordinator.

Project Expeditor (PE): the PE is a facilitator who acts as the staff assistant to the executive who has ultimate responsibility for the project. This person has little formal authority. The PE's primary responsibility is to communicate information between the executive and the workers. This type of structure is useful in functional organizations where project costs are relatively low.

EXAM TIP
A functional organization is recognized by PMI as being the most prevalent type of organizational structure in place today. Therefore, on the exam, when a question compares organizations and the type of the second organization is not mentioned, assume it is a functional organization.

2 - 7

2

PROS	CONS
• Flexibility in staff use • Availability of experts for multiple projects • Grouping of specialists • Technological continuity • Normal advancement path	• Client is not the focus of activity • Function rather than problem oriented • No one fully responsible for the project • Slow response to the client • Tendency to suboptimize • Fragmented approach to the project

Figure 2-3
Functional
Organization
Pros and Cons

Project Coordinator (PC): the PC reports to a higher level in the hierarchy and is usually a staff position. A PC has more formal authority and responsibility than a PE. A PC can assign work to functional workers. This type of structure is useful in functional organizations in which project costs are relatively low compared to those in the rest of the organization.

Matrix Organization

Understand the different matrix organizations. The pros and cons of the matrix organization are listed in Figure 2-4.

PROS	CONS
• Project is the point of emphasis • Access to a reservoir of technical talent • Less anxiety about team future at project completion • Quick client response • Better firm-wide balance of resources • Minimizes overall staff fluctuations	• Two-boss syndrome • More time and effort needed to acquire team members • Functional managers may be reluctant to share top performers • Conflicts of authority between project manager and functional manager • Careful project monitoring required • Political infighting among project managers

Figure 2-4
Matrix Organization
Pros and Cons

On the matrix organization, you should also see the PMBOK Guide:
- Figure 2-9 Weak Matrix Organization
- Figure 2-10 Balanced Matrix Organization
- Figure 2-11 Strong Matrix Organization
- Figure 2-12 Composite Organization

2 - 8

Matrix organizations have:
- High potential for conflict
- Team members who are borrowed from their functional groups and who are therefore caught between their functional manager and their project manager (but as projects draw to a close, these team members know they have a "home" with their functional groups)
- Team members who only see pieces of the project and may not see the project to completion
- An advantage in relatively complex projects where cross-organizational knowledge and expertise are needed
- Project managers whose authority and time on a project increases from weak matrix (lowest) to balanced matrix to strong matrix

Projectized Organization

In a projectized organization, team members are often colocated and the project manager has a great deal of independence and authority. Team members worry about their jobs as a project draws to a close. Figure 2-5 shows the pros and cons of the projectized organization.

> **EXAM TIP**
>
> PMI places enormous emphasis on the social, economic and environmental influences on projects. This is apparent in the *Role Delineation Study* by PMI (2000). A key influence on the role and authority of the project manager is the various organizational structures. Anyone wishing to pass the PMP exam must understand the organizational influences and roles of functional, weak, balanced, strong matrix, projectized, project office, project expeditor and project coordinator types of organizational structures.

PROS	CONS
• One boss • Project manager has great deal of independence and authority • Team members are often colocated • Team members are treated as insiders • Most resources are involved in project work	• If not tracked closely, hourly costs may become inflated while specialists are waiting between assignments or are on call • Bureaucracy, standards, procedures, and documentation may result in an abundance of red tape

Figure 2-5
Projectized
Organization
Pros and Cons

2

Project Management Office (PMO)

The project management office is an additional layer of organization dedicated to helping project managers. Although most often found in matrixed or projectized organizations, they may exist in any type of organizational structure. Figure 2-6 shows the pros and cons of adding the PMO layer of organization.

Figure 2-6
PMO Pros and Cons

PROS	CONS
• Emphasis on project management career paths • Less anxiety among project managers about next assignment at project completion • Centering of project management competencies • Standardization of the project management system • Centralized management	• Additional layer of hierarchy • Some of the adverse aspects of a matrix organization • All of the adverse aspects of a projectized organization • Lack of application knowledge by the project managers

MANAGEMENT BY OBJECTIVE (MBO)

MBO is a system of managerial leadership that defines individual managerial responsibilities in terms of corporate objectives. MBO is a proactive type of management. The pitfalls of MBO are that it is time consuming, it can become the sole focus and it does not link objectives to performance appraisals.

SAMPLE PMP EXAM QUESTIONS ON MANAGEMENT FRAMEWORK

1. The difference between a project life cycle and a product life cycle is:

   a) A project may be one phase of the overall product life cycle
   b) The product is the result of the project
   c) There is no difference between project and product life cycles
   d) Project life cycles are typically longer than product life cycles

2. The ability of the stakeholders to influence the final characteristics of the project's product and cost:

   a) Can be difficult to measure
   b) Can increase over the course of the project
   c) Is highest at the start and gets progressively lower as the project continues
   d) Is dependent on the amount of contingency planned

3. Phase exits, stage gates or kill points are all terms for:

   a) Phase end reviews
   b) Project closure criteria
   c) Kickoff for next phase
   d) None of the above

4. Your boss asks you to create a detailed project budget; in order to do this you use:

   a) A skill from facilities management
   b) A skill from project management planning
   c) A skill from general management
   d) A skill commonly used in both general and project management

2

2 - 11

5. Politics may be defined as:

   a) The totality of socially transmitted behavior patterns, arts, beliefs, institutions and all other products of human work and thought
   b) Getting collective action from a group of people who may have quite different interests
   c) Small changes that can translate, usually with a time lag, into cataclysmic upheavals in the project
   d) The ability to influence behavior, to change the course of events, to overcome resistance and to get people to do things that they would not otherwise do

6. A standard is a:

   a) Category of projects that have common elements
   b) Document approved by a recognized body, with which compliance is not mandatory
   c) Document that lays down product, process or service characteristics with which compliance is mandatory
   d) Totality of socially transmitted behavior patterns, arts, beliefs, institutions and all other products of human work and thought

7. General management consists of:

   a) Developing a project plan for a desired outcome
   b) Managing projects that do not require budget or schedule control
   c) Planning, organizing, staffing, executing and monitoring and controlling the operations of an ongoing enterprise
   d) Managing programs only, where a program is a group of projects managed in a coordinated way to obtain benefits not available from managing them individually

Notes:

8. Which of the following is not considered a key stakeholder on a project?

   a) The financial institution
   b) The project manager
   c) The customer
   d) The performing organization

9. Functional organizations do not have:

   a) Project managers with little or no authority
   b) The organization's personnel assigned full time to projects
   c) Part-time administrative staff
   d) A hierarchy in which each employee has one clear superior

10. In order to successfully manage projects, the project manager must understand how each of the following influence the project except:

    a) Organizational cultures
    b) Organizational structure
    c) Contract file
    d) Whether or not the organization derives its revenue from projects

11. What is a tight matrix?

    a) A balanced matrix organization
    b) An organization in which all matrix team members are brought together in one location
    c) An organization in which functional managers operate in a dual reporting structure reporting to both their own departments and the project manager
    d) An organization in which all project team members report to the project manager

Notes:

2 - 13

12. The nearer a project is to _____, the less cost flexibility exists.

    a) Kickoff
    b) Initiation
    c) Completion
    d) Formal acceptance

Notes:

**ANSWERS AND REFERENCES FOR SAMPLE
PMP EXAM QUESTIONS ON
MANAGEMENT FRAMEWORK**
Section numbers refer to the PMBOK Guide.

1. A **Framework Section 2.1**
       A project may be one phase of the overall
       product life cycle. Choice B is not necessarily
       true; choices C and D are false.

2. C **Framework Section 2.1.1**
       See Figure 2-2, Stakeholder's Influence Over Time

3. A **Framework Section 2.1.2**

4. D **Implied in Framework Section 1.5.4**
       Know the general management skills.

5. B **Framework Section 1.5.3**
       Know the political climate that could affect
       the project.

6. B **Framework Section 1.5.2**
       Choice A is an application area, choice C is a
       regulation and choice D is the definition of
       culture.

7. C **Framework Section 1.5.4**
       General management provides the foundation
       for project management skills.

8. A **Framework Section 2.2**
       See the PMBOK Guide's Figure 2-5.

9. B **Framework Section 2.3.3**
       Notice the "not have"; watch out for double
       negatives.

10. C **Framework Section 2.3**
       Project objectives are the desired results of the
       project but do not directly influence how the
       project will be executed.

11. B   Verma, *Organizing Projects,* page 168

12. C   Framework Section 2.1.1

PROCESSES

3

PROJECT MANAGEMENT PROCESSES, PROCESS GROUPS AND THE INTERACTION OF PROCESSES

PMI has created a standard which documents the processes needed to manage a project. These processes are based on best practices that are practiced on most projects, most of the time. However, PMI recognizes that not all of the processes need be, or even should be, applied to all projects all of the time. The project managers and their teams need to consider each process and determine if it is appropriate to their specific situation. This process is called tailoring by PMI. PMI feels that the processes and interactions among processes described in the PMBOK Guide should serve as a baseline for a **Project Management Methodology**. Like any baseline, there will be variances, and those variances must be documented.

Things to Know

1. **Project Management Processes and Process Groups**
2. **Project Management Processes Interactions**

Key Definitions

Input: a tangible item internal or external to the project that is required by a process for the process to produce its output.

Output: a deliverable, result or service generated by the application of various tools or techniques within a process.

Phase: one of a collection of logically related project activities usually resulting in the completion of one or more major deliverables. A project phase is a component of a project life cycle.

Process: a collection of related actions performed to achieve a predefined desired outcome. The PMBOK Guide defines a set of 44 project management processes, each with various inputs, tools, techniques and outputs. Processes can have predecessor or successor processes, so

3

3 - 1

outputs from one process can be inputs to other processes. Each process belongs to one and only one of the 5 process groups and one and only one of the 9 knowledge areas.

Process Group: a logical grouping of a number of the 44 project management processes. There are 5 process groups and all are required to occur at least once for every project. The process groups are performed in the same sequence each time: initiating, planning, executing, more planning and executing as required and ending with closing. The monitoring and controlling process group is performed throughout the life of the project. Process groups can be repeated for each phase of the project life cycle and so are different from phases. Process groups are independent of the application area or the life cycle utilized by the project.

Technique: a defined systematic series of steps applied by one or more individuals using one or more tools to achieve a product or result or to deliver a service.

Tool: a tangible item such as a checklist or template used in performing an activity to produce a product or result.

PROJECT MANAGEMENT PROCESSES AND PROCESS GROUPS

The PMBOK Guide defines 5 process groups required for any project. They are:
- **Initiating:** defining and authorizing the project (or phase of the project)
- **Planning:** defining objectives, refining them and planning the actions required to attain them
- **Executing:** integrating all resources to carry out the plan
- **Monitoring and Controlling:** measuring progress to identify variances and taking corrective action when necessary
- **Closing:** bringing the project or phase to an orderly end, including gaining formal acceptance of the result

The process groups are NOT project phases. In fact, it is not unusual to see all of the process groups represented within a single phase of a larger project.

In preparing for the PMP exam, take the time to read carefully Chapter 3 of the PMBOK Guide. PMI has put a lot of thought into the descriptions of the process groups, the interactions of the processes within them and the relationships of each process group to the other process groups.

Each process group contains a number of processes, as listed below, but PMI has also identified 9 topic-related groupings for the processes called **Knowledge Areas**. The processes associated with a particular knowledge area all address a single topic. For example, the processes within the time knowledge area address defining and planning the project schedule. The PMBOK Guide is organized around these knowledge areas: Chapters 4 through 12 define each of the processes in detail, covering the knowledge areas of integration, scope, time, cost, human resources, quality, communications, risk and procurement. This study guide is organized the same way to facilitate the PMP exam candidate's study. The process group lists below show the process group, the processes in that group and, in parentheses, the knowledge area where that process is described.

Initiating Process Group

1. Develop Project Charter (Integration)
2. Develop Preliminary Project Scope Statement (Integration)

Planning Process Group

1. Develop Project Management Plan (Integration)
2. Scope Planning (Scope)
3. Scope Definition (Scope)
4. Create WBS (Scope)
5. Activity Definition (Time)
6. Activity Sequencing (Time)
7. Activity Resource Estimating (Time)

3 - 3

3

8. Activity Duration Estimating (Time)
9. Schedule Development (Time)
10. Cost Estimating (Cost)
11. Cost Budgeting (Cost)
12. Quality Planning (Quality)
13. Human Resource Planning (Human Resources)
14. Communications Planning (Communications)
15. Risk Management Planning (Risk)
16. Risk Identification (Risk)
17. Qualitative Risk Analysis (Risk)
18. Quantitative Risk Analysis (Risk)
19. Risk Response Planning (Risk)
20. Plan Purchases and Acquisitions (Procurement)
21. Plan Contracting (Procurement)

Executing Process Group

1. Direct and Manage Project Execution (Integration)
2. Perform Quality Assurance (Quality)
3. Acquire Project Team (Human Resources)
4. Develop Project Team (Human Resources)
5. Information Distribution (Communications)
6. Request Seller Responses (Procurement)
7. Select Sellers (Procurement)

Monitoring and Controlling Process Group

1. Monitor and Control Project Work (Integration)
2. Integrated Change Control (Integration)
3. Scope Verification (Scope)
4. Scope Control (Scope)
5. Schedule Control (Time)
6 Cost Control (Cost)
7. Perform Quality Control (Quality)
8. Manage Project Team (Human Resources)
9. Performance Reporting (Communications)
10. Manage Stakeholders (Communications)
11. Risk Monitoring and Control (Risk)
12. Contract Administration (Procurement)

Closing Process Group

1. Close Project (Integration)
2. Contract Closure (Procurement)

PROJECT MANAGEMENT PROCESSES INTERACTIONS

Each process has inputs, tools, techniques and outputs as defined in the PMBOK Guide. You must take the time to learn the flow of the processes within each process group, the relations of processes across process groups and how the outputs of one process become the inputs to other processes.

In order to help you understand how process groups flow and interact with one another, refer to Figure 3-1 and do Exercise 3-1.

Figure 3-1 Interaction of Process Groups (PMBOK Guide Figure 3-11)

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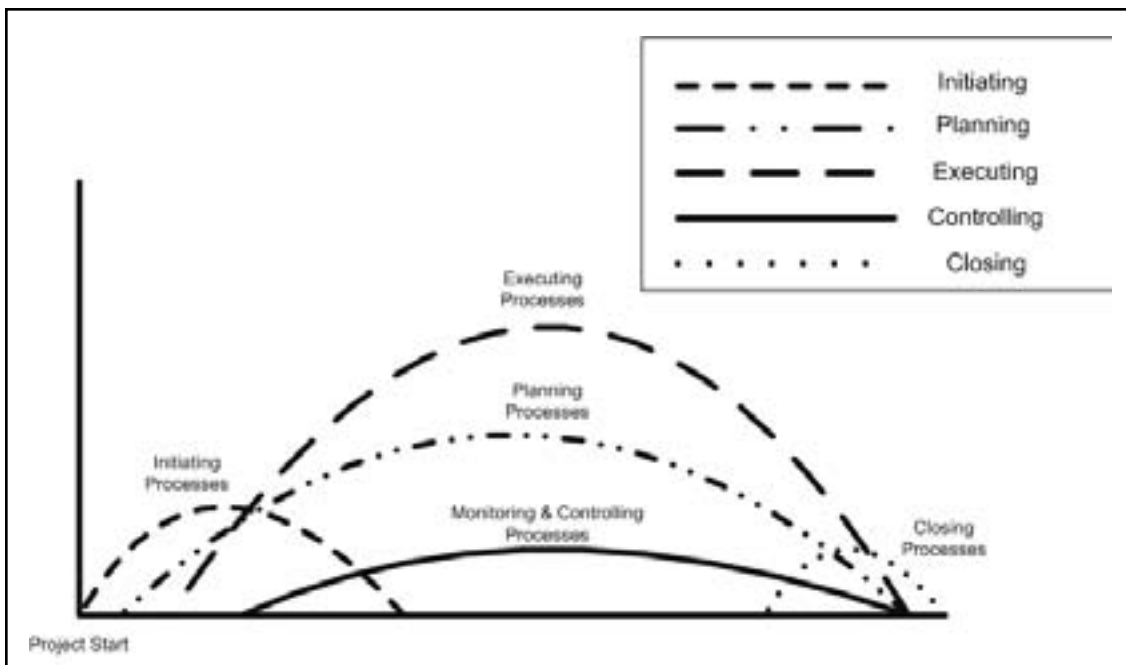
Exercise 3-1

In the WAV files there are charts of the 44 processes with the inputs, tools, techniques and outputs for each process. Print out each chart, in color if possible, and cut out and rearrange the processes for each one of the process groups.

HINT: See PMBOK Guide Figures 3-6 through 3-10.

The charts of each process will also make a very portable quick reference you can use as a study aid.

SAMPLE PMP EXAM QUESTIONS ON MANAGEMENT PROCESSES

1. All of the following are true about inputs and outputs except:

   a) Closing processes only contain inputs and no outputs
   b) Both link individual processes within each process group
   c) Outputs from the planning processes can be inputs to the executing processes
   d) Both consist of documents or documentable items

2. _____ must be measured regularly to identify variances from the plan.

   a) Project controls
   b) Project performance
   c) Schedule controls
   d) Stakeholder requirements

3. During the end phase of a project, the project manager must be concerned with the responsibilities of employee _____.

   a) Retention
   b) Morale
   c) Placement
   d) Replacement

Notes:

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4. The initiating process group consists of which 2 processes?

   a) Develop project charter and develop preliminary project scope statement
   b) Develop scope statement and initiation
   c) Develop project charter and initiation
   d) Initiation and develop preliminary project scope statement

5. Which process group is the project manager acting under if he or she is assessing the performance of the team?

   a) Executing
   b) Initiating
   c) Monitoring and controlling
   d) Planning

6. Significant changes occurring throughout the project life cycle can trigger:

   a) A rewrite of the project charter
   b) The need to revisit one or more of the planning processes or some of the initiating processes
   c) Assignment of a new project manager
   d) Cancellation of the project

7. The planning processes do all of the following except:

   a) Mature
   b) Identify
   c) Define
   d) Validate

Notes:

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8. Which process group consists of the processes used to complete the work defined in the project management plan?

   a) Closing
   b) Executing
   c) Initiating
   d) Planning

9. The planning process group:

   a) Defines deliverables
   b) Facilitates project planning across multiple processes
   c) Limits the number of processes
   d) Plans the entire project prior to initiation of work

10. One value of breaking large or complex projects into phases is:

    a) Cost containment
    b) Ability to review the business need at each phase
    c) Avoiding scope creep
    d) Ability to assign multiple project managers

Notes:

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3

ANSWERS AND REFERENCES FOR SAMPLE PMP EXAM QUESTIONS ON PROCESSES
Section numbers refer to the PMBOK Guide.

1. **A Processes Section 3.2**

2. **B Processes Section 3.2.4**
See the PMBOK Guide Figure 3-2. Controlling happens throughout the project.

3. **C Kerzner, page 343**

4. **A Processes Section 3**

5. **A Processes Section 3**

6. **B Processes Section 3**
Although the project charter MAY be rewritten, the project manager reassigned or the project cancelled, the more accurate statement from a PMI standpoint is that the project manager should revisit various planning processes to determine what may need to change, if anything.

7. **D Processes Section 3**
Validation of project scope is a monitoring and controlling process.

8. **B Processes Section 3**

9. **B Processes Section 3**
Choice A: the identification of deliverables is part of the planning process, but it is a subset of the overall planning process group. Choice C: all processes in the PMBOK Guide are expected to be performed with the exception of several procurement processes. Choice D: the concept of progressive elaboration enables a project to start without all details of the project being fully defined.

10. B   Processes Section 3
Choice A: cost may increase by separating phases.
Choice C: phases do not help manage changes on
the project. Choice D: although multiple project
managers may be on a project, it is not a primary
benefit of breaking a project into phases.

3

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CHAPTER 4 | **INTEGRATION**

4

INTEGRATION MANAGEMENT

The PMP certification exam addresses critical project management functions that ensure coordination of the various elements of the project. The PMBOK Guide explains that the processes in project management are integrative in nature. They involve making tradeoffs among competing objectives to meet stakeholders' needs and expectations. Integration processes drive the associated knowledge area processes within each of the process groups and all process groups are addressed by one or more integration management processes. These processes interact with each other as well as with the other eight knowledge areas.

It is important to note that integration occurs within as well as outside the project. For example, project scope and product scope must be integrated and project work must be integrated with the ongoing other work of the organization (such as operations and deliverables from various technical specialties). One of the key tools or techniques used to integrate the processes and measure project performance is the earned value technique (EVT). Therefore, EVT is introduced in this chapter and is utilized for performance measurement in Time Management (Chapter 6), Cost Management (Chapter 7), and Communications Management (Chapter 10).

Interactions often have a domino effect and can be overt or subtle. Interactions engender tradeoffs and the project manager must be able to orchestrate these interactions as the project flows and changes throughout its life cycle. For example, increased resource usage in one area may adversely affect the schedule in another area. Complicating the picture is the fact that the project manager has to answer to many stakeholders and must constantly communicate upward, downward and laterally to ensure success. The integration management knowledge area of the PMP exam stresses how the different knowledge areas interact to continuously improve our ability to plan, perform and predict work.

EXAM TIP
Although this is the first knowledge area to be discussed (following the sequence of the PMBOK Guide), we recommend that you revisit it after all other knowledge areas are reviewed.

4

4 - 1

Project integration management occurs throughout the project life cycle, from initiation to closing. The project manager faces many challenges that differ from those faced by functional or operational managers. The project manager must coordinate the integration of:
- Project work with ongoing operations
- Product and project scope
- Schedule, budget, metrics and reporting
- Skills, knowledge and deliverables from vendors, stakeholders and the performing organization
- Risks and staffing plans
- Performance and quality objectives

Things to Know

1. The 7 processes of integration management:
   - **Develop Project Charter**
   - **Develop Preliminary Project Scope Statement**
   - **Develop Project Management Plan**
   - **Direct and Manage Project Execution**
   - **Monitor and Control Project Work**
   - **Integrated Change Control**
   - **Close Project**
2. **Project Statement of Work**
3. **Project Selection Methods**
4. The contents of the **Project Charter**
5. **Configuration Management** and the **Change Control System**
6. The contents of the **Project Management Plan**
7. The types of **Work Performance Information**
8. The **Earned Value Technique**

Key Definitions

These are used throughout the PMBOK Guide.

Change Control: the procedures used to identify, document, approve (or reject) and control changes to the project baselines.

Enterprise Environmental Factors: the external and internal factors affecting the enterprise, including

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organizational culture and structure, existing resources, market conditions and project management software.

Expert Judgment: judgment based upon expertise appropriate to the activity. It may be provided by any group or person, either within the organization or external to it.

Organizational Process Assets: any or all process-related assets, including formal and informal plans, policies and procedures, guidelines and historical knowledge from lessons learned.

Progressive Elaboration: the progressive improvement of a plan as more specific and detailed information becomes available during the course of the project.

Project Management Information System (PMIS): the PMIS is the information system utilized by the organization to facilitate the implementation of techniques, documents and deliverables for ongoing and completed projects. Although PMIS can be manual or automated, automated systems are becoming more common today.

Project Management Methodology: an organization needs to come up with a project management methodology, which is any structured approach used to guide the project team during the development of the project plan. This methodology may utilize forms, templates and procedures standard to the organization.

DEVELOP PROJECT CHARTER PROCESS

This process is used to formally authorize a new project or validate an existing project for continuation into the next phase. Projects are initiated as a result of a problem to be solved, an opportunity or a business requirement. Therefore, many organizations often have more projects than resources and projects are selected based on how urgently each is needed. Important tools and techniques of this process are the project selection methods and

expert judgment to analyze the value or payback of the project's product or service.

All 7 of the project integration management processes contain the tools and techniques of **Project Management Methodology** and **Project Management Information System (PMIS)**. Both these tools and techniques must be defined, clearly understood and used in developing the project charter and other key documents of the project.

The project charter should contain the assigned project manager and his or her authority level for the project.

Project Statement of Work

An input to the develop project charter process is the statement of work (SOW). The SOW is a narrative description of the products or services to be delivered by the project. Since the products or services can be delivered by either an internal or an external organization, the SOW is also an important artifact of the project procurement management knowledge area. PMI calls an SOW for external organizations a contract statement of work.

An SOW generally includes:
- The business need or reasons the product or service is required
- The description of the product scope or product requirements with as much detail as possible to support project planning and estimates
- The strategic plan and how the project supports the organization's strategic goals to facilitate the project selection decision-making process

Project Selection Methods

Project selection methods are used to select and prioritize projects within the constraints of the organization's resources. The value or payback of the project is evaluated based on multiple decision criteria. The PMBOK Guide defines 2 categories of project selection methods: benefit measurement and mathematical models.

Benefit Measurement Methods are comparative approaches such as return on investment (ROI) analysis, scoring models, economic models, peer reviews and review boards (adversarial proceedings to stop a project).

Mathematical Models use various algorithms, often referred to as decision models (decision models are discussed further in Chapter 11 on risk management).

Expert Judgment

The **Delphi Technique** is a form of expert judgment in which opinions are obtained from a panel of experts who work independently and anonymously. It is often used in risk management but can also be used to gain consensus on project selection, scope of work, estimates and technical issues. This method can, however, be time consuming. See Chapter 11 on risk management for further discussion.

The Project Charter

The project charter is an important document that establishes a project. It:
- Contains the business need, purpose and justification for the project
- Includes the product requirements
- Should be issued by a manager external to the project who may be assisted by the project manager if he or she has been identified
- Gives the project manager the authority to do the project
- Could be the signed contract when procurement processes are used
- Defines the goals and objectives of the project (sets the project direction)
- Is approved by key stakeholders
- Shows organizational, environmental and external constraints and assumptions
- Contains the summary budget and milestone schedule
- Is the only output of this process

CASE STUDY: THE LAWRENCE RV GARAGE PROJECT

This case study will be used throughout this study guide. You will be asked to prepare various documents relating to the case as you go through the initiating, planning, executing and monitoring and controlling processes. Since this study guide is organized following the presentation of topics in the PMBOK Guide, the exercises are not necessarily in the order in which they would be completed in a real project. Although this case study is not on the exam, it is provided here to strengthen your understanding and application of project management disciplines and techniques.

Examples of each of the documents you need to provide for a project are provided for you to compare with your results. There are no right or wrong documents; you will develop different levels of detail in your answers and the examples provided simply demonstrate our interpretation of one approach. We have used Microsoft Project Standard 2002 to create some of the examples. Any of the currently available project management software packages will provide similar results.

Case Study Overview

The goal of the Lawrence RV Garage Project is to build an RV garage on the property of Mr. and Mrs. Lawrence. They have been parking their RV and their son's boat in their backyard in a fenced, gated area. However, their city has passed a new ordinance that prohibits residents with RVs, boats, off-road vehicles or utility trailers from storing or parking such vehicles on their property or on the street for more than 72 hours. These vehicles must now be parked or stored in a "building suitable for that purpose." Mr. and Mrs. Lawrence have decided to build an RV garage.

They hired an architectural firm to develop the plans and specifications for the garage. These have been completed,

along with all the working drawings and a bill of materials, and the architect has also agreed to be Mr. and Mrs. Lawrence's project manager, helping them select a contractor and working with the contractor's project manager.

Acme Construction and Engineering (ACE) has won the bid to build the garage. You have been appointed to be the project manager for ACE. You were not involved with the bidding process.

The garage is designed to be big enough to hold a motor home or travel trailer and a boat. It is 50 feet long and 30 feet wide with 2 14-ft.-high by 12-ft.-wide roll-up doors for the RV and boat and a standard 3-ft. side door. There are 2 windows on the side of the garage that has the standard door, 3 windows on the side with no door and 2 windows in the back wall. Inside there are to be lights and electrical outlets to be used when working on the RV or boat. The plans also show RV hookups inside (water, electric and sewer) and there should also be a drain in the floor. There should be a small bathroom (commode and sink only) in the back corner of the garage and a utility sink adjacent to the bathroom.

The exterior walls are to be stucco and the roof is to be asphalt shingles to match the existing house. Walls should be of 2X6 construction to allow for greater insulation.

Since there is an existing home, utilities are already present. The architect has submitted the plans to the city but they have not yet been approved and a permit has yet to be issued.

Case Study Exercise

Exercise 4-1: Create a project charter for the Lawrence RV Garage Project. It really should be written by the general manager for the contractor but she has asked you to write the draft and then the 2 of you will polish it together.

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DEVELOP PRELIMINARY PROJECT SCOPE STATEMENT PROCESS

PMI recognizes the iterative nature of projects and the use of progressive elaboration in the development of the project. The develop preliminary project scope process demonstrates that when projects are initiated, not all information is available in a detailed form. The object of this process is to get the project initiated and to assign resources to explore the detailed needs of the project. The **Preliminary Scope Statement** might be considered a "1st draft" of the understanding of project requirements. The preliminary scope statement proves that the project end satisfies the business need. The preliminary scope statement will be revised and refined during the planning processes.

Some aspects critical to the measurement of success of the project are outlined in the preliminary scope statement. These key aspects are:
- Product and project objectives
- Project boundaries, constraints and assumptions
- Initial WBS, preliminary milestones and cost estimates
- Initial human resource plan
- Identified risks
- Configuration management requirements
- Acceptance criteria

The preliminary scope statement is the only output of this process.

DEVELOP PROJECT MANAGEMENT PLAN PROCESS

The develop project management plan process integrates all the subsidiary plans from the various knowledge areas into one cohesive whole. This complete, consistent and coherent document is the project management plan. It is crucial that the project manager and the project team spend sufficient time in creating the project management plan because this

document serves to reduce project uncertainty, improve the efficiency of work, provide a better understanding of the project objectives and provide a basis for monitoring and controlling. This key document also serves as a communication and educational tool for stakeholders on the project.

PMI emphasizes the 4 concepts of planning:
- Planning begins during the initiating phase of a project.
- Planning does not end until the project is finished.
- Planning is an intellectual process that runs through all the other processes of the project.
- Planning is iterative; as the project proceeds, the project team must plan, replan and plan again.

In planning a project, first the project objectives are clearly defined, a WBS is created to define the work in more detail, this WBS is used to schedule the work with resources assigned to obtain a time-phased budget. This time-phased budget is used to obtain the planned value S-curve as seen in Figure 4-1.

Figure 4-1 Project Scope and Time Definitions of Cost

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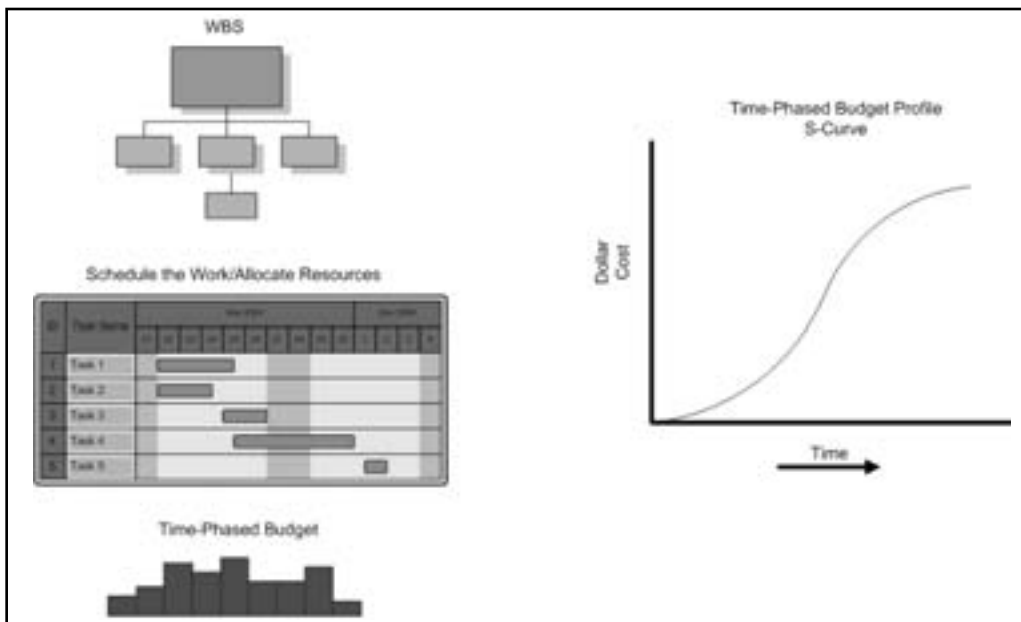
The project management information system is a tool or technique of the develop project management plan process. This system can include both manual and automated systems used to gather, integrate and disseminate the outputs of the project management plan processes. It is used by the project management team to create and control changes to the project management plan. It contains 2 subsystems, the configuration management system and the change control system.

Configuration Management

Configuration management (CM) is a systematic procedure that refers to change management. CM protects both the customer from unauthorized changes by project staff and the project staff from new or undocumented requirements changes from the customer. A configuration management system:

- Is a collection of formal documented procedures used to apply direction and control compliance of products and components with project requirements
- Is a subsystem of the project management information system
- Includes the processes for submitting proposed changes, validating change requests, tracking approval or rejection of these proposed changes and defining the various levels for authorizing changes
- In some areas includes the change control system

The purpose of CM is to ensure compliance to stated requirements by:

- Defining the process by identifying and documenting the characteristics of the configurable items (project products or components)
- Controlling and managing change requests to characteristics of configurable items
- Ensuring the integrity and consistency of the items as defined by the requirements and approved modifications by the use of internal or external audits.

Change Control System

The change control system is also a collection of formal documented procedures that define how project deliverables and documentation are controlled, changed and approved. In many areas the change control system is a subset of the configuration management system.

The Project Management Plan

A project management plan is more than just a set of instructions. It is not just a WBS or an output of MS Project™. Planning is an analytical exercise whose objective is to eliminate crisis by preventing anything from falling through the cracks. Creating it is an iterative process used to guide project execution. It is a collection of documents that identify the project assumptions and decisions. The project management plan provides both a standard communication tool throughout the lifetime of the project and a verification and agreement on objectives and requirements from the stakeholders. The plan is documented and approved by both the customer and the sponsor. All baselines for tracking, control, analysis, communications and integration elements are incorporated into the project management plan.

The project management plan is a key document that integrates outputs from all the other planning processes to form a consistent, comprehensive document to guide the execution and control of the project.

The key elements of the project management plan may ultimately include:
- The project management approach or strategy to be used by the definition of the selected processes and tools and techniques
- How project work will be managed and executed
- How changes will be monitored and controlled
- How configuration management will be performed
- How the integrity of performance baselines will be maintained
- How the project will be closed

EXAM TIP

The project management plan is begun in the develop project management plan process but it gets updated by other planning, executing and monitoring and controlling processes.

- The selected project life cycle to be used
- The description of other phases or related projects in multiphase or multiprogram environments
- The level of frequency and techniques for communicating with stakeholders
- The schedule or milestone chart of key management reviews for progress, issue resolution and decisions
- Subsidiary management plans, including the following plans and their definitions:
  - **Scope Management Plan**: tracks how scope changes are identified and classified and indicates how these changes are integrated into the project
  - **Schedule Management Plan**: describes how changes to the schedule will be managed
  - **Cost Management Plan**: describes how cost variances will be managed based on the needs of the stakeholders
  - **Quality Management Plan** and **Process Improvement Plan**: describe how the project management team will implement its quality policy
  - **Staffing Management Plan**: describes how and when human resources will be brought into and taken off the project team
  - **Communications Management Plan**: addresses the collection, distribution, access to and updates of project information
  - **Risk Management Plan**: documents procedures to manage risk throughout the project
  - **Procurement Management Plan**: describes how procurement processes will be managed

DIRECT AND MANAGE PROJECT EXECUTION PROCESS

Project execution is the primary process whereby the project management plan is put into action. Most of the project resources and costs are expended in this process. Important tools and techniques used in this process are the Project Management Methodology and the PMIS.

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In order for the project management plan to be executed, work is assigned to resources by the project manager and then monitored for completion of deliverables and work results. Therefore, the key outputs of this process are deliverables, requested changes and work performance reports. Since project activities are performed by people, the project manager must understand the organizational structure and individual motivations of the people working on the project. These skills are addressed within the team development process of the human resource management knowledge area.

Work Performance Information

Performance reports are an output of the direct and manage project execution process and are used to identify problems and issues so that corrective action can be taken. As the product of the project is created, performance against project baselines must be monitored and reported. Performance reports and work results are addressed in all knowledge areas of the PMBOK Guide. It is important to know the various types of reports for the exam.

Typical reports used are:
- Status or progress reports (daily, weekly, etc.)
- Trend analysis
- Variance analysis
- Exception reports
- Earned value reports
- Schedule reports that consist of:
  - Gantt charts
  - Milestone charts
  - Network diagrams
- Cost reports that consist of:
  - S-curves
  - Histograms
  - Expenditure tables

> **EXAM TIP**
> Know the types of schedule and cost reports.

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MONITOR AND CONTROL PROJECT WORK PROCESS

As the work of the project is carried out, deliverables or work results are created. The project manager checks on how the project is doing by completing evaluations using the earned value technique (EVT) and expert judgment, such as the Delphi Technique discussed above. The results of the evaluations are used in performance reports and are an important part of the communications management knowledge area processes.

Earned Value Technique

EVT is a tool used to integrate the project's scope, schedule and resources to measure and report project performance from initiation to closure. There are basically 3 independent variables that form the basis for EVT.

- **Planned Value** (PV): the estimated cost for activities scheduled to be performed during a given period of time
- **Actual Costs** (AC): the actual costs incurred to complete the activities in a given period of time
- **Earned Value** (EV): the value of the activities accomplished during a given period of time

Common types of project evaluations are the mid-project and the final or post-project evaluations.

Mid-Project Evaluations are conducted while project work is still in progress. The main purpose of such evaluations is to determine if objectives are still relevant and if these objectives are being met. Lessons learned should also be documented at this time instead of waiting for the project to be completed.

A third party or people outside the team should be used to conduct mid-project evaluations so that results are less biased. Mid-project evaluations, however, often cause stress and conflict within the project team for the following reasons:

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- Evaluations are disruptive, they take time away from project work, they require review meetings to be scheduled and could result in significant changes.
- The evaluation could generate the impression in project team members that they are not to be trusted (i.e., that "Big Brother is watching").
- The evaluation could be arbitrary or inconsistent, making the evaluation results misleading, skewed or invalid.
- Management may misuse evaluation results to identify and punish poor performance.
- Management may use evaluation results to support personal agendas or gains.
- Identification of significant problems would result in drastic changes.
- The project could be terminated.

However, mid-project evaluations can prove extremely beneficial if conducted well. Such evaluations may involve project participants who enter or leave a project at phase transitions. Those departing can provide useful insights based on intimate experience with the project. Those arriving could provide "fresh eyes" and new methods for achieving project objectives. An enterprise quality assurance function, a corporate audit department or a project office with proven processes and experienced staff may help mid-project evaluations be more readily accepted.

Final or **Post-Project Evaluations** are conducted after the project is completed. Their main purpose is to determine the lessons learned and best practices for ongoing, other or future projects.

INTEGRATED CHANGE CONTROL PROCESS

Changes are inevitable in projects. The integrated change control process coordinates changes across the entire project by determining that a change has occurred, managing the change when it does occur and ensuring that changes are controlled and agreed upon. Through

4 - 15

the use of an integrated change control process, the project manager is able to be in control and make necessary adjustments to ensure the project's success.

The integrated change control process works hand-in-hand with the performance reporting process in communications management to integrate the subsidiary change control processes found in the scope, time, cost, quality, risk and procurement knowledge areas. The tools and techniques used in this process are:

- Project management methodology, which is any structured approach used to guide the project team during the development of the project plan (This methodology may utilize standard forms, templates and procedures standard to the organization.)
- Project management information system
- Expert judgment

CLOSE PROJECT PROCESS

The close project process is 1 of the 2 processes in the closing process group, the other process being contract closure described in project procurement management (Chapter 12). There are many questions about the similarities and differences between these 2 processes. Make sure you read Sections 4.7 and 12.6 of the PMBOK Guide carefully. The close project process outputs include 2 procedures that define the activities needed to conclude the project (or phase):

- Administrative closure
- Contract closure

The administrative closure procedure occurs not just at the end of the project but also at the end of each phase.

SAMPLE PMP EXAM QUESTIONS ON INTEGRATION MANAGEMENT

Integration — Initiating Questions

1. The CEO of a corporation wants to consolidate the disparate systems of his organization by creating a central repository of data. He allocates 0.5 million dollars for this project to be done. A predefined budget is an example of:

   a) An assumption
   b) A constraint
   c) An organizational policy
   d) An organizational procedure

2. Which of the following is an example of an assumption in the develop preliminary project scope statement process?

   a) Records of past performance
   b) A predefined budget
   c) The available start date of a key team member
   d) A lesson learned from a prior project that lowers the project risk

3. Each of the following are examples of project selection methods except:

   a) Decision models
   b) Request for proposal (RFP)
   c) Benefit measurement methods
   d) Linear or nonlinear mathematical models

Notes:

4. A project charter is:

   a) Issued by the project manager
   b) A document that serves as a base for future project decisions and for developing common understanding of project deliverables among the stakeholders
   c) A document to address the collection, distribution, access and updates of project information
   d) A document that formally recognizes the existence of a project

5. When should the project manager be assigned?

   a) At the start of the feasibility study
   b) It varies, depending on expert judgment
   c) After the project planning is done but before project execution
   d) As early in the project as feasible and preferably before project planning

6. A project manager new to project management has been given an unapproved project charter. He comes to you for advice; what should you tell him to do first?

   a) Create a WBS
   b) Start documenting the project constraints and assumptions
   c) Find out who should approve the project charter and obtain approval
   d) Begin obtaining resources for his team

Notes:

Integration — Planning Questions

7. Any and all of the organizations involved in a project may have formal and informal policies whose effects must be considered during project plan development. Organizational policies that should be considered are all of the following except:

   a) Personnel administration
   b) Quality management
   c) Financial controls
   d) Quality assurance responsibilities

8. An organization's project management methodology may utilize standard forms, templates and procedures. A facilitated kickoff meeting is an example of:

   a) A template
   b) A change control procedure
   c) An organizational policy
   d) A project management plan output

9. Who should contribute to the development of the project management plan?

   a) Only the project manager
   b) The entire project team including the project manager and sponsor
   c) The resources from the planning functional area
   d) The external manager who issued the project charter

10. The project management plan generally contains all of the following except:

    a) Scope statement, scope management plan and expert judgment
    b) Project charter and subsidiary management plans
    c) WBS, cost estimates and performance measurement baselines
    d) Project charter, scope statement and risk management plan

Integration — Executing Questions

11. A work authorization system is defined as:

    a) Sustained physical effort to overcome obstacles and achieve objectives
    b) Formal or informal procedures that are useful during project execution
    c) A formal procedure for sanctioning project work to ensure it is done at the right time and in the proper sequence
    d) Always a written authorization to begin work on a specific activity or work package

12. Which of the following skills are not needed for project plan execution?

    a) Effective meeting management and listening skills
    b) Negotiation and organizational procedure knowledge
    c) Benchmarking and flowcharting techniques
    d) Knowledge about the project's product and how work is authorized

Notes:

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13. All of the following statements are true about the direct and manage project execution process except:

    a) The majority of the project's budget is expended here
    b) The product of the project is actually created here
    c) Outcomes of activities performed to accomplish the project are collected here
    d) Change requests are identified and carried out right away

Integration — Monitoring and Controlling Questions

14. All EVT control account plans (CAPs) continuously measure project performance by relating which of the following 3 independent variables?

    a) Cost variance (CV), actual costs (AC) and estimate at completion (EAC)
    b) Planned value (PV), actual costs (AC) and cost performance index (CPI)
    c) Planned value (PV), actual costs (AC) and earned value (EV)
    d) Earned value (EV), cost performance index (CPI) and schedule performance index (SPI)

15. Which of the following is NOT true of a change control system?

    a) It is a collection of formal, documented procedures that define how project performance will be evaluated
    b) It varies from project to project and must be developed by the project management team
    c) It often includes a group responsible for approving or rejecting changes
    d) It includes approval levels for authorizing changes

Notes:

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Integration — Closing Questions

16. The close project and contract closure processes are similar because they both involve:

    a) Gathering lessons learned and archiving that information for future use
    b) Kickoff meetings to ensure stakeholders understand the scope of the project
    c) Quality assurance activities to ensure deliverables meet requirements
    d) Creation of a scope verification plan

17. An output of the close project process is:

    a) Creation of project files
    b) Creation of a project charter
    c) Creation of a risk analysis plan
    d) Creation of a project plan

Notes:

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ANSWERS AND REFERENCES FOR SAMPLE PMP EXAM QUESTIONS ON INTEGRATION MANAGEMENT

Section numbers refer to the PMBOK Guide.

1. **B Initiating Section 4.2 Develop Preliminary Project Scope Statement**
    Constraints are listed as part of the project scope statement. Also see Constraint in the PMBOK Guide's Glossary.

2. **C Initiating Section 4.2 Develop Preliminary Project Scope Statement**

3. **B Initiating Section 4.1.2.1 Develop Project Charter**

4. **D Initiating Section 4.1.2.1 Develop Project Charter**
    Choice B is the scope statement and choice C is the communications management plan.

5. **D Initiating Section 4.1 Develop Project Charter**

6. **C Initiating Section 4.1 Develop Project Charter**
    The project charter provides the authority to proceed. Without the authority, the project manager faces future problems.

7. **D Planning Section 4.3.1.4 Develop Project Management Plan**

8. **B Planning Section 4.3 Develop Project Management Plan**
    A kickoff meeting can be an organizational process asset and may be defined as part of the project management methodology.

9. **B Planning Section 4.3 Develop Project Management Plan**

10. A   **Planning Section 4.3 Develop Project Management Plan**
Expert judgment is a tool and technique used in the development of the project management plan, but it is not contained in the project management plan itself.

11. C   **Executing Section 4.4 Direct and Manage Project Execution**
Work authorization is a subsystem of the overall project management system. Choice A is the definition of work. Choice B is based on organizational procedures. Choice D is incorrect because work authorization does not always have to be written.

12. C   **Executing Section 4.4 Direct and Manage Project Execution** and **Section 2.3.5 Project Management System**

13. D   **Executing Section 4 Direct and Manage Project Execution**
Change requests are collected and become input to the change control system.

14. C   **Monitoring and Controlling Section 4.5.2.3 Monitor and Control Project Work**
Integrated change control EV also comes up in cost management (Chapter 7) and communications management (Chapter 10).

15. B   **Monitoring and Controlling Section 4.6 Integrated Change Control**

16. A   **Closing Section 4.7 Close Project**

17. A   **Closing Section 4.7.3.4 Close Project**

CASE STUDY SUGGESTED SOLUTION

Exercise 4-1
Project Charter for the Lawrence RV Garage Project

This project has as its goal to build a recreational vehicle (RV) and boat garage on the property of Mr. and Mrs. David Lawrence in Anytown, United States. The garage will be built according to the architectural plans and specifications provided by the owners.

The major deliverables are the garage structure, including a finished interior, and a driveway connecting to the existing driveway per the plans and specs.

The garage is being built to comply with new city codes that require boats and/or RVs stored for more than 72 hours to be enclosed in a structure suitable for that purpose.

This project is scheduled to start on or about May 20, 2004 and should be completed within 120 calendar days. The initial budget is $37,500.

The project sponsors are Mr. and Mrs. Lawrence. Their project manager is Scott Hiyamoto, who is also the architect. The project manager for Acme Construction and Engineering (ACE) is [Your Name Here]. Mr. Hiyamoto is acting as the agent of the Lawrences and has full authority to make decisions on their behalf. Mr. and Mrs. Lawrence will direct all their communications through Mr. Hiyamoto. Mr./Ms. [Your Name Here] is acting as the agent for ACE and has full authority to make decisions on its behalf. All employees of ACE and all of its subcontractors, and their employees, will direct all their communications through Mr./Ms. [Your Name Here].

Signed

_____   _____
Susan Ruzicka, General Manager   David E. Lawrence
Acme Construction & Engineering   Property Owner

_____   _____
[Your Name Here]   Scott Hiyamoto, Managing Partner
Acme Construction & Engineering   Hiyamoto, Kwame, & Blum, LLP

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SCOPE

CHAPTER 5 | SCOPE

5

SCOPE MANAGEMENT

Project scope management questions on the PMP certification exam cover diverse yet fundamental project management topics. Defining and managing the scope or the amount of work of the project is an important aspect of project management. There must be an understanding of how the project scope is broken down into smaller, more manageable, components and how these components are controlled. The scope management plan, the updated and refined scope statement, work breakdown structures (WBSs), scope verification and scope changes are the topics covered.

The role of the project manager includes defining the work, making sure that only the work of the project is being completed and preventing additional work (scope creep) not defined in the project. PMI does not advocate "gold plating" or giving the customer more than what was asked for.

In the project context, the term "scope" may refer to:
- Product scope, which consists of the features and functions of a product or service, with results measured against the product requirements
- Project scope, which describes the work that must be done to deliver a product, with completion being measured against the project management plan

Project scope management is concerned with defining and controlling both what is and what is not included in the project.

Things to Know

1. The 5 processes of scope management:
   - **Scope Planning**
   - **Scope Definition**
   - **Create WBS**
   - **Scope Verification**
   - **Scope Control**

> ### EXAM TIP
> PMI places enormous emphasis on the tool or technique of decomposition, which is breaking down the major project deliverable into smaller, more manageable elements. These elements are further subdivided until the deliverables are specific enough to support the planning, executing, monitoring and controlling and closing process group activities. The resulting collection of elements that define the total scope of the project is called the work breakdown structure (WBS).

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2. The purpose of the **Scope Management Plan**
3. The purpose and contents of the **Scope Statement**
4. All aspects of the **WBS**
5. The **Code of Accounts** (and how it differs from the **Chart of Accounts**)
6. The purpose of the **Control Account Plan**
7. The differences between **Scope Verification** and **Perform Quality Control**
8. The aspects of **Scope Control**
9. The **Influence Curve**

Key Definitions

Chart of Accounts: the financial numbering system used to monitor project costs by category. It is usually related to an organization's general ledger.

Code of Accounts: the numbering system for providing unique identifiers for all items in the WBS. It is hierarchical and can go to multiple levels, each lower level containing a more detailed description of a project deliverable. The WBS contains clusters of elements that are child items related to a single parent element; for example, parent item 1.1 contains child items 1.1.1, 1.1.2 and 1.1.3.

Note the code of accounts used in the PMBOK Guide. For example, Section 5.3.3.1 indicates the chapter (first level), the process (second level), inputs, tools, techniques or outputs (third level) and the item (fourth level). In this case, 5.3.3.1 is the project scope management chapter, the create WBS process, outputs and the project scope statement updates.

Control Account Plan (CAP): the point at which integration of scope, budget and schedule takes place and at which performance is measured.

Decomposition: the process of breaking down a project deliverable into smaller, more manageable components. In the "Create WBS" process, the results of decomposition are deliverables, whereas in the activity definition process

(PMBOK Guide, Time Management Section 6.1) project deliverables are further broken down into schedule activities.

Scope Baseline: the approved detailed project scope statement along with the WBS and WBS dictionary.

Work Breakdown Structure (WBS): a framework for defining project work into smaller, more manageable pieces, it defines the total scope of the project using descending levels of detail.

WBS Dictionary: houses the details associated with the work packages and control accounts. The level of detail needed will be defined by the project team.

Work Package: the lowest level of a WBS; cost estimates are made at this level.

SCOPE PLANNING PROCESS

This process defines the activities needed to determine and manage the project scope. It uses the project charter, the preliminary project scope statement and the project management plan to develop the scope management plan.

The Scope Management Plan

The scope management plan is an important document that assists the project manager in communication, thereby lessening possible future issues of scope creep, project changes, conflict issues and project risks. The scope management plan:
- Describes how project scope will be managed
- Describes how scope changes will be identified and classified
- Describes how scope changes will be integrated
- Could be formal or informal
- Can be very detailed, if necessary
- Is a subsidiary component of the project management plan

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SCOPE DEFINITION PROCESS

Although a preliminary scope statement was prepared in the develop project charter process, it is refined here with additional information about the project.

The Scope Statement

The scope statement is the basis for future project decisions and is critical to project success. It provides the basis for agreement on project scope between the project team and the customer. The scope statement contains enough information to allow stakeholders to document their agreement on the:
- Project's justification
- Project's product
- Project's deliverables
- Project's objectives
- Project acceptance criteria

A detailed project scope statement:
- Provides documentation for future project decisions
- Can have multiple levels as project work goes through decomposition
- Is refined or revised to reflect approved changes to the scope of the project
- Is referred to in some organizations as the scope of work or statement of work (SOW) (However, PMI uses the SOW in the context of a buyer and seller agreement to define the scope of work involved; see Chapter 12 on procurement management.)

In order to ensure project success, project objectives must be defined. Good objectives should be clear, defined well and feasible. PMI advocates project objectives that follow the SMART guideline. That is, objectives must be:
- **S**pecific — clear with no ambiguity
- **M**easurable — with quantifiable indicators of success
- **A**ssignable — with responsibility resting on an individual or organization
- **R**ealistic — achievable within the constraints
- **T**imely — with specific duration and due dates

Case Study Exercise

Exercise 5-1: Once the project charter from Exercise 4-1 has been accepted by the stakeholders, you need to develop a scope statement for the Lawrence RV Garage Project. It should be detailed enough so that all stakeholders know what is being done but since there are architectural drawings already existing, you will not need to describe every board.

CREATE WBS PROCESS

In order to understand further and define the work of the project, it must be broken down into smaller, more manageable components. The resulting deliverable-oriented hierarchical structure in known as the Work Breakdown Structure (WBS). The lowest levels of the WBS are the planned units of work the project team must execute in order to achieve the project objectives and results.

The Work Breakdown Structure

The WBS provides input to other planning processes such as scope control, activity definition, cost estimating, cost budgeting and plan purchases and acquisitions.

The WBS, WBS dictionary and the scope baseline are the primary outputs of the Create WBS process. Any work not defined in the WBS is outside the scope of the project; therefore the WBS is the foundation of the project and contains the building blocks of project work. The WBS:
- Breaks the project into smaller pieces, those at the lowest level being known as work packages
- Defines the total scope of the project using descending levels of detail
- Is deliverable oriented
- Contains items that are assigned unique identifiers (i.e., **Code of Accounts**)

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> **EXAM TIP**
> Project roles and responsibilities (see PMBOK Guide Section 9.1.3.1) should be closely linked to the work packages of the WBS. A Responsibility Assignment Matrix (RAM) is often used to show this relationship. Know what a RAM looks like and how it should be used (see PMBOK Guide Figure 9-4 for an example).

The benefits of using a WBS are that it:
- Facilitates communication and a common understanding of project scope
- Provides a framework for project identification
- Brings focus to project objectives
- Forces a breakdown of project work into smaller work packages that are more easily assigned and tracked
- Creates work packages that are small enough for more accurate estimates
- Identifies holes or weak areas of project scope requirements
- Facilitates performance measurement
- Clearly defines responsibilities
- Facilitates progress status reporting, problem analysis and the tracking of time, cost and performance
- Allows for improved handling of change control requests
- Is available for reuse with appropriate modifications for similar projects

What needs to be done to develop a WBS? The following are some guidelines for developing a WBS:
- Utilize the project team for help
- Identify higher levels before breaking down into more detailed levels
- Know that some components will break down into more detailed levels than others
- Work down toward tangible deliverables (work packages), keeping in mind that:
  - The effort to produce the deliverable can be confidently estimated
  - The types of skills required for the deliverable can be evaluated
  - Required resources can be determined
  - Costs can be determined and confidently estimated
  - The deliverable can be easily tracked

Some examples of names of WBS levels are:
- **Program**
- **Project**
- **Work Package** is the lowest-level item of the WBS. Cost estimates are made at this level; it is sometimes stipulated that a work package is not more that 80 hours of effort. Work packages assist risk identification and may be broken down further during the activity definition process into schedule activities and even smaller tasks.
- **Schedule Activity** is a further subdivision of the work package
- **Task** is work not necessarily listed in the WBS and is the lowest level of effort on the project

Key outputs of the create WBS process are the WBS, of course, but also the WBS dictionary and the scope baseline.

An important aspect of the WBS is the **Control Account Plan (CAP)** which is where integration of scope, schedule and cost takes place and is where performance is measured. Management control of projects at the work package level can be very time consuming, so PMI advocates the use of a CAP at a level of the WBS above the work package. The advantages of a CAP are:
- All earned value performance measurement in a project should take place at the CAP level.
- It is the building block of performance measurement.
- The sum of the CAPs will add up to the total project value.

There is no recommended standard for the appropriate dollar size of a CAP. Some organizations define a rule of thumb, such as 300 hours — but it should be whatever is manageable.

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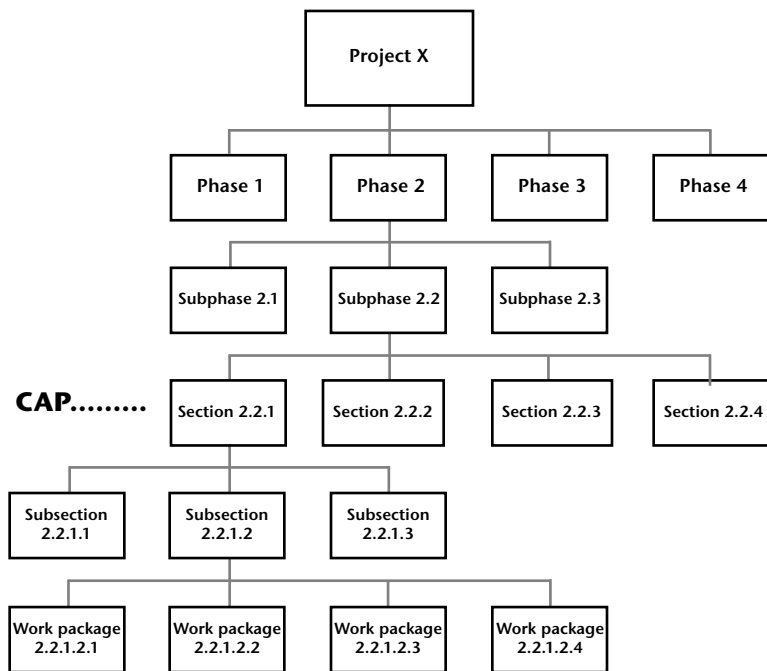
Figure 5-1
The Control Account Plan

In the example in Figure 5-1, the CAP is placed at the section level (2.2.1, 2.2.2, etc.) and individual or small group efforts at the subtask or work package level are rolled up to the CAP to be managed by the project manager and reported to stakeholders. This avoids micromanaging of individual team members and smoothes out minor variances from the plan.

Case Study Exercise

Exercise 5-2: After the scope statement from Exercise 5-1 has been approved, develop the WBS to show the breakdown of the work that needs to be done to deliver the complete Lawrence RV Garage Project.

SCOPE VERIFICATION PROCESS

Scope Verification is the process of getting formal acceptance of the project scope from stakeholders who may be the project sponsor, clients or customers. In order to confirm work was completed correctly and satisfactorily, scope verification is:
- The review of work results by conducting audits, reviews and inspections
- Similar to the perform quality control process as both involve checking work products
- Different from the perform quality control process because it focuses on the acceptance criteria of the deliverables (i.e., the scope of work) instead of the correctness of the deliverables
- Often performed in parallel with the perform quality control process
- A determination of whether work results conform to requirements
- The documentation of the completion of deliverables
- Getting formal signoff
- Repeated at the end of each project phase

Verification is typically determined through a predefined process of inspection that should have been agreed upon as part of the scope statement and scope management plan.

SCOPE CONTROL PROCESS

Requested scope changes and recommended corrective actions are the primary outputs of scope control. Frequently, a scope change also requires adjustments to project objectives, cost, time and quality. Therefore, a scope change usually means changes to the characteristics of an item or system where replanning would be necessary.

Within the scope control process there is a tool or technique called the **Change Control System** (PMBOK Guide Section 5.5.2.1) which defines the procedures by which project scope may be changed. It differs from a **Configuration Management (CM) System** which provides the procedures for the identification, documentation and verification of the integrity of project work products.

CM and the change control systems are tools and techniques of the scope control process. These systems define the procedures that ensure the requested changes to the project and product scope are properly considered and documented before being processed through the integrated change control process. Both systems are integrated with the overall project management information system.

The Influence Curve

We have already encountered this useful curve in Chapter 2. It demonstrates that the ability of a stakeholder to influence a scope change is high at the beginning of a project and decreases as the project progresses. Conversely, the impact or cost of a scope change is low at the beginning of a project and increases as the project progresses, as seen in Figure 5-2.
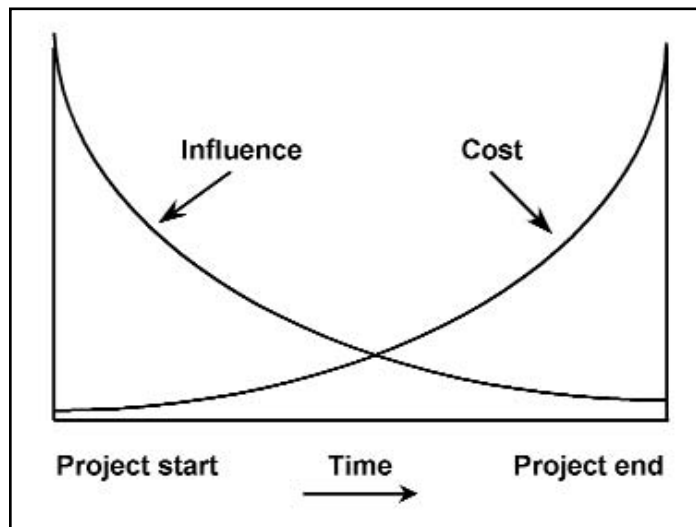
Figure 5-2
The Influence Curve

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**SAMPLE PMP EXAM QUESTIONS ON
SCOPE MANAGEMENT**

Scope — Planning Questions

1. Sources of expert judgment may come from any of
   the following except:

   a) Other units within the performing organization
   b) Nonindustry executives
   c) Consultants and professional and technical
      associations
   d) Industry groups

2. The scope management plan should include:

   a) Project deliverables, justifications and objectives
   b) A description of how formal verification will be
      obtained and how scope changes will be handled
   c) A description of how project scope will be
      managed, the project's product and all
      supporting details
   d) A description of how scope changes will be
      integrated along with corrective actions and
      lessons learned

3. All the following statements are true about outputs
   of scope planning except:

   a) Supporting details are sometimes called critical
      success factors
   b) The project justification provides the basis for
      evaluating future tradeoffs
   c) The scope statement should include the project
      product
   d) Project objectives must include at least cost,
      schedule and quality measures

Notes:

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4. The scope statement should include all of the following except:

   a) The business need that the project was undertaken to address
   b) A summary of the product description and project deliverables
   c) Clear responsibility assignments
   d) Project objectives or criteria that must be met for the project to be considered successful

5. Which of the following tools and techniques are commonly used in the create WBS process?

   a) WBS templates and decomposition
   b) Identification of alternatives and decomposition
   c) Product and benefit/cost analysis
   d) Expert judgment and inspection

6. You come into a project that has already begun. There are a lot of questions about what work is included in each of the work packages. The best place to look for this information is:

   a) The scope statement
   b) The project charter
   c) The activity list from the activity decomposition
   d) The WBS dictionary

Scope — Monitoring and Controlling Questions

7. Change requests may be any of the following except:

   a) Oral or written
   b) Externally mandated events
   c) Internally initiated only if scope is reduced
   d) Directly or indirectly generated

Notes:

8. The primary concern of scope verification is to ensure:

   a) The project will be completed on time
   b) The acceptance of the work results
   c) The correctness of the work results
   d) A scope change has occurred

9. During a project meeting, 2 team members are arguing about when scope verification should be done. You settle the argument for them by telling them that scope verification should be done:

   a) Only once, during planning
   b) Every time a deliverable is produced
   c) At the end of each project phase
   d) At the very end of the project to obtain formal acceptance

10. You are managing a project that is on schedule with 60 work packages completed. One day a stakeholder tells you that she has found a critical product function that was omitted in the project plan. To solve this problem you should:

    a) Tell the stakeholder to keep quiet and maybe nobody will notice
    b) Communicate the error to senior management
    c) Update the project schedule and budget to reflect the necessary changes
    d) Submit a change request to the change control board and rebaseline the project

Notes:

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11. A member of your team brings ideas for enhancing the scope of work to a team meeting. These suggestions will add work to the project that is beyond the requirements of the project charter. As project manager, you point out that only the work required for the project should be completed by the team or the project could miss its goals. You are practicing:

    a) Scope management
    b) Scope planning
    c) Scope control
    d) Risk management

12. Management by objectives involves:

    a) Managing work that is ongoing and repetitive
    b) The collection of quantitative data for statistical analysis
    c) A system of leadership that defines managerial responsibilities in terms of corporate objectives
    d) Errors and defects that happen before management intervention

Notes:

ANSWERS AND REFERENCES FOR SAMPLE PMP EXAM QUESTIONS ON SCOPE MANAGEMENT
Section numbers refer to the PMBOK Guide.

1. **B   Planning Section 5.1.2.1 Scope Planning**

2. **B   Planning Section 5.1.3.1 Scope Planning**
It is easy to remember that the scope management plan is from the planning process group. Choice D is incorrect because it contains outputs from a controlling process. Choices A and C list some of the contents of the scope statement.

3. **A   Planning Section 5.2.3.1 Scope Definition**
Objectives are critical success factors. Supporting detail should contain all identified assumptions and constraints.

4. **C   Planning Section 5.2.3.1 Scope Definition**

5. **A   Planning Section 5.3.2 Create WBS**
Note that in scope definition decomposition, the results are deliverables, whereas in time activity definition decomposition, the results are activities.

6. **D   Planning Section 5.3.3.1 Create WBS**
The scope statement and project charter do not have information at the work package level. Activities are smaller breakdowns of work packages.

7. **C   Monitoring and Controlling Section 5.5.1.6 Scope Control**

8. **B   Monitoring and Controlling Section 5.4.3.1 Scope Verification**
The main output of the scope verification process is formal acceptance. Scope verification differs from quality control, which is concerned with the correctness of work results.

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9. **C   Monitoring and Controlling Section 5.4 Scope Verification**
Scope verification is performed more than once. However, it is not tied to the WBS for each deliverable, making C the best answer.

10. **D   Monitoring and Controlling Section 5.5 Scope Control**

11. **A   Monitoring and Controlling Section 5 Scope Management**
The answer cannot be B as the scope plan has already been created. It is not C because no change has actually been approved.

12. **C   Executing, see Ireland and Management by Objective (MBO) in Chapter 2 of this study guide**
Choice B is the basis for proactive management by fact and choice D is management by exception.

CASE STUDY SUGGESTED SOLUTIONS

Exercise 5-1
Scope Statement for the Lawrence RV Garage Project

As stated in the project charter, the goal of this project is to build a recreational vehicle (RV) and boat garage on the property of Mr. and Mrs. David Lawrence in order to comply with a new city ordinance regarding RV and boat parking.

The garage is designed to be big enough to hold a motor home or travel trailer and a boat, with room at the back for miscellaneous storage and a small workshop area. It is 50 feet long and 30 feet wide with 2 14-ft.-high by 12-ft.-wide roll-up doors for the RV and boat and a standard 3-ft. side door. There are 2 windows on the side of the garage that has the standard door, 3 windows on the side with no door and 2 windows in the back wall. Wall height is 16 ft. The roof is to use engineered trusses, manufactured by an approved supplier. Inside there are to be lights and electrical outlets to be used when working on the RV or boat. The interior is to be heated and air conditioned. The plans also show RV hookups inside (water, electric and sewer) and there should also be a drain in the floor. There should be a small bathroom (commode and sink only) in the back corner of the garage and a utility sink adjacent to the bathroom.

The exterior walls are to be stucco and the roof is to be asphalt shingles to match the existing house. Walls should be of 2X6 construction to allow for greater insulation.

Since there is an existing home, utilities are already present. The garage will have its own electric service and its own hot water heater. The architect has submitted the plans to the city but they have not yet been approved, and a permit has not yet been issued.

The major deliverables are the garage structure, including finished interior, and a driveway connecting to the existing driveway per the site plan. No landscaping is included in the specifications.

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This project is scheduled to start on or about May 20, 2004 and complete within 120 calendar days. The initial budget is $37,500.

Assumptions: the plans will be approved by the city as submitted. The plans will be approved by June 1, 2004. The plans and specifications, which are attached by reference, are complete and sufficient to plan, execute and complete this project. Anything not included in the plans and specifications is explicitly outside the scope of this project.

Constraints: construction permits for residential units, including detached garages, state that construction must be complete within 185 days from the issue date. The owner states that any change order resulting in an increase of $1,000 from the baseline cost, or when accumulated change orders exceed $2,000, a formal review of the proposed change or changes must be held with the owners, architect and general contractor all present.

Attached by reference:

Site plan
Foundation and slab plan
Framing plan
Electrical plan
Plumbing plan
Heating, ventilating and air conditioning plan
Door and window specifications
Exterior finish plan
Interior finish plan
Roof truss engineering specifications
Driveway specifications
Bill of materials

Exercise 5-2
WBS List for the Lawrence RV Garage Project

WBS	Task Name
0	Lawrence recreational vehicle garage
1	Project management
1.1	Finalize plans and develop estimates
1.2	Sign contract and notice to proceed
1.3	Apply for permits
1.4	Execute and control project
1.4.1	Track progress
1.4.2	Weekly status meeting
2	Site work and foundation
2.1	Clear and grub lot
2.2	Install temporary power service
2.3	Install underground utilities
2.4	Excavate for foundations
2.5	Install forms and rebar
2.6	Pour concrete for foundation and slab
2.7	Cure concrete
2.8	Strip forms
2.9	Perform foundation/slab inspection
2.99	Foundation complete
3	Framing
3.1	Install mudsills
3.2	Frame walls
3.3	Frame corners
3.4	Install roof trusses
3.5	Complete roof framing
3.6	Conduct framing inspection
3.99	Framing complete
4	Exterior
4.1	Install wall sheathing
4.2	Install roof decking
4.3	Install felt, flashing and shingles
4.4	Hang exterior doors
4.5	Install windows
4.6	Wrap exterior
4.7	Apply brown coat
4.8	Cure brown coat 7 days
4.9	Apply finish coat
4.99	Exterior complete

WBS List for the Lawrence RV Garage Continued

5	Interior
5.1	Finish rough-in plumbing
5.2	Rough-in electrical
5.3	Rough-in HVAC
5.4	Rough-in communication (phone, cable, computer, alarm)
5.5	Utility inspections
5.6	Place wall insulation
5.7	Place ceiling insulation
5.8	Install drywall on walls
5.9	Install drywall on ceilings
5.10	Tape and float drywall
5.11	Prime all walls and ceilings
5.12	Paint all walls and ceilings
5.13	Install bath and storage cabinets
5.14	Complete plumbing
5.15	Complete electrical
5.16	Complete communications (phone, cable, computer, alarm)
5.17	Complete HVAC
5.99	Interior complete
6	Grounds work
6.1	Grade for driveway and sidewalk
6.2	Setup driveway and sidewalk forms
6.3	Lay out driveway rebar
6.4	Pour concrete driveway and sidewalks
6.5	Cure concrete
6.6	Remove forms
6.99	Grounds complete
7	Final acceptance
7.1	Complete final inspection for certificate of occupancy
7.2	Cleanup for occupancy
7.3	Perform final walk-through inspection
7.4	Complete punch list items
7.99	Project complete

CHAPTER 6 | TIME

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TIME MANAGEMENT

Time management is that portion of project management concerned with the project schedule. It includes defining the project activities, ordering the activities in their logical sequence, estimating the effort and duration of each activity and building an overall project schedule. Time management also includes managing the schedule once the project is under way, since the actual amount of time it takes to complete activities does not always match the estimates.

The PMP certification exam focuses time questions heavily around the precedence diagramming method (PDM), the critical path method (CPM) and three-point estimating. You must be familiar with the differences between these 3 techniques and the appropriate circumstances for their use. The exam will test your knowledge of how CPM networks are constructed, how schedules are computed, what the critical path is and how networks are used to analyze and solve project scheduling, resource allocation and resource leveling issues. The exam may also contain some rather elementary scheduling exercises. Variance analysis and earned value calculations can also appear in time management knowledge area questions.

> **EXAM TIP**
> Of the 6 time management processes, 5 are in the planning process group; therefore, a large portion of the planning exam questions will come from this knowledge area. Be prepared to answer multiple questions dealing with estimating techniques, critical path and network diagrams.

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Things to Know

1. The 6 processes of time management:
    - **Activity Definition**
    - **Activity Sequencing**
    - **Activity Resource Estimating**
    - **Activity Duration Estimating**
    - **Schedule Development**
    - **Schedule Control**
2. The **Precedence Diagramming Method** (PDM), the **Arrow Diagramming Method** (ADM) and the **Conditional Diagramming Method**
3. Definitions of **Finish-to-Start**, **Start-to-Start**, **Finish-to-Finish** and **Start-to-Finish** logical relationships
4. **Lag** and **Lead**

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5. Estimating tools and techniques for activity duration estimating:
   - **Expert Judgment**
   - **Analogous Estimating**
   - **Quantitatively-Based** or **Parametric Estimating**
   - **Three-Point Estimating** or **Triangular Distribution**
   - **Reserve Analysis**
6. Difference between **Weighted-Average** and **Critical Path Method** (CPM) estimating techniques
7. The **Critical Path Method** and the **Critical Path Method Schedule Development**
8. What **Crashing** and **Fast Tracking** are and how to use them
9. How to perform a **Forward Pass** and a **Backward Pass**
10. Definitions of **Float**, **Total Float, Slack** and **Free Float**
11. The impact of **Resource Constraints** on a project schedule and how to **Finalize Resource Requirements**
12. **Earned Value** terms and formulas (these will be needed in several other sections too):
    - **PV** or planned value
    - **AC** or actual cost
    - **EV** or earned value
    - **CV** or cost variance
    - **SV** or schedule variance
    - **CPI** or cost performance index
    - **SPI** or schedule performance index

Key Definitions

Crashing: using alternative strategies for completing project activities (such as using outside resources) for the least additional cost. Crashing should be performed on tasks on the critical path. Crashing the critical path may result in additional or new critical paths.

Critical Chain Method: a schedule network analysis technique that is performed after the critical path has been determined to take into account resource availability. The resulting schedule often has an altered critical path.

Critical Path: the path with the longest duration within the project. It is sometimes defined as the path with the least float (usually zero float). The delay of a task on the critical path will delay the completion of the project.

Fast Tracking: overlapping or performing in parallel project activities that would normally be done sequentially. Fast tracking increases rework and project risk.

Float: the amount of time that a schedule activity can be delayed without delaying the end of the project. It is also called **Slack** or **Total Float**. Float is calculated using a **Forward Pass** (to determine the early start and early finish dates of activities) and a **Backward Pass** (to determine the late start and late finish dates of the activities). Float is calculated as the difference between late finish date and early finish date. The difference between the late start date and the early start date always produces the same value for float as the preceding computation.

Hammock: summary activities used in a high-level project network diagram.

Lag: the amount of time a successor's start or finish is delayed from the predecessor's start or finish.

Lead (negative lag): the amount of time a successor's start or finish can occur before the predecessor's start or finish. In a finish-to-start example, activity A (the predecessor) must finish before activity B (the successor) can start. If a lag of 3 days is also defined, it means that B will be scheduled to start 3 days after A is scheduled to finish. Similarly, a lead of 3 days means that B can be scheduled to start 3 days before A is scheduled to finish.

Logical Relationships: there are 4 logical relationships between a predecessor and a successor:
- **Finish-to-Start**, in which the predecessor must finish before the successor can start. This is the most common relationship and the default for most software packages

- **Finish-to-Finish**, in which the predecessor must finish before the successor can finish
- **Start-to-Start**, in which the successor can start as soon as the predecessor starts
- **Start-to-Finish**, in which the predecessor must start before the successor can finish (This is the least used and some software packages do not even allow it.)

Predecessor: the activity that must happen first when defining dependencies between activities in a network.

Project Network Schedule Calculations: there are 3 types of project network schedule calculations, a forward pass, a backward pass and float. A forward pass yields early start and early finish dates, a backward pass yields late start and late finish dates, and these values are used to calculate total float.

Resource Leveling: a schedule network analysis technique that is performed after the critical path has been determined to address specific delivery dates and take into account resource availability or to keep resource usage at a constant level during specified time periods of the project. The resulting schedule often has an altered critical path and could result in the project taking longer to complete.

Schedule Activity: an element of work performed during the course of a project. It is a smaller unit of work than a work package and the result of decomposition in the activity definition process of project time management. Activities can be further subdivided into tasks.

Scheduling Charts: there are 4 types of scheduling charts: the Gantt chart, the milestone chart, the network diagram and the time-scaled network diagram.
- A **Gantt Chart** is a bar chart that shows activities against time. Although the traditional early charts did not show task dependencies and relationships, modern charts often show dependencies and precedence relationships. These popular charts are useful for understanding

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project schedules and for determining the critical path, time requirements, resource assessments and projected completion dates.

- A **Milestone Chart** is a bar chart that only shows the start or finish of major events or key external interfaces (e.g., a phase kickoff meeting or a deliverable). It consumes NO resources and has NO duration. These charts are effective for presentations and can be incorporated into a summary Gantt chart.
- A **Network Diagram** is a schematic display of project activities showing task relationships and dependencies. The precedence diagramming method (PDM) and the arrow diagramming method (ADM) are the 2 major diagramming techniques. These diagrams are useful for forcing the total integration of the project schedule, for simulations and "what if" exercises, for highlighting critical activities and the critical path and for determining the projected completion date.
- A **Time-Scaled Network Diagram** is a combination of a network diagram and a bar chart. It shows project logic, activity durations and schedule information.

Standard Deviation: the probability of being within 1, 2 or 3 standard deviations from the mean is the same for the normal distribution and the weighted average or beta distribution. It is important to memorize these percentages.

- $1\sigma = 68.27\%$
- $2\sigma = 95.45\%$
- $3\sigma = 99.73\%$

Statistical Sums: overall project variables are equal to the sum of their parts. The primary statistical sums are the project mean, variance and standard deviation.

- The project **Mean (μ)** is the sum of the means of the individual tasks.
- The project **Variance** is the sum of the variances of the individual tasks.
- The project **Standard deviation (σ)** is the square root of the project variance.

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Successor: the activity that happens second or subsequently to a previous activity when defining dependencies between activities in a network.

Triangular Distribution or **Three-Point Estimating**: takes the average of 3 estimated durations — the optimistic value, the most likely value and the pessimistic value. By using the average of 3 values rather than a single estimate, a more accurate duration estimate for the activity is obtained.

Weighted-Average Time Calculations: the weighted average places more emphasis on the most likely outcome in calculating the duration of an activity. Therefore, it produces a bell-shaped curve that is skewed to one side when possible durations are plotted against their probability of occurrence. A weighted-average estimate is most useful when the project involves activities with little or no previous historical data.

What-If Scenario Analysis: a technique used to assess the feasibility of the project schedule should unexpected events occur. This analysis is useful for preparing contingency and response plans to mitigate the impact of identified risk events and could involve simulations of various project durations using different sets of project assumptions. The most common simulation method is the **Monte Carlo Analysis** technique described in Section 11.4.2.2. of the PMBOK Guide.

ACTIVITY DEFINITION PROCESS

This process involves the identification of the specific activities that must be performed in order to produce the deliverables of the WBS work packages. Therefore, the key inputs are the WBS and the scope statement which includes the project justification and project objectives. Each of the work packages is then broken down (decomposed) into smaller components called schedule activities. These activities comprise the activity list. Note that decomposition is the tool or technique used in the create WBS process as well.

The primary difference between decomposition in the activity definition process and decomposition in the create WBS process is the final output. In the create WBS process, the results are deliverables; in the activity definition process, the results are activities. In some areas, the WBS and activity list are developed concurrently but in every case, by further breaking down the work, the scope is further refined and could result in WBS updates.

ACTIVITY SEQUENCING PROCESS

The 4 processes of activity sequencing, activity resource estimating, activity duration estimating, and schedule development are so closely linked that some projects combine the 4 processes into a single process to come up with the project schedule. Activity sequencing involves organizing project tasks in the order they must be performed. This is accomplished by using the activity list and product description to determine the immediate predecessor(s) and successor(s) of each task. In addition, **Mandatory Dependencies** (hard logic), **Discretionary Dependencies** (preferred or soft logic), **External Dependencies** and **Milestones** must be considered.

The primary tool or technique for this process is the network diagramming method to create the project network diagram. The network diagram may show that activity refinements are necessary, and it may result in updates to the activity list.

Diagramming Methods

Project network diagrams are an important output of the activity sequencing process. There are 2 main techniques used and a third technique that is occasionally used. All methods can be used for critical path determination. There are many exam questions on critical path as well as on float, duration estimates and forward and backward passes.

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- In the **Precedence Diagramming Method (PDM)**, also called **Activity-on-Node (AON)**, boxes or circles are used to represent activities while arrows show the sequence of workflow. Events (milestones, for example) are not usually shown on PDM diagrams. Four types of dependencies can be shown — **Finish-to-Start, Finish-to-Finish, Start-to-Start** and **Start-to-Finish**. Finish-to-start is the most common. Know how to calculate duration and elapsed time for simple PDM networks. PDM is more frequently utilized than the arrow diagramming method described below since it is easier to read. PDM can also show lead (i.e., negative lag) and lag times.
- In the **Arrow Diagramming Method (ADM)**, also called **Activity-on-Arrow (AOA)**, the arrow represents the activities from the WBS and the nodes are events (i.e., completion of the activity) that show the sequence of the activities. ADM may require "dummy" arrows (activities) to show correctly all sequence relationships. ADM uses only finish-to-start dependencies.
- A third diagramming method is the **Conditional Diagramming Method.** It allows for nonsequential activities such as loops or conditional branches.

ACTIVITY RESOURCE ESTIMATING PROCESS

Resources come in several forms — people, equipment, materials, facilities and money. One of the key components of determining an accurate schedule for any project is the ability to determine accurately the type of resources (by description, quantity and availability) needed to perform work activities. These resource estimates can then be used to estimate project costs. Therefore, the activity resource estimating process is very closely tied to the cost estimating process in the next chapter.

The PMBOK Guide breaks down estimating into 2 steps. The first is estimating resources from a skill and availability standpoint (which is the activity resource

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estimating process) and the second is estimating the duration of each work package based on the decisions made in the activity resource estimating process.

The activity list, activity attributes and resource availability are key inputs to the activity resource estimating process. By assigning resources and estimates to each activity — which then are rolled up to work packages within the WBS — a more detailed and accurate schedule is produced. The primary outputs of this process are the activity resource requirements, the requested changes and the **Resource Breakdown Structure** (RBS). The RBS is a hierarchical structure of the identified resources broken out by category and type.

ACTIVITY DURATION ESTIMATING PROCESS

Once the project tasks have been organized in the order that they are to be performed, activity duration estimating is the process of defining the number of work periods that will be needed to complete the individual activities. In estimating the duration of the task, it is necessary to know the resource requirements and capabilities, factors influencing elapsed time and any historical information of similar tasks. The project team must decide if the types of estimates should be deterministic (if a single estimate is used and the duration is known with a fair degree of certainty) or probabilistic (if the task duration is uncertain so a three-point estimating technique or weighted average is used).

Primary tools and techniques in this process are the various estimating methods. In obtaining the duration estimates of the tasks, activity refinements may be necessary and updates may need to be made to the activity attributes.

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Estimating Tools and Techniques

Expert Judgment (such as the **Delphi Technique):** one or more subject matter experts are used as a source for obtaining estimates. If subject matter experts lack historical information or experience, the risk of inaccurate estimates is increased.

Analogous Estimating (or **Top-Down Estimating**): obtained by comparing the current project activities to previous project activities and using the actual duration of the previous similar activity as the basis for the current activity. The degree of similarity affects accuracy. This technique should be used early in the estimating cycle when there is not much detail known about the activity. Analogous estimating is considered to be a form of expert judgment.

Quantitatively-Based Estimating (sometimes called **Parametric Estimating**): the quantities of the units of work are multiplied by a productivity unit rate to obtain an estimated activity duration. These estimates are based on historical information that has been codified. An example is the creation of a training manual in terms of pages per day. A junior writer may produce 2 pages per day while a senior writer may produce 5 pages per day. A software development example may be the number of lines of code produced per day by various levels of programmers.

Three-Point Estimating (also called **Triangular Distribution**): this could be seen on the exam. You do not need to know how to calculate variance or standard deviation for this distribution on the exam, but you may need them in your actual work as a project manager, so here are formulas for the mean, variance and standard deviation in this type of estimating:
- Mean $(\mu) = [(a + m + b)]/3$
  where a = lowest value, m = most likely value and b = highest value

- Variance and standard deviation
  $V = \sigma^2$ or
  $V = [(a - b)^2 + (m - a)(m - b)]/18$

Reserve Analysis (contingency): the additional reserve or buffer time to allow for unexpected delays. It can be added to the estimated activity duration directly or it can be created as an activity by itself. It can also be a percentage added to all activities. It should be increased for projects of high or unknown risk.

Weighted-Average vs. CPM Estimating

The Weighted-Average Time Calculations use 3 time estimates — optimistic (O), most likely (ML), and pessimistic (P) — to come up with a weighted average (WA) for activity duration. The formula is:
- WA (μ) = [O + 4(ML) + P]/6

A standard deviation can also be calculated using the formula:
- WA Standard Deviation (σ) = (P - O)/6

The weighted-average estimate is used in calculating the schedule while the standard deviation is used to compute the probability of schedule completion and provide a range of estimates.

Critical Path Method (CPM) Estimating uses a single estimate for each activity. The estimate may come from historical data of similar activities, or it may be from expert judgment figures. No standard deviation figure is calculated. CPM estimates are used when there is a high degree of similarity to previous activities.

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SCHEDULE DEVELOPMENT PROCESS

The schedule development process utilizes the duration estimates for each task in order to determine the start and finish dates for each task. By traversing the longest path within the project, the critical path can be determined and the project schedule is developed. Therefore, necessary inputs to developing the project schedule are the network diagrams with duration estimates, resource requirements, activity list, project and resource calendars, other constraints and assumptions, leads and lags, risk register and attributes of the activities.

In order to produce the project schedule, schedule network analysis is used to calculate early and late start and finish dates without regard for resource availability and limitations. Schedule network analysis uses various analytical techniques such as the CPM, the **Critical Chain Method**, **What-if Scenarios Analysis** and **Resource Leveling**. Loops and open-end nodes in the network diagram are adjusted before the analytical technique is applied.

Schedule Compression is a special case of schedule network analysis where the project schedule is shortened without changing the project scope. **Crashing** and **Fast Tracking** are 2 techniques supported by PMI as ways to accelerate the project schedule without changing the project scope. Both techniques require an understanding of network diagrams. You must know the advantages offered by networks over bar charts and flow diagrams and understand the two ways in which networks can be represented (activity-on-arrow and activity-on-node).

Both crashing and fast tracking can result in increased costs and can increase the risks of achieving the shorter project schedule. Simulations such as Monte Carlo analysis are also used to calculate the probable results for the total project.

Float, or **Slack**, is also a concept you must understand. You must know how it presents challenges and opportunities to project schedulers.

Both **Resource Leveling** and the **Critical Chain Method** utilize resource availability to produce a resource-limited schedule which could result in an extended critical path.

The project schedule, schedule baseline and updated schedule management plan are the primary outputs of the schedule development process.

Critical Path Method Schedule Development

When developing a network schedule for your project using activity-on-node for each activity, the following variables are determined:
- Duration
- Float
- Early start date (ES)
- Early finish date (EF)
- Late start date (LS)
- Late finish date (LF)

TASK ID	
Duration	Float
ES	EF
LS	LF

Figure 6-1
Matrix for a
Network Diagram

These variables are formatted into a simple matrix for each task of the network diagram, as shown in Figure 6-1.

The network diagram is traversed from left to right in a **Forward Pass** to determine ES and EF:
- Start time of the project is zero (0)
- ES = EF of the immediate predecessor
- EF = ES plus duration
- A successor starts when ALL its predecessors are complete
- Project finish date = EF of the final task

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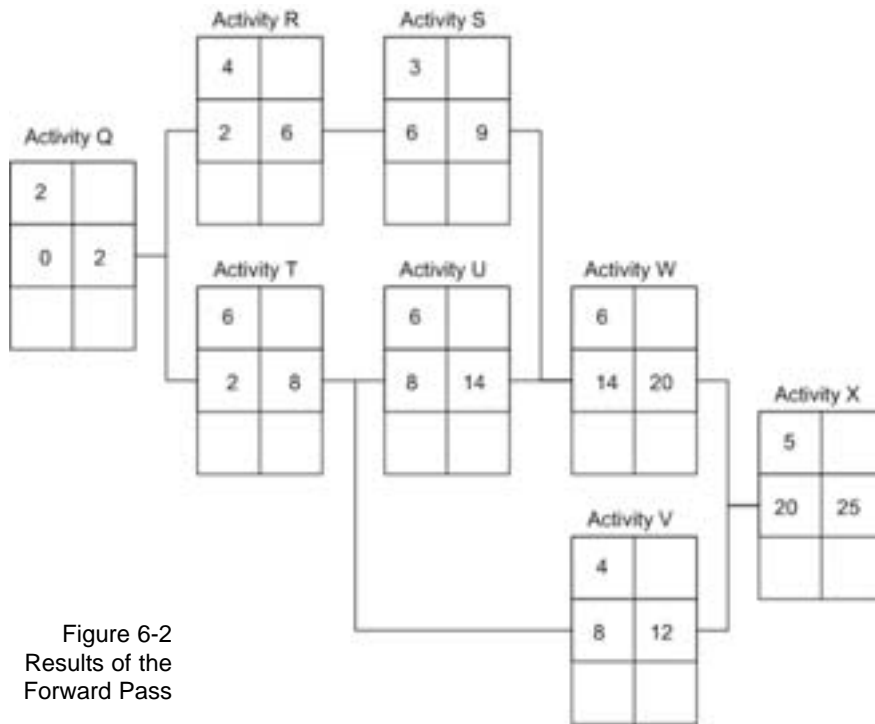
Figure 6-2
Results of the
Forward Pass

Figure 6-2 illustrates the results of the forward pass. Once the forward pass is complete, begin the **Backward Pass** by traversing the network diagram from right to left to determine LF and LS of each task:
- Project LF = EF of the final task of the project
- LS = LF minus duration
- LF = the earliest LS of ALL its successors

Once LF and EF are known, float can be calculated:
- Float = LF - EF

The results are shown in Figure 6-3. Note that both activities R and S in the example each have a **Total Float** of 5 days. The combined duration of activity R and S is 7 days, while the combined duration of activity T and U (on the critical path) is 12 days and activity W (also on the critical path) is the successor to both activities U and S. Since **Free Float** is defined as the amount of time an activity can be delayed without delaying the start of an immediate successor, the free float for activity R is 0 days, which allows activity S to have a free float of 5 days.

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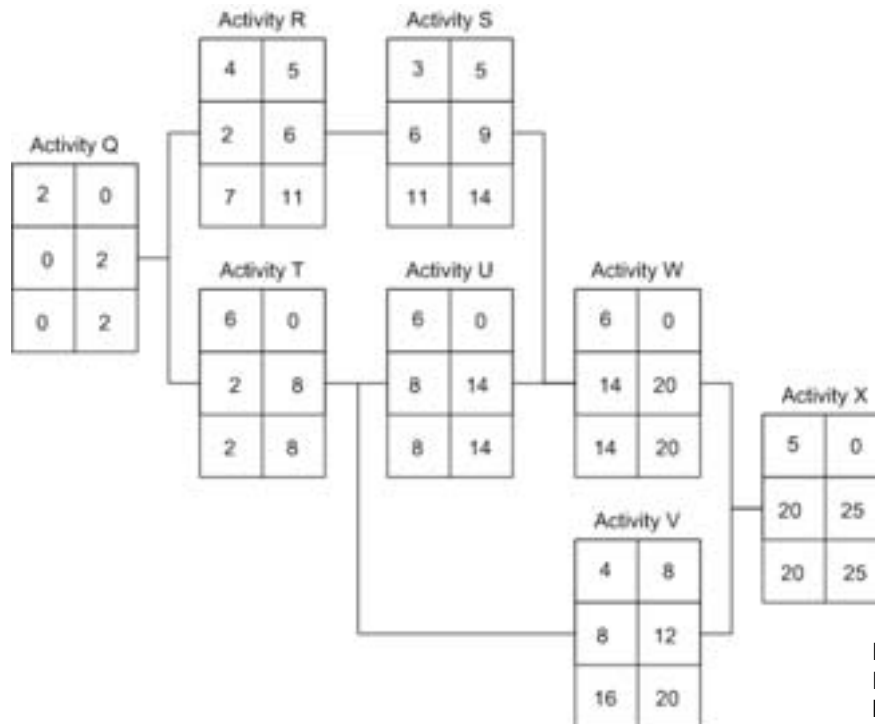
Figure 6-3
Results of the
Backward Pass

In CPM analysis a finish-to-start relationship is used exclusively. Other relationships available are finish-to-finish, start-to-start and the least used, start-to-finish.

Once the network diagram is completed and the schedule activity relationships are known, a Gantt chart can be developed. Gantt charts are generally used to monitor schedule progress. Other relationships besides finish-to-start can be reflected along with leads and lags. A sample Gantt chart is shown in Figure 6-4.

Figure 6-4
Gantt Chart

ID	Task Name	Start	Finish	Duration	Jun 2005			Jul 2005			
					6/12 6/19 6/26	7/3	7/10 7/17	7/24 7/31			
1	Activity Q	6/13/2005	6/14/2005	2d							
2	Activity R	6/15/2005	6/20/2005	4d							
3	Activity S	6/21/2005	6/23/2005	3d							
4	Activity T	6/15/2005	6/22/2005	6d							
5	Activity U	6/23/2005	6/30/2005	6d							
6	Activity V	6/23/2005	6/28/2005	4d							
7	Activity W	6/30/2005	7/7/2005	6d							
8	Activity X	7/8/2005	7/14/2005	5d							

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Case Study Exercises

Exercise 6-1: Using the WBS for the Lawrence RV Garage Project developed in Chapter 5, Exercise 5-2, create a network diagram showing the dependencies of the various WBS items. Use the activity-on-node (AON) technique. Also include your estimates for how many days each activity will take. All estimates should be in whole days.

Exercise 6-2: Draw a Gantt chart based on the precedence diagram from Exercise 6-1 for the Lawrence RV Garage Project.

Schedule Compression

Schedule compression is the use of techniques to shorten the critical path, such as crashing and fast tracking. As a project manager you must recognize that there are always tradeoffs to schedule compression. You may have to bring in extra resources or more expensive resources in order to perform schedule activities in shorter time frames or in parallel.

Depending upon risk tolerances and the constraints and assumptions in your scope statement, the choice of where to compress the schedule will usually become obvious.

Figure 6-5 shows an example of opportunities to compress the schedule project depicted in Figures 6-2 through 6-4.

Possible Opportunity	Schedule	Cost	Risk
Reduce Activity W 3 days by hiring an expert	Reduce 3 days		Low
Break Activity W into 2 equal activities and hire another resource at the current rate	Reduce 3 days		High
Reduce Activity T 2 days by working over the weekend	Reduce 2 days		Medium

Figure 6-5
Schedule
Compression

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Resource Constraints

In many cases projects are resource constrained, which limits optimal scheduling. Two methods that can be used to facilitate scheduling with limited resources are resource leveling and critical chain method. In general these methods typically lengthen the schedule.

Finalizing Resource Requirements

The output of the schedule development process is an official set of plans for the project that includes:
- The project schedule
- The baselines
- Resource requirement updated histogram (see Figure 6-6)
- Supporting data
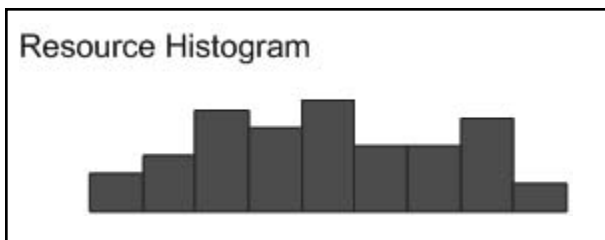
Figure 6-6
Resource
Histogram

The steps to be taken for assigning people to work identified for each schedule activity in a work package and detailed into a Gantt chart are:
- Assign resources to each activity, one resource at a time
- For each time period, sum up the resources required
- Develop a histogram

6

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SCHEDULE CONTROL PROCESS

The schedule control process involves the handling of factors that could impact the project schedule. It involves:

- The review and approval processes of changes that lead to schedule changes
- Determining the size and impact of the change
- Managing the actual schedule change

Changes to the project schedule could come in the form of a change request or in response to project performance or nonperformance needing corrective action. Variance analysis is a key technique of time control. Comparing actual start and finish dates to planned dates provides early problem determination.

Although the earned value technique (EVT) is not discussed in detail in project time management, it is very much a part of variance analysis and many exam questions could utilize earned value concepts in this knowledge area.

Earned Value Terms and Formulas

Remember that EVT is a technique that uses cost figures to calculate both the cost and schedule status of a project that has started. Since costs are the basis of all the calculations, even schedule information is stated in cost units. Also, remember that EVT is always as of a specific date (the data date).

Independent Variables:
- **Planned Value** (PV): the sum of the approved cost estimates for activities scheduled to be performed during a given period
- **Actual Cost** (AC): the amount of money actually spent in completing work in a given period
- **Earned Value** (EV): the sum of the approved cost estimates for activities completed during a given period

Dependent Variables:

- **Cost Variance** (CV) = earned value minus actual cost. It is the difference between the budgeted cost of the work completed and the actual cost of completing the work. A negative number means the project is over budget.
  - CV = EV - AC

- **Schedule Variance** (SV) = earned value minus planned value. It represents the difference in value between what was accomplished and what was scheduled. A negative number means the project is behind schedule.
  - SV = EV - PV

- **Cost Performance Index** (CPI) = earned value divided by actual cost. This is the ratio of what was completed vs. what it cost to complete. For example, if we completed work that was worth $100 (EV), but it cost $125 to do it (AC). Our CPI is 0.8 (or 80%), meaning that we got 80 cents of work for every dollar we spent.
  - CPI = EV/AC
  - CPI = 100/125 = 0.8

- **Schedule Performance Index** (SPI) = earned value divided by planned value. This is the ratio of what was completed vs. what was planned to be completed. Expanding on the example above, if we completed work worth $100, but we were supposed to complete $110, our SPI is 0.91, meaning that we are only completing 91 cents of every dollar that was scheduled to be spent.
  - SPI = EV/PV
  - SPI = 100/110 = 0.91

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SAMPLE PMP EXAM QUESTIONS ON TIME MANAGEMENT

Time — Planning Questions

1. The first step in building a schedule network is to:

   a) Create a flow chart
   b) Determine the critical path
   c) Show task relationships
   d) Create a WBS

2. Resource leveling will often affect the project by making it:

   a) Shorter
   b) Longer
   c) More responsive to customer needs
   d) More complex

3. As a control tool, the bar chart (Gantt) method is most beneficial for:

   a) Rearranging conflicting tasks
   b) Depicting actual vs. planned tasks
   c) Showing the outer dependencies of tasks
   d) Displaying contingency

4. Excessive flexibility in specifying requirements will _____ the likelihood of time overruns.

   a) Reduce
   b) Eliminate
   c) Double
   d) Increase

Notes:

Mary drives 6 miles to work and passes through 13 traffic lights. Optimistically, she could get all green lights and make it to work in 10 minutes. However, she could also hit all red lights, taking her 23 minutes to get to work. Most often, it takes Mary 14 minutes to drive to work because she usually only hits 5 red lights.

5. Calculate the expected value duration (in minutes) for the above problem using the weighted-average technique.

   a) 7.9
   b) 14.8
   c) 29.2
   d) 15.7

6. As project manager, you have come up with the following time spread for completing the project: most likely = 20 weeks, least time = 10 weeks, longest time = 30 weeks. Using the weighted-average technique, you determine that there is a 95.5% probability that the project will last:

   a) Between 16.7 and 23.33 weeks
   b) Between 20.0 and 23.33 weeks
   c) Between 13.4 and 26.66 weeks
   d) Between 16.7 and 26.66 weeks

7. In crashing a task, you would focus on:

   a) As many tasks as possible
   b) Noncritical tasks
   c) Accelerating performance of tasks on critical path
   d) Accelerating performance by minimizing cost

Notes:

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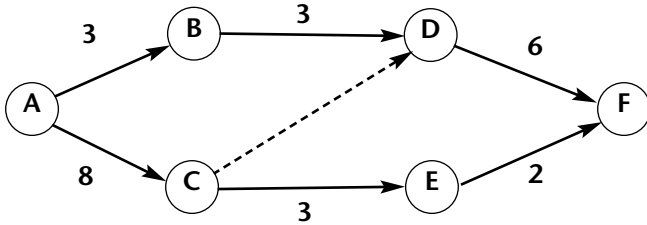
8. How long will the project portrayed in the activity-on-arrow diagram above take to complete?

   a) 11 days
   b) 12 days
   c) 13 days
   d) 14 days

Time — Monitoring and Controlling Questions

9. A plan has budgeted 3 weeks of effort for consultants, but the job was done in only 2 weeks. Calculate the variance:

   a) 10.5%
   b) 33%
   c) 75%
   d) 67%

10. On November 1, $1,000 worth of work on task A was supposed to have been done (planned value); however, the earned value was $850. Calculate the schedule variance.

   a) -$100
   b) $100
   c) -$150
   d) $150

Notes:

	Planned Value	**Earned Value**
Planning	20K	24K
Testing	16K	5K
Design	34K	34k

11. As project manager you need to let your team know how it is doing on the project schedule overall. Of the 3 project phases in progress to date — planning, testing and design — you calculate planned value and earned value as shown in the above table. As a whole, your project is roughly:

a) 10% behind schedule
b) 10% ahead of schedule
c) 10% behind schedule and budget
d) 10% ahead of schedule, but over budget

Foundation Budget			
Task	PV	AC	EV
Survey	500	2,000	400
Remove Debris	2,000	3,500	2,000
Dig Hole	3,000	2,000	2,800
Set Up Forms	1,200	1,000	1,100
Pour Concrete	5,000	3,000	2,500

12. Which task in the table above is on schedule?

a) Dig hole
b) Remove debris
c) Survey
d) Set up forms

ANSWERS AND REFERENCES FOR SAMPLE PMP EXAM QUESTIONS ON TIME MANAGEMENT
Section numbers refer to the PMBOK Guide.

1. **D Planning Section 6.1.1.4 Activity Definition**
   The WBS lists the deliverables of the project. It also serves as an estimating tool in which time estimates are made for each activity within the work package of the WBS.

2. **B Planning Section 6.5.2.5 Schedule Development**
   Resource leveling is the process of rescheduling tasks to eliminate resource overcommitment, usually leading to an extension of the duration of the project and a possible change to the critical path.

3. **B Planning Section 6.5.3.1 Schedule Development**
   Gantt (bar) charts show start and end times of tasks. They are useful for portraying actual vs. planned start and end times.

4. **D Planning**
   Excessive flexibility causes chaotic planning and leads to major inefficiencies in the implementation of the project.

5. **B Planning Section 6.4.2.4 Activity Duration Estimating**
   Expected value of duration (weighted-average) = [Optimistic + 4(Most Likely) + Pessimistic]/6
   $$= \frac{10 + 4(14) + 23}{6}$$
   = 14.8 minutes

6. **C Planning Section 6.4.2.4 Activity Duration Estimating**
   Calculate the mean (10 + 4X20 + 30)/6 = 20, then calculate the standard deviation = (30 - 10)/6 = 3.33. 95.5% is 2 standard deviations from the mean or +/- 6.66 from 20.

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7. **C   Planning Section 6.5.2.3 Schedule Development**
Only by accelerating the performance of the critical path tasks can one shorten the project duration. Accelerating performance of noncritical tasks does not affect project duration.

8. **D   Planning Section 6.5.2.1 Schedule Development**
Critical path   = (task A - C) + (dummy C - D)
                 + (task D - F) = 14 days.

9. **B   Monitoring and Controlling Section 6.6.2.5 Schedule Control**
Variance = Plan - Actual
Variance = 3 weeks - 2 weeks
Variance = 1 week
% Variance = Variance/Plan
% Variance = 1 week/3 weeks
% Variance = 0.33 or 33%

10. **C   Monitoring and Controlling Section 6.6.2.3 Schedule Control**
Schedule Variance (SV) =
        Earned Value (EV) - Planned Value (PV)
SV = $850 - $1,000 = -$150

11. **A   Monitoring and Controlling Section 6.6.2.3 Schedule Control**
SPI = 63/70 = 0.90 <1 which means behind schedule

	PV	EV
Planning	20K	24K
Testing	16K	5K
Design	34K	34K
Total	70K	63K

12. **B   Monitoring and Controlling Section 6.6.2.3 Schedule Control**
For the task remove debris, SV = EV - PV
= 2,000 - 2,000 = 0. Zero variance = task on schedule or complete.

CASE STUDY SUGGESTED SOLUTIONS

Exercise 6-1
Network Diagram for the Lawrence RV
Garage Project

This example uses the phases of the project as tasks to show
dependencies.

SITE PREP Start: 6/11/04 ID: 2 Finish: 6/14/04 Dur: 2 days	**FOUNDATION** Start: 6/15/04 ID: 3 Finish: 6/28/04 Dur: 10 days	**FRAMING** Start: 6/29/04 ID: 4 Finish: 7/12/04 Dur: 10 days

UTILITY ROUGH-IN Start:7/13/04 ID: 5 Finish: 7/20/04 Dur: 6 days	**INTERIOR** Start: 7/22/04 ID: 8 Finish: 8/18/04 Dur: 20 days		**FINAL ACCEPTANCE** Start: 8/19/04 ID: 10 Finish: 8/20/04 Dur: 2 days
ROOF Start: 7/13/04 ID: 6 Finish: 7/21/04 Dur: 7 days	**EXTERIOR** Start: 7/22/04 ID: 7 Finish: 8/4/04 Dur: 10 days	**GROUNDS** Start: 8/5/04 ID: 9 Finish: 8/9/04 Dur: 3 days	

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Exercise 6-2
Gantt Chart for the Lawrence RV Garage Project

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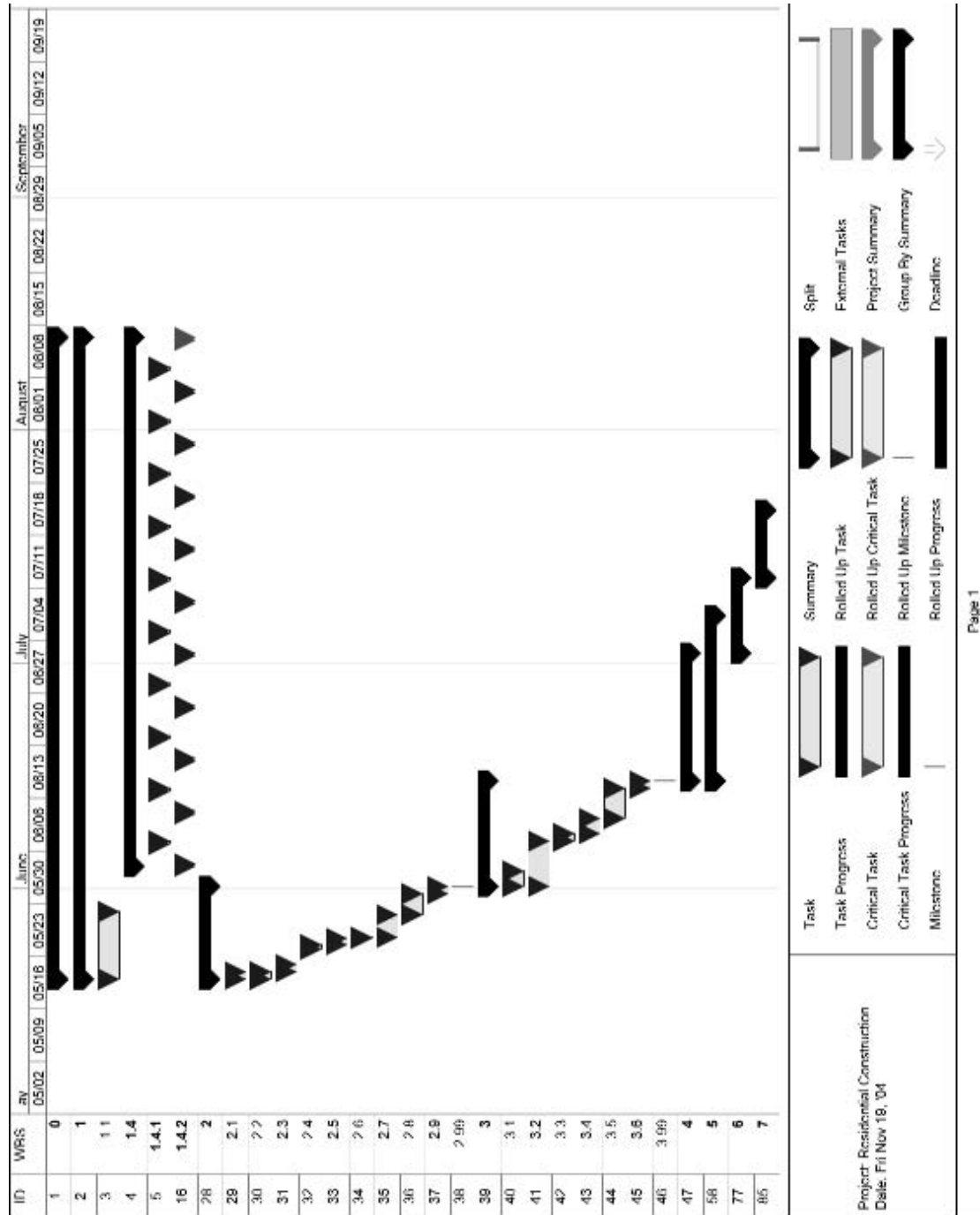
COST

CHAPTER 7 | COST

7

COST MANAGEMENT

Project cost management questions on the PMP certification exam do not require you to be a math whiz. The questions address cost management from a project manager's perspective, which is much more general. However, these questions are NOT easy.

Project cost management focuses on the cost of the resources needed to complete a project. The PMBOK Guide emphasizes **Life Cycle Costing** as a way to get a broader view of project costs. Life cycle costing includes acquisition, operation, maintenance and disposal costs. Project decisions should take into consideration life cycle costing. For example, a project manager may purchase a proprietary technology because he or she realizes, in considering life cycle costing, that the purchase will increase future maintenance support and training.

This section addresses a broad range of cost issues such as basic and capital budgeting, cost estimating, earned value, creating and interpreting S-curves and the like. This is probably the section people spend the most time studying.

In addition, performance reporting, including earned value analysis and communications are integrated into the questions on cost. Formulas you will need to know are fairly simple but you must know them. You must also understand and be able to evaluate costs using earned value formulas and variance analysis.

Cost management is a 3-step process comprised of cost estimating, cost budgeting and cost control.

Things to Know

1. The 3 processes of cost management:
    • **Cost Estimating**
    • **Cost Budgeting**
    • **Cost Control**
2. The difference between **Cost Estimating** and **Pricing**

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3. The tools for cost estimating:
   - **Analogous Estimating**
   - **Parametric Estimating**
   - **Bottom-Up Estimating**
4. Types and ranges of estimates:
   - **Order of Magnitude Estimate**
   - **Preliminary Estimate**
   - **Budget Estimate**
   - **Definitive Estimate**
   - **Final Estimate**
5. **Reserve Analysis**, types of uncertainty and what a **Management Contingency Reserve** is
6. How to create an **S-Curve**
7. How to **Crash** with time and/or cost tradeoffs
8. The earned value terms and formulas:
   - **PV** or planned value
   - **AC** or actual cost
   - **EV** or earned value
   - **CV** or cost variance
   - **SV** or schedule variance
   - **CPI** or cost performance index
   - **SPI** or schedule performance index
   - **BAC** or budget at completion
   - **EAC** or estimate at completion
   - **ETC** or estimate to complete
   - **VAC** or variance at completion
9. How to calculate **Depreciation**, both straight line and accelerated
10. The **Profitability Measures (ROS, ROI, PV, IRR and BCR)**

Key Definitions

Crashing Costs: costs incurred as additional expenses above the normal estimates to speed up an activity.

Direct Costs: costs incurred directly by a project.

Fixed Costs: nonrecurring costs that do not change if the number of units is increased.

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Indirect Costs: costs that are part of doing business and are shared among all ongoing projects.

Opportunity Costs: costs of choosing one alternative over another and giving up the potential benefits of the other alternative.

Sunk Costs: money already spent; there is no more control over these costs. Since these are expended costs they should not be included when determining alternative courses of action.

Variable Costs: costs that increase directly with the size or number of units.

COST ESTIMATING PROCESS

There is often confusion between **Cost Estimating** and **Pricing**. Cost estimating is the process of estimating the cost of the project, considering the tradeoffs between time and cost and evaluating the overall impact of costs on the project. Pricing is a business decision about what the customer or client should be charged for the product or service produced by the project. Cost is part of the pricing decision but they are separate entities.

The **Cost Management Plan** is a subsidiary plan of the project management plan. It can establish certain ground rules for developing cost budgets such as:
  • Estimating rounding rules
  • Standardized units of measure
  • Commonly used parametric data such as resource rates, overhead rates, inflation rates, etc.
  • Earned value credit criteria

Tools and techniques of the cost estimating process are analogous estimates, parametric estimates and bottom-up estimates. The primary outputs of this process are the cost estimates for each schedule activity and the updates to the cost management plan.

Analogous Estimating (also called **Top-Down Estimating**): compares the current project activities to previous, similar projects. The degree of similarity between the prior project and the current project affects the accuracy of the estimate. Also, remember to consider changes in labor rates, purchased resources and overhead since the prior project.

Parametric Estimating (also called **Quantitatively-Based Estimating**): is based on historical information that has been codified. An example used in home construction is the cost per square foot. This number remains about the same no matter how big the house. Software development companies may base their parametric estimates on lines of code and function points.

Bottom-Up Estimating: is based on a very detailed WBS that allows the estimator to estimate each activity more accurately. When the individual activity estimates are rolled up, they become the project estimates. This technique requires detailed specifications as well as a good understanding of the cost components for each activity.

Types and Ranges of Estimates

The following types of estimates range in accuracy from -25% (or even as low as -50%) to +75% (or even as high as +100%). Figure 7-1 lists each type of estimate and its typical range.

Order of Magnitude Estimate (also known as a feasibility, conceptual or ball-park estimate): an approximate estimate made with no detailed data to back up the estimate. Used in the initial concept phase. Range: -25% to +75%, although the PMBOK mentions that it can be as great as -50% to +100%.

Preliminary Estimate (also called an **Analogous Estimate**): a more refined estimate than the order of magnitude, based on a more detailed understanding of the project scope. It is often based on similar projects already completed. Range: -15% to +50%.

7 - 4
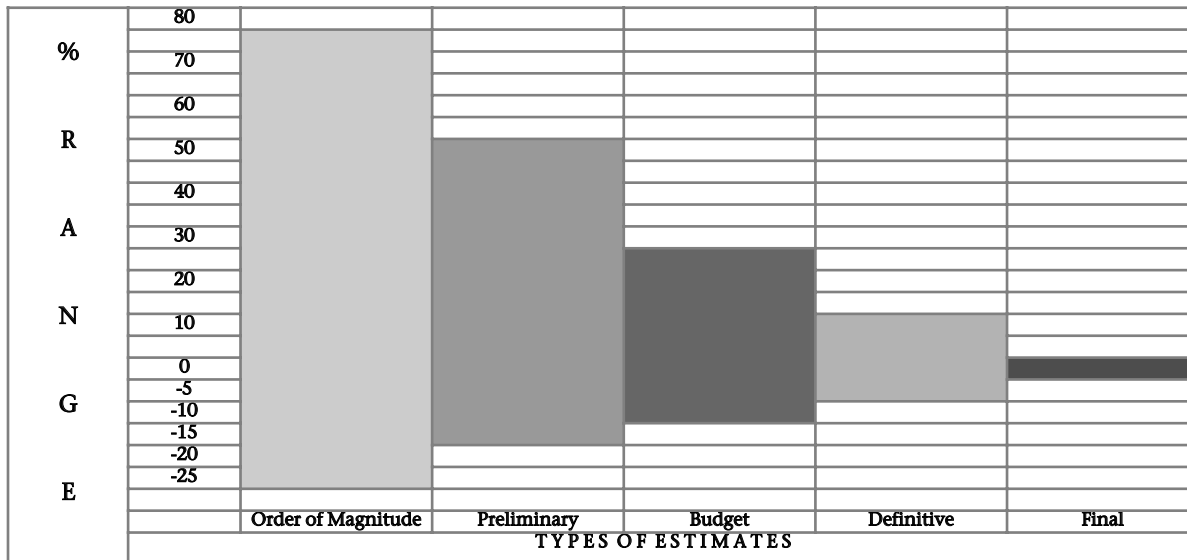
TYPES OF ESTIMATES

Figure 7-1
Types and Accuracy
Ranges of Estimates

7

Budget Estimate (also called an **Appropriations** or **Semi-Detailed Estimate**): an estimate used to obtain funds and approval for a project. Range: -10% to +25%.

Definitive Estimate (also called a **Bottom-Up Estimate**): an estimate prepared from well-defined specifications or detailed data. It is often used for bid proposals, legal claims, permits or government approvals. Range: -5% to +10%.

Final Estimate: actual expenditures for the project. Range: -0% to +0%.

Note that the risk register (discussed in Chapter 11) is a key input to cost estimating since estimates are highly sensitive to the expected probability of risk events.

COST BUDGETING PROCESS

Once the cost estimates for each activity are available, the cost budgeting process involves aggregating the values to create the cost baseline. This cost baseline is used to measure project performance. The updates to the cost management plan are included in the project management plan.

Reserve Analysis yields contingency reserves on individual activities or groups of related activities. These allowances are in response to uncertainty or potential risk events. Uncertainty can be defined in terms of knowns and unknowns.

- **Known** items are those things you plan for.
- **Known Unknowns** are those things you hedge for (contingency).
- **Unknown Unknowns** are those items that were never part of the scope and should be addressed through a well-defined change control process.

A **Management Contingency Reserve** may be established for potential required changes to scope at the project level. Sometimes simply called **Contingency Reserve**, these are the amount of funds, budget or time needed above the estimate to reduce the risk of overruns of project objectives to a level acceptable to the organization. Management contingency reserves are NOT part of the cost baseline, but are in the project budget.

Funding Requirements and Funding Limit Reconciliation

As many of you have probably experienced, if you have built a home or added to a home, funds for construction are released as certain milestones are achieved. PMI recognized that many organizations have limited resources and expenditures which must be managed. Based on funding limits that may be set by the customer, work schedules may have to be adjusted or reconciled to accommodate the payment schedule.

S-Curves

S-curves are a graphical representation of accumulated budgeted costs over time. Typically, costs rise gradually early in the project, accelerate during execution and taper off as a project closes, creating a curve that resembles an "S."
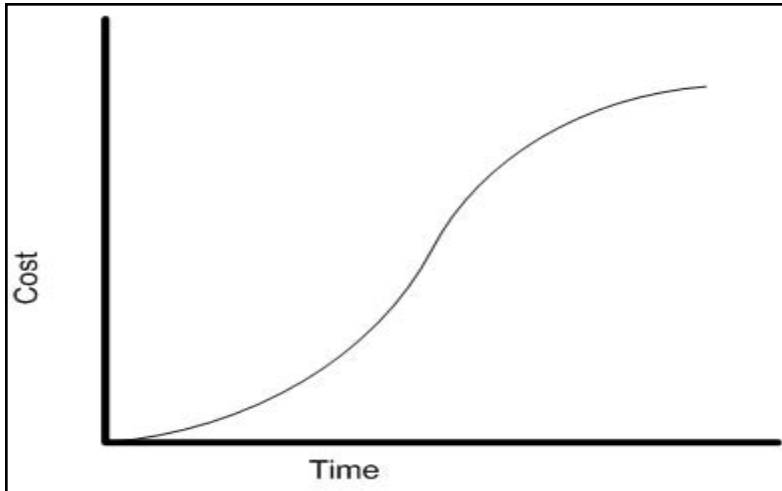
Figure 7-2
Sample S-Curve

The source of S-curves is what you have already worked on: the WBS, project schedule and histogram. Now all you have to do is add your material costs and factors for overhead items and you have your curve. Figure 7-2 is an example of an S-curve like one that would be generated from the data in Figure 7-3.

Figure 7-3
S-Curve data

Activity	Week 1	Week 2	Week 3	Week 4	Week 5
Q	400				
R	600	200			
S		600			
T	600	600			
U		200	800		
V		200	400		
W			200	1,000	
X					1,000
Total Labor	1,600	1,800	1,400	1,000	1,000
Material	1,000	1,000	1,000	1,000	1,500
Overhead (10% of labor)	160	180	140	100	100
Total Budget	2,760	2,980	2,540	2,100	2,600
Cumulative Budget	2,760	5,740	8,280	10,380	12,980

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Case Study Exercise

Exercise 7-1:   Using the schedule from the previous exercises and the data below for the Lawrence RV Garage Project, develop an S-curve diagram.

Phase	Labor	Materials and Equipment	Total
Project Management	$5,000		$5,000
Site Prep	$500	$500	$1,000
Foundation	$1,000	$1,500	$2,500
Framing	$2,500	$7,500	$10,000
Utilities			
Plumbing (subcont.)			$800
Electrical (subcont.)			$1,100
HVAC (subcont.)			$1,800
Roof (subcont.)			$4,500
Stucco (subcont.)			$500
Insulation (subcont.)			$550
Drywall	$350	$1,950	$2,300
Painting	$250	$250	$500
Interior Finish	$150	$450	$600
Driveway and Walks	$300	$1,200	$1,500
Acceptance	$225		$225
TOTALS	**$10,275**	**$13,350**	**$32,875**

COST CONTROL PROCESS

Of the 3 components of the triple constraint — time, cost and scope — cost is one of the most difficult to control. As changes occur, adjustments and contingency plans can be established to maintain time and scope objectives. Costs however are nearly always negatively affected as schedules slip or scope increases. In addition, if unforeseen costs are incurred, adjusting or absorbing these changes to stay on budget is extremely difficult.

In order to counteract these forces, it is important to ensure that any changes to cost are agreed upon, that changes to cost are identified quickly and that any changes are managed as they occur.

PMI advocates the use of EVT to integrate scope, schedule and resources. EVT promotes common understanding by using common metrics and it helps assess the magnitude of cost variations quickly. It also accurately reflects the variations associated with schedule and costs separately. EVT provides a consistent methodology for measuring performance across projects.

Crashing with Time and/or Cost Tradeoffs

In Chapter 6 on time management, crashing was discussed as a strategy to compress the project schedule without reducing project scope. Crashing requires using alternative strategies for completing project activities (such as using outside resources) for the least additional cost. Figure 7-4 on the following page recalls the schedule compression table in Figure 6-4, but with the cost component added.

In order to control crashing costs, the following steps should be followed:
- Isolate the critical path; crashing should be performed on activities on the critical path.
- Calculate cost for the estimated duration of each activity.
- Calculate crash cost per time unit (usually days) for each activity.

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- Begin with those activities in which the crash cost per time unit saved is the lowest.
- Continue with the next lowest crash cost per time unit saved activity until the desired reduction in project schedule is achieved.
- Note that crashing the critical path may result in additional or new critical paths where additional crashing of activities must occur.

Possible Opportunity	Schedule	Cost	Risk
Reduce Activity W 3 days by hiring an expert	Reduce 3 days	Increase $2,000 for the 3 days	Low
Break Activity W into 2 equal activities and hire another resource at the current rate	Reduce 3 days	Increase $600 for the 3 days	High
Reduce Activity T 2 days by working over the weekend	Reduce 2 days	Increase $400 for the 3 days	Medium

Figure 7-4
Schedule
Compression
with Cost
Component

Earned Value Terms and Formulas

Some of these are the same terms and formulas used in time management, but in cost management, there are additional terms that facilitate cost management and forecasting.

Independent Variables are planned value, actual cost and earned value.
- **Planned Value (PV)** is the sum of the approved cost estimates for activities scheduled to be performed during a given period.
- **Actual Cost (AC)** is the amount of money actually spent in completing work in a given period.
- **Earned Value (EV)** is the sum of the approved cost estimates for activities completed during a given period.

Dependent Variables are cost and schedule variances, the cost and schedule performance indices and budget and estimate at completion.

- **Cost Variance (CV)** is earned value (EV) minus actual cost (AC). It is the difference between the budgeted cost of the work completed and the actual cost of completing the work. A negative number means the project is over budget.
  - CV = EV - AC

- **Schedule Variance (SV)** is earned value (EV) minus planned value (PV). It represents the difference between what was accomplished and what was scheduled. A negative number means the project is behind schedule.
  - SV = EV - PV

- **Cost Performance Index (CPI)** is earned value (EV) divided by actual cost (AC). It is the ratio of what was completed to what it cost to complete it. Values less than 1.0 indicate we are getting less than a dollar's worth of value for each dollar we have actually spent. CPI measures cost efficiency.
  - CPI = EV/AC

- **Cumulative CPI (CPI^C)** is the sum of the periodic earned value (EV^C) divided by the sum of the individual actual costs (AC^C). It is used to forecast project costs at the completion of the project.
  - CPI^C = EV^C/AC^C

- **Schedule Performance Index (SPI)** is earned value (EV) divided by planned value (PV). It is the ratio of what was actually completed to what was scheduled to be completed in a given period. Values less than 1.0 mean the project is receiving less than a dollar's worth of work for each dollar we were scheduled to spend. SPI measures schedule efficiency.
  - SPI = EV/PV

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EXAM TIP

According to Fleming and Koppelman (pages 23 to 24), CPI and SPI may be used to determine the efficiency of the project when the project is at least 20% complete. That is, a project that is 10% over budget after 20% of the work is complete will probably overrun the entire project budget by at least 10%.

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7

- **Budget At Completion (BAC)** is the estimated total cost of the project when completed.

- **Estimate At Completion (EAC)** is the amount we expect the total project to cost on completion and as of the "data date" (time now). There are 3 formulas listed in the PMBOK Guide for computing EAC. Each of these starts with AC^C or actual costs to date and adds a slightly different formula for the work remaining to be completed. The question of which to use depends on the individual situation and the credibility of the actual work performed compared to the budget up to that point.

  This formula is most applicable when future variances are projected to approximate the same level as current variances:
  - $EAC = AC^C + (BAC - EV^C)/CPI^C$

  This is most applicable when the actual performance to date shows that the original estimates were fundamentally flawed or when they are no longer accurate because of changes in conditions relating to the project:
  - $EAC = AC^C + $ New Estimate for Remaining Work

  This formula is most applicable when actual variances to date are seen as being the exception and the expectations for the future are that the original estimates are more reliable than the actual work effort to date:
  - $EAC = AC^C + (BAC - EV^C)$

  This is another formula that might appear on the exam. It is similar to the first EAC formula above but is not included in the PMBOK Guide. This is applicable when the project manager desires to make an adjustment to the budget based on the level of work variance to date:
  - $EAC = BAC/CPI^C$

- **Estimate to Complete (ETC)** is the expected additional costs to complete an activity(-ies) or the project. Like the EAC, there are 3 ways to compute ETC, depending on an assessment of variances to date.
  - ETC = BAC - EC^C for atypical variances
  - ETC = (BAC - EV^C)/CPI^C for typical variances
  - ETC = revised estimate for each remaining work package when prior estimates are flawed

- **Variance at Completion (VAC)** is the difference between the total amount the project was supposed to cost (BAC) and the amount the project is now expected to cost (EAC).
  - VAC = BAC - EAC

Additional Earned Value Formulas are for percent complete and percent spent:
- **Percent Complete** = EV/BAC
- **Percent Spent** = AC/BAC

Case Study Exercise

Exercise 7-2: After the garage is framed, the roof installed and the plumbing, electrical and HVAC are in, the owner asks for a formal project review. You are tasked with creating the earned value reports for the Lawrence RV Garage Project based on the following actuals-to-date data.

Phase	Actual Start Variance	Actual End Variance	Actual Duration Variance	Actual Resources Variance	Actual Materials Costs Variance	Notes
Site Prep	+4	+4	Per plan	Per plan	Per plan	Permit delay
Foundation	+6	+7	+1	Per plan	Per plan	Rain delay
Framing	+8	+9	+1	Per plan	Per plan	Materials delay
Utilities	+12	+12	Per plan	Per plan	+8%	Materials delay
Roof	+13	+12	-1	Per plan	Per plan	Materials delay
Interior						
Exterior						
Grounds						
Acceptance						

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Depreciation

Depreciation is a write-off of capital assets over a recovery period mandated by tax regulations. There are 2 methods of depreciation. These methods are compared in Figure 7-5.

- **Straight Line Method**: an equal credit is taken during each year of the useful life of an asset. For example, a $5,000 computer depreciated over 3 years with a $200 salvage value, using the straight line method, gives $1,600 each year: $5,000 - $200 = $4,800 and $4,800/3 = $1,600.
- **Accelerated Method**: more credit is taken during certain years, so the asset depreciates faster than the straight line method. There are 2 types of accelerated depreciation that may show up on the exam:
  - **Sum of the Years**: this method uses the sum of the digits of the years of useful life to get the denominator and uses the number of years remaining as the numerator to calculate a percentage to be depreciated. Our computer with 3 years of useful life would give 6 (3 + 2 + 1) as the denominator and therefore 3/6 (50%) depreciation the first year, 2/6 (33.3%) of the original depreciable value the second year and 1/6 (16.67%) the third year.
  - **Double Declining Balance**: in this method, the percentage of depreciation that would be taken the first year using the straight line method is doubled. This percent is then used to calculate the accelerated depreciation. Each succeeding year, the same percentage is used but it is taken against the remaining asset value.

Figure 7-5
Comparing
Depreciation
Methods

Comparing Depreciation Methods			
A $5,000 computer system with 3 years useful life and a salvage value of $200.			
Method	Year 1	Year 2	Year 3
Straight Line	$1,600	$1,600	$1,600
Sum of the Years	$2,400	$1,600	$800
Double Declining Balance	$3,200	$1,067	$533

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Profitability Measures

Many projects require an evaluation of the projected profits or returns for the dollars expended. There are a variety of ways to measure profit:

- **Return on Sales (ROS)** measures the ratio of profit to total sales.
  - ROS = Gross Profit/Total Sales or
  - ROS = Net Profit/Total Sales
- **Return on Investment (ROI)** measures the ratio of profit to total investment or to total assets, in which case it is called **Return on Assets (ROA)**.
  - ROI = Net Profit/Total Investment
  - ROA = Net Profit/Total Assets
- **Present Value (PV)** (not to be confused with planned value) is the value today of future cash flows, based on the concept that payment today is worth more than payment in the future because we can invest the money today and earn interest on it.
  - $PV = M/(1+r)^t$ where M = amount of payment t years from now, and r is the interest rate (also known as the discount rate)
  - For example: if we think we can get 2% interest for the next 2 years, how much must we invest now in order to have $1,000 2 years from now?
    $PV = 1,000/(1 + 0.02)^2$
        = 1,000/1.0404
        = 961.17
  - For **Net Present Value (NPV)** (as of a cash flow), add up the PVs over the number of years
- **Internal Rate of Return (IRR)** is the percentage rate that makes the present value of costs equal to the present value of benefits.
- **Benefit Cost Ratio (BCR)** is just that, a ratio of benefits to costs. The BCR should be >1.3 before considering the project.
  - BCR = PV(revenue)/PV(cost)

SAMPLE PMP EXAM QUESTIONS ON COST MANAGEMENT

Cost — Planning Questions

1. All of the following types of cost are relevant to making a financial decision except:

   a) Opportunity costs
   b) Direct costs
   c) Sunk costs
   d) Unavoidable costs

2. An order of magnitude estimate should give the manager cost data accurate to within:

   a) -25 to +25 percent of actual costs
   b) -30 to +85 percent of actual costs
   c) -10 to +25 percent of actual costs
   d) None of the above

3. Your boss has asked you for a preliminary (analogous) cost estimate for a project. Your estimate is $200,000. Which estimate are you likely to give him?

   a) $150,000 to $350,000
   b) $180,000 to $250,000
   c) $190,000 to $220,000
   d) $170,000 to $300,000

Notes:

Periods	r = 10%	r = 12%	r = 14%
t = 1	0.909	0.893	0.877
t = 2	0.826	0.797	0.769
t = 3	0.751	0.712	0.675
t = 4	0.683	0.636	0.592
t = 5	0.621	0.567	0.519

4. Keeping in mind that present value $= M/(1+r)^t$, and using the above table, what is the net present value of an annual income flow of $1,600 at 14% over the next 3 years?

   a) $3,713.60
   b) $ 0.68
   c) $1,080.00
   d) $ 476.19

5. Based on the above table, what is the present value of $1,000 at 12% at the end of 5 years?

   a) $3,605.00
   b) $ 0.57
   c) $ 567.00
   d) $ 892.86

6. Life cycle costing:

   a) Is the concept of including all costs over the life of the product of the project
   b) Is an activity devoted to optimizing cost or performance
   c) Is an activity of appraising the cost and technical performance of a completed project
   d) Is a process of predicting the life of a project

Notes:

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7. Sunk costs are:

    a) Future costs held in reserve
    b) Costs invested in commodities
    c) Overhead costs
    d) Expended costs over which we have no control

8. Parametric cost estimating involves:

    a) Using the WBS to do bottom-up estimates
    b) Defining the parameters of the life cycle
    c) Calculating individual estimates of work packages
    d) Using a statistical model to estimate costs

Task	Duration	Predecessor	Cost	Crash Cost	Max Crash Days
A	3	-	$1,500	$300/day	1
B	5	A	$1,000	$200/day	2
C	4	A	$2,400	$300/day	2
D	3	B	$1,100	$100/day	1
E	2	C	$500	$100/day	1

9. Given the above table, what is the cost of completing this project in 11 days?

    a) $6,500
    b) $7,400
    c) $8,000
    d) $7,300

10. Given the above table, what is the cost of completing this project in 7 days?

    a) $6,500
    b) $7,400
    c) $8,000
    d) $7,300

Notes:

Notes:

11. In the cumulative cost curve above, height B represents:

    a) Actual costs to date
    b) Total budgeted costs for the project
    c) Planned costs for month 6
    d) Cost variance

Cost — Monitoring and Controlling Questions

Planned and Actual Costs	Direct Material	Direct Labor
Planned price/unit	$0.60	$4.00
Actual units	36,810	15,000
Actual price/unit	$0.58	$4.10
Actual cost	$21,350	$61,500

12. Based on the above table, what is the labor rate cost variance?

    a) $5,500.00
    b) $1,500.00
    c) $ -100.00
    d) $ -0.10

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Case	PV	AC	EV
1	10,000	8,000	9,000
2	12,000	10,000	11,000

13. Based on the schedule and cost variance table above, what is the cost variance for Case 2?

   a) -1,000
   b) 1,000
   c) -2,000
   d) 2,000

14. The cost performance index is computed as:

   a) Earned value divided by actual cost
   b) Earned value minus actual cost
   c) Earned value minus planned value
   d) Planned value divided by earned value

Task	PV	AC	EV
1	95	100	95
2	150	130	110
3	130	130	130
4	80	60	70

15. Based on the above table, which task is on schedule and within budget?

   a) Task 1
   b) Task 2
   c) Task 3
   d) Task 4

16. Based on the above table, which task is late but under budget?

   a) Task 1
   b) Task 2
   c) Task 3
   d) Task 4

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17. Percent complete is calculated by:

    a) AC/BAC
    b) EV/BAC
    c) EAC/BAC
    d) EV - AC

Notes:

ANSWERS AND REFERENCES FOR SAMPLE PMP EXAM QUESTIONS ON COST MANAGEMENT
Section numbers refer to the PMBOK Guide.

1. **C** **Planning, see Key Definitions in this chapter**
   Since sunk costs have been expended, we no longer have control over them and they are irrelevant to choosing among alternatives.

2. **D** **Planning, see Types and Ranges of Estimates in this chapter**
   Order of magnitude estimates are at a high level (-25 to +75%), preliminary estimates are narrower (-15 to +50%), budget estimates are even narrower (-10 to +25%) and definitive estimates are narrowest (-5 to +10%).

3. **D** **Planning, see Types and Ranges of Estimates in this chapter**
   Preliminary estimates have a range of -15% to +50%; choice A is an order of magnitude estimate (-25% to +75%), choice B is a budget estimate (-10% to +25%) and choice C is a definitive estimate (-5% to +10%).

4. **A** **Planning, see Profitability Measures in this chapter**
   Net present value of an income flow of $1,600 over 3 years at 14%:
   PV 1   =   0.877X$1,600 = $1,403.20
   PV 2   =   0.769X$1,600 = $1,230.40
   PV 3   =   0.675X$1,600 = $1,080.00
   NPV   = $3,713.60

5. **C** **Planning, see Profitability Measures in this chapter**
   Present value of $1,000 at 12% at the end of 5 years: PV 5 = 0.567X$1,000 = $567.00.

6. A   **Planning Section 7.0**
Life cycle costing includes all costs within the total life of a project. Value analysis is devoted to optimizing cost/performance. Post-project evaluation appraises the cost and technical performance of a completed project. Cost estimating and forecasting predicts the costs of a project.
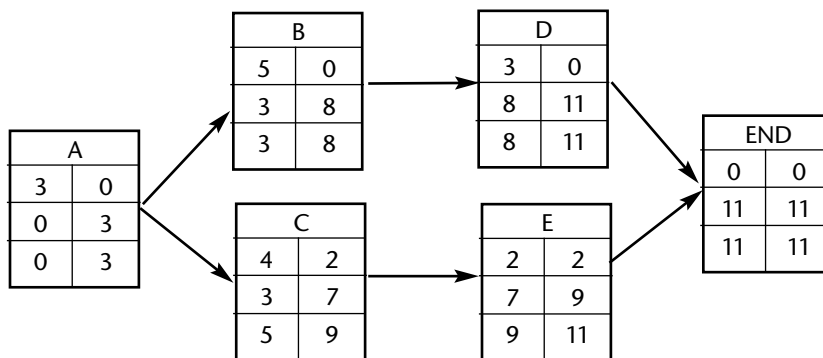
7. D   **Planning Section 7.0**

8. D   **Planning Section 7.1.2.4 Cost Estimating**
Parametric cost estimating is a statistical approach to estimating project costs based on historical statistical patterns. It is a top-down estimating technique.

9. A   **Planning Section 7.2.2.1 Cost Estimating**
First the critical path and project duration must be calculated:

B	
5	0
3	8
3	8

D	
3	0
8	11
8	11

A	
3	0
0	3
0	3

END	
0	0
11	11
11	11

C	
4	2
3	7
5	9

E	
2	2
7	9
9	11

The diagram shows the project duration to be 11 days, and the critical path to be ABD. Since the question asks the cost to complete in 11 days, we can just add up the cost of each task; no crashing needed.

10. B   Planning Section 7.2.2.1 Cost Estimating
Now we need to complete in 7 days. Can we do it? The table shows us the maximum number of days SAVED through crashing. Starting with the critical path tasks, when we crash A we will save 1 day at a cost of $300, crash B and save 2 days at $200/day and D will save us 1 day at a cost of $100. Total days saved = 4, so the new length of path ABD is 7 (hooray!) and it has cost an ADDITIONAL $800. But look at path ACE. We crashed A already so it is down to 2 days, but C and E are still at their original durations of 4 and 2 days respectively, for a total path length of 8 days! Oops, we need to shave an additional day here to get down to 7 to meet the requirement. Which task (C or E) is cheaper to crash? C is $300/day, but E is $100/day. Crashing E gives us the day we need for $100. So our total crashed cost is the original cost of $6,500, plus the crashing cost of ABD of $800, plus the crashing cost of E of $100 for a total cost of $7,400.

11. B   Planning Section 7.2.3.1 Cost Budgeting
The cumulative cost curve, also called the S-curve, shows how much has actually been spent, or was planned to have been spent, on a given date in total. The height of the planned curve at the end of the project thus shows total anticipated costs (budget).

12. D   Monitoring and Controlling Section 7.3.2.2 Cost Control
Labor Rate Cost Variance =
Planned Price per Unit - Actual Price per Unit
CV = $4.00 - $4.10 = $-0.10

13. B   Monitoring and Controlling Section 7.3.2.2 Cost Control
Cost Variance (CV) = EV - AC
CV = $11,000 - $10,000 = $1,000

14. A   Monitoring and Controlling Section 7.3.2.2
Cost Control
CPI = Earned Value/Actual Cost or EV/AC

15. C   Monitoring and Controlling Section 7.3.2.2
Cost Control
SPI = 1, CPI = 1

16. D   Monitoring and Controlling Section 7.3.2.2
Cost Control
SPI = 0.875, CPI = 1.16

Calculations for questions 15 and 16:

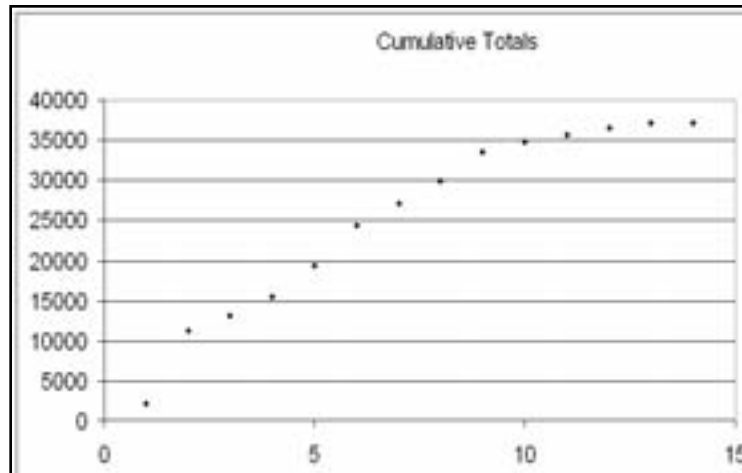| Task	PV	AC	EV	SPI = EV/PV	CPI = EV/AC
1	95	100	95	1 = 95/95	0.95 = 95/100
2	150	130	110	0.73 = 110/150	0.84 = 110/150
3	130	130	130	1 = 130/130	1 = 130/130
4	80	60	70	0.875 = 70/80	1.16 = 70/60

17. B   Monitoring and Controlling Section 7.3.2.2
Cost Control
Percent Complete = Earned Value/Budget At
Completion, or EV/BAC.

CASE STUDY SUGGESTED SOLUTIONS

Exercise 7-1
S-Curve for the Lawrence RV Garage Project

This diagram was generated in Excel using the following data:

Cumulative Totals

Week	1	2	3	4	5	6	7	8	9	10	11	12	13
Phase													
PM	384	384	384	384	384	384	384	384	384	384	384	384	384
Site	1,000												
Foundation	800	1,700											
Framing		7,000	1,000	1,000	1,000								
Utilities			500	1,000	2,500								
Roof						4,500							
Stucco							2,300	2,200					
Insulation									550				
Drywall									1,500	800			
Paint											500		
Interior												600	
Grounds									300	1,200			
Acceptance													225
Weekly Totals	2,184	9,084	1,884	2,384	3,884	4,884	2,684	2,884	3,634	1,184	884	984	609
Cumulative Totals	2,184	11,268	13,152	15,536	19,420	24,304	26,988	29,872	33,506	34,690	35,574	36,558	37,167

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Exercise 7-2
Earned Value Reports for the Lawrence RV Garage Project

Using the information in this exercise, we extrapolated the following data:

Week	1	2	3	4	5	6	7	8	9	10	11	12	13
Phase													
PM	384	384	384	384	384	384	384	384	384	384	384	384	384
Site		1,000											
Found		800	1,500	200									
Framing				7,000	1,000	1,000							
Utilities					500	1,150	2,500						
Roof								4,500					
Stucco							2,300	2,200					
Insulation									550				
Drywall									1,500	800			
Paint											500		
Interior												600	
Grounds								300	1,200				
Accept													225
Weekly Totals	384	2,184	1,884	7,584	1,884	2,534	5,184	7,384	3,634	1184	884	984	609
Actuals	*384*	*2,184*	*1,884*	*7,584*	*1,884*	*2,534*	*2,884*	*4,884*					
Cumulative Actuals	384	2,568	4,452	12,036	13,920	16,454	19,338	24,222	24,222	24,222	24,222	24,222	24,222

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These data yielded the EVT results below, based on the cumulative numbers and the planned numbers from Exercise 7-1.

Week	1	2	3	4	5	6	7	8	9	10	11	12	13
Cum EVT													
PV	2,184	11,268	13,152	15,536	19,420	24,304	26,988	29,872	33,506	34,690	35,574	36,558	37,167
EV	384	2,568	4,452	12,036	13,920	16,304	19,188	24,072					
AC	384	2,568	4,452	12,036	13,920	16,454	19,338	24,222					
SV	-1,800	-8,700	-8,700	-3,500	-5,500	-8,000	-7,800	-5,800					
SVI	0.176	0.228	0.339	0.775	0.717	0.671	0.711	0.806					
CV	0	0	0	0	0	-150	-150	-150					
CVI	1.000	1.000	1.000	1.000	1.000	0.991	0.992	0.994					

Looking at the schedule variance (SV), we can see that we fell behind right away in the first week. We picked up over the next 3 weeks, then slipped even more for 2 weeks and have regained some in the last 2 weeks. We are currently at about 80% of where we had planned to be at this time.

Cost variance (CV) is better. In fact, for the tasks we completed, we were right on target for the first 5 weeks. In week 6 we went over budget, but have not yet had any additional budget slippage. We are getting about 99 cents worth of value for every dollar spent.

QUALITY

CHAPTER 8 | QUALITY

8

QUALITY MANAGEMENT

The quality management questions on the PMP certification exam are straightforward — especially if you know definitions of terms and understand statistical process control. You are not required to solve quantitative problems but there are questions on statistical methods of measuring and controlling quality.

An emphasis on customer satisfaction and continuous improvement is likely to be on the exam; how tools such as Pareto analysis and cause-and-effect diagrams are used may also be on the exam.

To pass, you must know the differences among the 3 quality processes: quality planning, perform quality assurance and perform quality control.

Many organizations use these terms interchangeably; however PMI specifically defines each in terms of the process group in which it is performed. The following chart summarizes the 3 processes as defined by PMI and within the PMP exam.

Process	Quality Planning	Perform Quality Assurance	Perform Quality Control
Primary Activity	Plan	Implement/Manage	Measure/Monitor
Explanation	Determine what the quality standards on the project will be and how quality will be measured.	Use the measurements to see if the quality standards will be met; validate the standards.	Perform the measurements and compare to specific quality standards; identify ways of eliminating the problem in the future.
Process Group	Planning	Executing	Monitoring and Controlling

Things to Know

1. The 3 processes of quality management:
   - **Quality Planning**
   - **Perform Quality Assurance**
   - **Perform Quality Control**
2. The contents of a good **Quality Management Plan**
3. The **Legal Implications of Quality**
4. **Market Expectations** regarding quality
5. Where **Responsibility for Quality** lies
6. The **Impact of Poor Quality**
7. **Prevention Over Inspection**
8. **Quality** vs. **Grade**
9. The concept of **Cost of Quality**
10. The components of a **Quality Training** program
11. The importance of **Process Improvement**
12. What a **Quality Audit** is and the differences among **Deming, Crosby, Juran, TQM, CIP** and **Taguchi** theories of quality
13. The use of **Quality Control Tools**

Key Definitions

Quality: the degree to which a set of inherent characteristics satisfies the stated or implied needs of the customer. To measure quality successfully, it is necessary to turn implied needs into stated needs via project scope management.

Quality Objective: a statement of desired results to be achieved within a specified time frame. In writing objectives, it is important to realize the perspective from which they are being written. For customers, quality is typically defined by the ability of the project's product to be fit for use. From a project perspective, adherence to specifications will define quality. Whether defining objectives from the customer's or the project's perspective, it is important to define goals specifically through stated quality objectives and ensure that they are communicated well and understood by all stakeholders.

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Quality Policy: a statement of principles for what the organization defines as quality. It does NOT define how quality will be achieved. When organizations create quality policies, they do so to promote consistency, to provide specific guidelines for important matters and to help outsiders better understand the organization. For example, some companies consider quality as the ability to produce products very inexpensively and want to be considered the low-cost leader, while others prefer to offer the most options or features for a higher price. Successful quality policies are drafted by specialists, approved by top management and understood by and adhered to by the entire organization.

Warranties: assurance that the products are fit for use or the customer receives compensation. It could cover downtime and maintenance costs.

QUALITY PLANNING PROCESS

Quality planning is included along with all other project planning. Quality planning includes:

- Identifying which **Quality Standards** are relevant to the project and determining how to satisfy them
- **Benchmarking** past projects to find ideas for improvements and to establish quality performance measures
- Using **Cost Benefit Analysis** to compare the benefits and the costs of quality
- **Flowcharting** a process or system to show how various components interrelate (used to help determine potential future quality problems and establish quality standards)
- Having a **Design of Experiments** with "what if" scenarios to determine which variables will have the most influence on project outcomes, thereby improving quality

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Quality Management Plan

A quality management plan is the output of the quality planning process. It should describe how the project management team will implement its quality policy and will provide input to the overall project plan. A good quality management plan will specifically address each of the following:
- Design control
- Document control
- Purchased material control
- Material identification and control
- Inspections
- Test control
- Measuring and testing equipment control
- Corrective actions
- Quality assurance records
- Audits
- Process improvements

PMI does not advocate developing quality policies from scratch. Most organizations have some level of quality policy which can be adjusted to fit the needs of the project.

Legal Implications of Quality

In addition to the benefits organizations gain from implementing quality programs, there are legal considerations that must be addressed when developing the quality management plan:
- Criminal liability
- Fraud or gross negligence
- Civil liability
- Criminal or civil liability, even if following orders
- Lawsuits against the company
- Appropriate corporate actions

Market Expectations

In determining what preventative measures to take to avoid nonconformance costs, the project manager must take into consideration the market's expectations of the project's product by reviewing the customer's product expectations on the following criteria:

- Salability: a balance of quality and cost
- Producibility or constructability: the ability of the product to be produced with available technology and workers at acceptable cost
- Social Acceptability: the degree of conflict between the product or its process and the values of society
- Operability: the degree to which a product can be safely operated
- Availability: the probability that the product, when used under given conditions, will perform satisfactorily. The 2 key parts of availability are:
  - Reliability: the probability that the product will perform, without failure, under given conditions for a set period of time
  - Maintainability: the ability of the product to be restored to its stated performance level within a specified period of time

Responsibility for Quality

The organization as a whole has responsibilities relating to quality, but PMI recommendations may not be what your organization practices. The PMI position is:

- The project manager has the ultimate responsibility for the quality of the product of the project. (In reality, the project manager may delegate work but must retain responsibility.)
- The team member has the primary responsibility for quality at the task or work package level.
- The primary responsibility for establishing design and test criteria resides with the quality engineer.

EXAM TIP

Be sure to read the PMP test questions on responsibility for quality carefully to determine to whom in the organization the question refers.

Whoever is responsible for quality within an area of expertise must identify quality problems, recommend solutions when problems occur, implement solutions and, if the process is nonconforming, limit further processing.

Impact of Poor Quality

Regardless of the organization, poor quality can result in higher costs to the entity or the customer, less customer satisfaction, lower team morale and greater risk of project failure.

Prevention Over Inspection

For many years, the determination of quality relied heavily on inspection methods. Over the years, it has been determined that the costs of inspection can become so high that it is better to spend money preventing problems from ever occurring. The current views of PMI subscribe to the notion that quality must be planned in and not inspected in. In reaching this conclusion, PMI researched many key quality experts from the past several decades. The exam could include questions on specific theories or experts' opinions.

Quality vs. Grade

Quality and grade are different. Grade is a way to distinguish between products with the same functional use but different technical attributes. For example, a Grade 1 bolt has a certain strength while a Grade 3 bolt of the same size is stronger and a Grade 5 bolt is stronger still. The Grade 1 bolt, though of low grade, can still be of high quality (no defects, of proper size, etc.)

Cost of Quality

Conformance is the ability for the product of the project to meet requirements. A project manager has options when planning a project. He or she can implement quality processes to increase the likelihood

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that the products will meet requirements, or the project manager can inspect the product, determine if it meets requirements and take corrective action if it does not.

PMI advocates the Deming approach, described further below, that says approximately 85% of the costs of quality are the direct responsibility of management. These costs can be broken up into 2 categories: the costs of conformance and the costs of nonconformance.

Costs of Conformance	Costs of Nonconformance
Quality training	Rework
Studies	Scrap
Surveys	Inventory costs
Validation and audits	Warranty costs

Costs of conformance can be categorized as preventative, such as the use of high-quality parts or appraisals, which assess quality at various stages of the project to increase the likelihood of conformance.

Costs of nonconformance can be categorized as internal or external failures.
- Internal failures are the costs associated with scrapping or reworking the product before it reaches the end customer.
- External failures are those that have reached the customer. External failures include costs associated with handling and resolving customer concerns.

Quality Training

Quality does not happen because a plan is created. In order to implement a quality plan successfully, training the organization should be at the top of the priority list.

Process Improvement

PMI emphasizes the importance of continually assessing the gap between the current position of the organization and the desired goals or capabilities to be achieved. This

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continual activity of planning and implementing processes within the organization to improve is known as process improvement. Therefore, process improvement is an analytical approach that focuses on activities that provide value to the organization. Continuous process improvement provides an iterative means for ongoing incremental improvement of all processes, including project management processes.

PERFORM QUALITY ASSURANCE PROCESS

Quality assurance occurs during the execution phase of the project. It is the process of regular structured reviews to ensure the project will comply with the planned quality standards. This is usually done by means of a **Quality Audit.**

Quality audits are independent evaluations of quality performance to ensure that:
- Intended quality will be met
- Products are safe and fit for use
- Laws and regulations are followed
- Data systems are adequate
- Corrective action is taken, if needed
- Improvement opportunities are identified
- Quality standards, procedures and methods established during quality planning are reevaluated and are still relevant

A good quality assurance system will:
- Identify objectives and standards
- Be multifunctional and prevention oriented
- Collect and use data
- Establish performance measures
- Include a quality audit

Deming

W. Edwards Deming is well known for his 4-step cycle to improve quality: **Plan, Do, Check, Act (PDCA).** He also

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developed 14 activities for implementing quality. For the PMP exam, know some major points of his works:

- Use participative approach to quality
- Adopt new philosophy of quality throughout the organization
- Cease the use of mass inspections
- End awards based on price
- Improve production and service
- Institute leadership
- Eliminate numerical quotas
- Emphasize education and training
- Encourage craftsmanship

Crosby Absolutes of Quality

Philip Crosby is also well known for his books on quality. Similar to Deming, he too developed 14 steps to improving quality. These steps emphasize management commitment, measurement, zero defect planning, goal setting, quality awareness and quality councils.

In addition, Crosby stressed 4 absolutes of quality:

- Quality is conformance to requirements
- The system of quality is prevention
- The performance standard is zero defects
- The measure of quality is the price of nonconformance

Juran Trilogy

Joseph Juran developed the fitness-for-use concept of quality which emphasizes that the measure of high quality is achieved by ensuring that the product meets the expectations of the stakeholders and customers.

Juran's fitness-for-use concept looks at 3 components of quality. These components are known as the Juran trilogy:

- Quality of design: design may have many grades
- Quality of conformance: determined by choice of process, training, adherence to program and motivation

- Quality characteristics: determine the characteristics important to the customer
  - Structural (length and frequency)
  - Sensory (taste and beauty)
  - Time oriented (reliability and maintainability)
  - Ethical (courtesy and honesty)

Juran also established the following trilogy as an approach to improving quality:
- **Plan**: attitude breakthrough, identify vital few new projects
- **Improve**: knowledge breakthrough, conduct analysis, institute change
- **Control**: overcome resistance, institute controls

Total Quality Management (TQM)

Although there is no explicit definition of TQM, most definitions include providing quality products at the right time and at the right place, thereby meeting or exceeding customer requirements. Kerzner has defined 7 primary strategies for TQM (pages 806 to 809):
- Solicit improvement ideas from employees
- Encourage teams to identify and solve problems
- Encourage team development
- Benchmark every major activity in the organization
- Utilize process management techniques
- Develop staff to be entrepreneurial and innovative in dealing with customers and suppliers
- Implement improvements in order to qualify for ISO 9000

Continuous Improvement Process (CIP) or Kaizan

Kaizan is the Japanese word for a sustained gradual change for improvement. It differs from innovation, which consists of sudden jumps that plateau and mature over time before the next jump. The PDCA cycle developed by Deming and described above is the basis for CIP. The Japanese also came up with the concept of providing materials only when they are needed in manufacturing environments.

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This concept is known as **Just In Time (JIT).** TQM (also described above) and **Six Sigma Initiatives** help to improve project management processes as well as project management products.

Taguchi

Dr. Genichi Taguchi developed the concept of loss functions according to which, as variation for the target increases, losses will also increase.

PERFORM QUALITY CONTROL PROCESS

Quality control is performed as part of the monitoring and controlling process group. Quality control involves measurement of the process or performance using quality control tools. It also includes the technical processes that compare and report a project's actual progress with its standard. A good quality control system will:
- Select what to control
- Set standards
- Establish measurement methods
- Compare actuals to standards
- Act when standards are not met

Key outputs of the perform quality control process are validated deliverables and defect repair recommendations. Based on these recommendations, corrective actions are performed as part of the direct and manage project execution process group. Corrections are validated again within the perform quality control process through defect repair reviews.

Plan for Improvements

There are many exam questions on **Quality Control Tools**. You will need to know the uses and differences in the following tools and techniques. In general, to use these control tools effectively, an agreement must be made on what will be observed, the time frame for observation, the form of the presentation and how the data will be collected. These quality control tools are:

- **Inspections**: used after the work is completed; may use **Checklists** or **Data Tables** to assist in the measuring, examining and testing activities. Figure 8-1 shows a sample inspections checklist.

Problem	Month			
	1	2	3	Total
A	II	II	I	5
B	I	I	I	3
C	THL	II	THL	12
Total	8	5	7	20

Figure 8-1
Sample Inspections
Checklist

- **Control Charts**: a graphical display of results of a process over time. Figure 8-2 shows a sample control chart. Control charts include a defined upper and lower control limit, a mean and a visual pattern indicating out-of-control conditions, such as **Outliers** (points outside upper [UCL] or lower [LCL] control limits). Control charts that produce particular patterns can provide visual information to the project manager. Some such patterns are:
  - **Limit Huggers**: a run of points close to control limits
  - **Run**: a series of consecutive points on the same side of the mean
  - **Trend**: a series of consecutive points with an increasing or decreasing pattern
  - **Cycle**: a repeating pattern of points
  - **Rule of Seven**: a run of 7 or more points above or below the mean indicating adjustment is needed
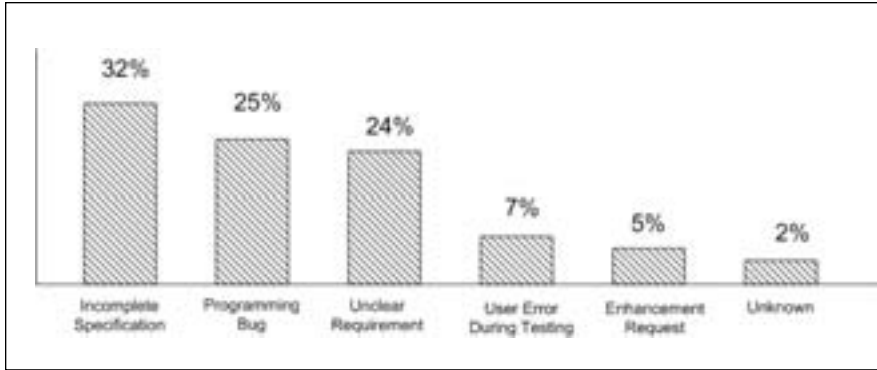
Figure 8-2
Sample Control
Chart

8 - 12
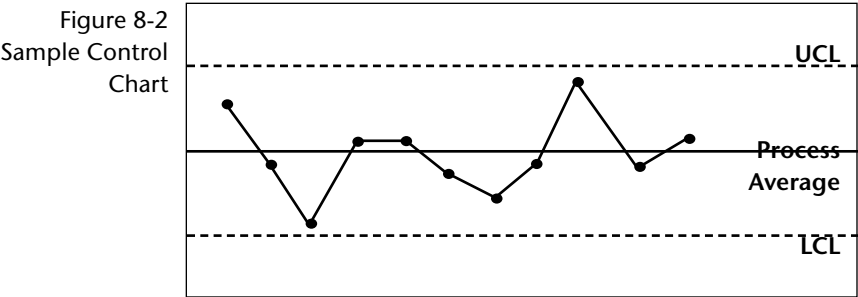
Figure 8-3
Sample Pareto Diagram

- **Pareto Diagrams**: a histogram ordered by frequency of occurrence. Pareto diagrams are conceptually related to Pareto's law, which visually shows that 20% of causes produce 80% of defects. Figure 8-3 shows a sample Pareto diagram.

- **Statistical Sampling**: choosing part of a population for inspection for the purpose of accepting or rejecting the entire lot. The results of statistical sampling can be depicted through the use of a variety of charting methods such as histograms, scatter diagrams or Pareto diagrams. Figure 8-4 on the next page shows a sample histogram created through statistical sampling.

  The advantages of using sampling techniques include less product damage, the ability to make decisions more quickly, fewer expenses and fewer sources. The disadvantage is the possibility of bad decisions due to incomplete information. Here are some sampling definitions:
  - **Attribute**: characteristic of the product that is appraised in terms of whether or not it exists
  - **Variable**: anything measured
  - **Sampling Plan**: must include the sample size and the acceptance criteria
  - **Producer's Risk**: the chance of rejecting a good lot prior to selling to the customer
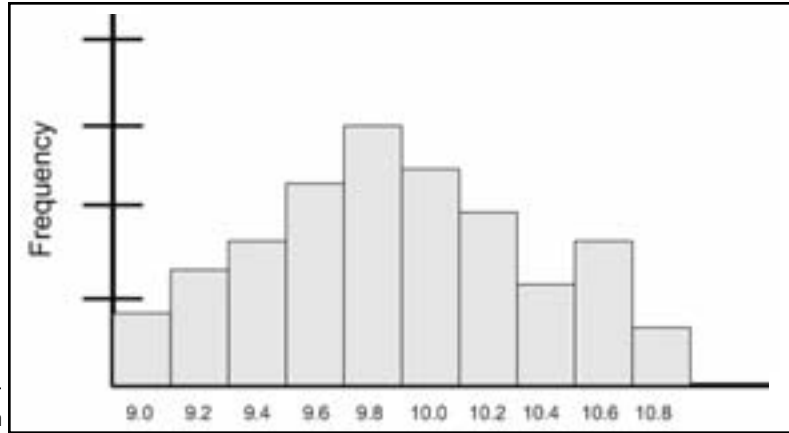 - **Consumer's Risk**: the chance of accepting a bad lot after purchase

8

Figure 8-4
Sample Histogram

- **Flowcharting**: diagrams that show how various elements of a system relate. System or process flow-charts are the most common types of flowcharts.

- **Fishbone Diagrams** (also called cause-and-effect or Ishikawa diagrams): show how various causes and subcauses relate to create problems or effects.

- **Run Charts**: line graphs showing data points plotted in the sequence of occurrence. Used for analysis of trends. Run charts can be used for technical performance such as measuring errors or defects, or cost and schedule performance through the use of earned value techniques. A sample run chart showing trend analysis is shown in Figure 8-5.
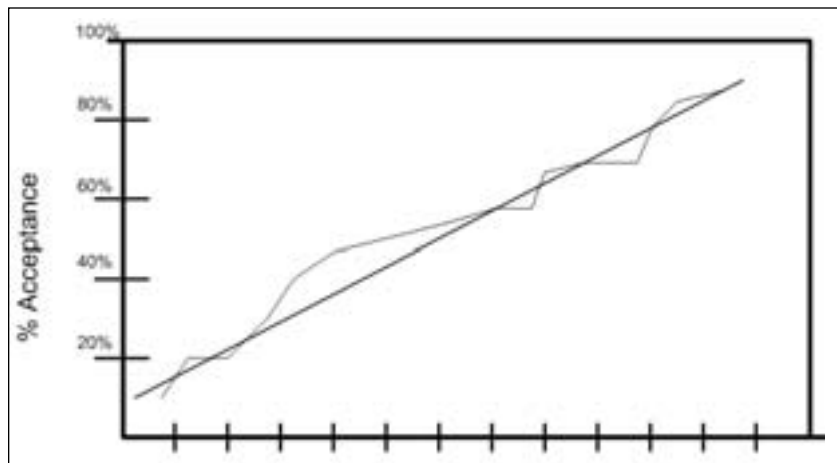
Figure 8-5
Sample Run Chart
Showing Trend Analysis

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Case Study Exercise

Exercise 8-1: Using the data in the table below for the Lawrence RV Garage Project, create a Pareto diagram for the reasons each phase was completed later than planned. What do you think your results indicate?

Phase	Actual Start Variance	Actual End Variance	Actual Duration Variance	Actual Resources Variance	Actual Materials Costs Var	Notes
Site Prep	+4	+4	Per plan	Per plan	Per plan	Permit delay
Foundation	+6	+6	+1	Per plan	Per plan	Rain delay
Framing	+8	+9	+1	Per plan	Per plan	Materials delay
Rough-ins	+12	+12	Per plan	Per plan	Per plan	Materials delay
Roof	+13	+12	-1	Per plan	Per plan	Materials delay
Exterior						
Interior						
Grounds						
Completion						

SAMPLE PMP EXAM QUESTIONS ON QUALITY MANAGEMENT

Quality — Planning Questions

1. The importance of quality compared to cost and schedule in project management can be characterized as which of the following:

    a) Schedule is most important, quality next and then cost
    b) Quality is more important than either
    c) Cost is most important, quality next and then schedule
    d) All three are equal

2. Where does the primary responsibility for quality management in the project rest?

    a) Project manager
    b) Purchasing agent
    c) Quality manager
    d) Project engineer

3. The absolutes of quality by Phillip Crosby include all of the following except:

    a) Award is based on price
    b) Quality is conformance to requirements
    c) Performance standard is zero defects
    d) System of quality is prevention

Notes:

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4. According to the PMBOK Guide, quality is:

    a) Conformance to management's requirements
    b) Conformance to requirements, specifications and fitness-for-use
    c) Adding extra to make the customer happy
    d) Conformance to the customer's needs

Quality — Executing Questions

5. The concept of making a giant leap forward followed by a period of maturity is called:

    a) Continuous Improvement Process (CIP)
    b) Kaizan
    c) Innovation
    d) Just In Time (JIT)

6. A project sponsor is not comfortable with the quality level of the project. He instructs the project manager to come up with quality standards and to improve quality. The project manager, however, is concerned about the effect of quality improvements on the project. Which best describes the results of an increase in quality in the long run?

    a) Reduced productivity and an increase in overall product or service cost
    b) Reduced productivity and no change to cost effectiveness or cost risk
    c) Increased productivity, decreased cost effectiveness and increased cost risk
    d) Increased productivity, increased cost effectiveness and decreased cost risk

Notes:

Quality — Monitoring and Controlling Questions

7. A histogram ordered by frequency of occurrence that shows how many results were identified by each identified cause is a:

   a) Pareto diagram
   b) Cause-and-effect diagram
   c) Fishbone diagram
   d) Ishikawa diagram

8. _____ is credited with the practice of ceasing mass inspections and ending awards based on price.

   a) Pareto
   b) Ishikawa
   c) Crosby
   d) Deming

9. During the execution phase of the project, the project manager's company begins to make use of control charts on all its projects. What does a control chart help with?

   a) Exploring a desired future outcome
   b) Determining if a process is out of control
   c) Focusing on stimulating thinking
   d) Focusing on the most critical issues to improve quality

Notes:

10. Sample testing of a population should be used when testing the entire population would _____.

    a) Be too inexpensive
    b) Take too long
    c) Show too many defects
    d) Be mutually exclusive

11. Standard deviation is:

    a) A measure of how much time remains in the project
    b) A measure of how far you are from the mean
    c) A measure of how correct the sample is
    d) A measure of how far you are from the average estimate

12. What is the percentage of 3 standard deviations from the mean?

    a) 68.26%
    b) 98.6%
    c) 95.4%
    d) 99.7%

Notes:

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ANSWERS AND REFERENCES FOR SAMPLE PMP EXAM QUESTIONS ON QUALITY MANAGEMENT
Section numbers refer to the PMBOK Guide.

1. D **Planning, see The Triple Constraint in Chapter 2 of this study guide**
See the triple constraint.

2. A **Planning Section 8.0 Quality Management**

3. A **Planning, see Deming in this chapter**
Ending awards based on price is part of the theory by Deming.

4. B **Planning Section 8.0 Quality Management**
Quality is the degree to which a set of inherent characteristics fulfill requirements.

5. C **Executing, Ireland and see Continuous Improvement Process (CIP) or Kaizan in this chapter**
Know the meaning of choices A through D.

6. D **Executing, see Cost of Quality in this chapter**

7. A **Monitoring and Controlling Section 8.3.2.5 Perform Quality Control**
Choices B, C and D are the same and are examples of flowcharting (a method of quality planning).

8. D **Monitoring and Controlling, see Deming in this chapter**
Deming is also mentioned with the PDCA cycle and CIP.

9. B **Monitoring and Controlling Section 8.3.2 Perform Quality Control**

10. B **Monitoring and Controlling Section 8.3.2.8 Perform Quality Control**

11. B   Monitoring and Controlling Section 8.3
        Perform Quality Control

12. D   Monitoring and Controlling Section 8.3
        Perform Quality Control

8

CASE STUDY SUGGESTION SOLUTION

Exercise 8-1
Pareto Diagrams for the Lawrence RV Garage Project

5					
4					
3	▓				
2	▓				
1	▓	▓	▓		
Occurrences	Materials delay	Rain delay	Permit delay		

5					
4	▓				
3	▓	▓			
2	▓	▓	▓	▓	
1	▓	▓	▓	▓	▓
Days delayed	Permit delay	Materials delay 2	Rain delay	Materials delay 1	Materials delay 3

Looking at the Pareto diagram for the reasons for delays, it appears that our materials suppliers cannot seem to get us what we need when we need it. We would need to investigate further to see if this is really a supplier problem or if our project manager is not giving our suppliers enough notice of when materials will be needed.

HUMAN RESOURCES

CHAPTER 9 | **HUMAN RESOURCES**

9

9

HUMAN RESOURCES MANAGEMENT

The human resources management section of the PMP exam focuses heavily on organizational structures, roles and responsibilities of the project manager, team building and conflict resolution. It has questions from the PMBOK Guide as well as several of the publications listed in the bibliography to this study guide (Chapter 15, Appendix D).

Many of the definitions used in this section, although not widely used in many organizations, have been seen in project management literature for many years. It is important to memorize the definitions from this chapter.

You must also understand the various organizational structures, the experience and educational requirements of the project manager, types of power exercised by the project manager and conflict management concepts.

There are 4 processes in human resource management: Human Resource Planning, Acquire Project Team, Develop Project Team and Manage Project Team. Although both the administrative and behavioral aspects of human resources management are covered in the PMBOK Guide, the exam seems to emphasize the behavioral aspect.

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Things to Know

1. The 4 processes of Human Resource Management:
   - **Human Resource Planning**
   - **Acquire Project Team**
   - **Develop Project Team**
   - **Manage Project Team**
2. What a **Staffing Management Plan** is
3. Purpose of the **Responsibility Assignment Matrix**
4. **Roles, Responsibilities and Work Environment**
5. **Leadership Styles**
6. The **Types of Power**
7. **Team-Building Methods**
8. **Sources of Conflict** and **Ways to Manage Conflict**
9. **Motivational Theories**
10. **Issues Facing the Project Manager Today**

Key Definitions

Authority: the right to make decisions necessary for the project or the right to expend resources.

Leadership: the ability to get an individual or group to work towards achieving an organization's objectives while accomplishing personal and group objectives at the same time.

Organizational Breakdown Structure (OBS): different from a responsibility assignment matrix (RAM). The OBS is a form of organizational chart in which work package responsibility is related to the organizational unit responsible for performing that work. It may be viewed as a very detailed use of the RAM with work packages of the work breakdown structure (WBS) and organizational units as the 2 dimensions.

Power: the ability to influence people in order to achieve needed results.

Responsibility Assignment Matrix (RAM): a structure that relates project roles and responsibilities to the project scope definition.

Team Building: the process of getting a diverse group of individuals to work together effectively. Its purpose is to keep team members focused on the project goals and objectives and to understand their roles in the big picture.

Tight Matrix: a project team that is colocated. This usually takes place in a strong matrix. Colocation usually characterizes projectized organizations without matrixed relationships.

HUMAN RESOURCE PLANNING PROCESS

This process involves the identification, assignment and documentation of roles, responsibilities and reporting relationships. Therefore, it is closely linked with the communications planning process since the

organizational structure influences communications requirements.

Although the various organizational structures are discussed in Chapter 2 on framework and in the equivalent chapter in the PMBOK Guide, organizational structure does influence organizational planning and communications planning. Additional exam questions on functional, matrix and projectized organizational structures show up within this process. The organizational structure of the performing organization could be a constraint to the project team's options.

Role and responsibility assignments (often in the form of a RAM), the staffing management plan (often in the form of a resource histogram) and the organizational chart (sometimes including an organizational breakdown structure [OBS]) are the major outputs of this process.

Enterprise environmental factors play a key role in the latitude a project manager has in acquiring and maintaining a competent project team.

One of the most important outputs of the organizational planning process should be the documentation of the project manager's authority. It should be published to delineate his or her role in regard to:
- Point of contact for project communication
- Resolving conflicts
- Influence to cut across functional and organizational levels
- Major management and technical decision making
- Collaborating in obtaining resources
- Control over allocation and expenditure of funds
- Selection of subcontractors

Staffing Management Plan

A staffing management plan, together with the project organization chart and the roles and responsibilities needed to complete the project, is an output of the human

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resource planning process. The staffing management plan:
- Describes how the project's human resource needs will be met and the timing of these resources
- Includes how and where staff will be acquired
- Describes the timetable and staff hours required of team members
- Defines the release criteria for team members
- Identifies team member training needs
- Provides clear criteria for recognition and rewards
- Could include strategies for compliance with various regulations, contracts or policies
- Contains safety policies and procedures

Responsibility Assignment Matrix

This 2-dimensional structure relates group or individual roles and responsibilities to project work. The RAM may be at a high level, showing group or unit responsibility, or it may be at an individual or schedule activity level. If used correctly, a RAM can establish functional responsibility, contracting strategy and manageable work packages for control and reporting.

Figure 9-1 shows a lower-level RAM in which roles and responsibilities for various phases are assigned to particular individuals using the following assignments:
- Specialized responsibility (R = Responsible)
- Identification of those who perform the work (P = Participant)
- Identification of those who may be consulted (I = Input Required)
- Identification of those who must be notified (RR = Review Required)
- Identification of those who must approve (A = Approval)

Person Phase	Mary	Ivan	Tim	Erica	Allan	Janelle	Jose
Business Requirements	RR	R	A	P	P	-	-
Functional Requirements	RR	P	A	P	R	P	-
Design	RR	P	I	I	R	P	P
Development	I	-	-	R	R	-	P
Testing	R	A	I	P	RR	RR	P

P - Participant   A - Approval   R - Responsible   I - Input Required   RR - Review Required

Figure 9-1
Sample RAM

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Case Study Exercise

Exercise 9-1: Using the template on the following page, create a RAM for the Lawrence RV Garage Project.

Responsibility Assignment Matrix											

P = Participant
R = Responsible
A = Approval
I = Input Required

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ACQUIRE PROJECT TEAM PROCESS

This process involves obtaining the people to work on the project. In many cases it is the project manager who must obtain the human resources for the project. Therefore, the key tool and technique of this process is negotiation. The people resources can be from functional groups, other project teams or new hires. In addition, resources may be obtained from outside the performing organization, as discussed in Chapter 12 on Project Procurement Management.

There are 5 basic requirements for conducting a successful project. In order of importance, they are:
- Choosing the right people
- Finding people with a positive attitude
- Obtaining people with the appropriate skills
- Setting up the right organization
- Using the right methods

In order to acquire the people with the appropriate skills, virtual teams are becoming more and more commonplace. The lower costs and improved technology of electronic communications such as email, electronic meetings and video conferencing make virtual teams feasible. However, team building becomes more challenging when team members spend little or no time meeting face-to-face. Frequent and regular communication becomes critically important for a virtual team to work. Ground rules for communication must be set with clear objectives, shared goals, protocols for conflict and issues resolution, involvement of the team in decision making and recognition of individual and team successes.

The ground rules for the method of team member interactions should be specified in the communications plan for the project. Therefore, communications planning is closely linked to the acquisition of team members for the project.

Acquiring the project team is truly an iterative process. As progressive elaboration is applied to the scope and

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schedule, new requirements for resources will be uncovered. It is important for the project manager to assess continually the human resource needs of the project.

DEVELOP PROJECT TEAM PROCESS

This process involves all aspects of improving the interactions and interpersonal relationships of the project team members to enhance project performance. As feelings of trust, cohesiveness and teamwork increase among team members, the project team improves its ability to achieve project objectives. Training and development of team members, setting ground rules, implementing team-building activities and colocating team members (where possible) are important techniques of this process.

Other critical techniques include using the general management skills of leadership, communication, negotiation, problem solving, influencing the organization and motivating the team by recognition and rewards. Roles and responsibilities, project manager skills, leadership styles, power, team building and motivation of people are all techniques that fall into this process.

PMI recommends a concerted team-building effort to be initiated at the start of every project. However, team building is a continuous process due to the arrival and departure of project participants and the alteration of roles and responsibilities over the life cycle of the project.

Roles, Responsibilities and Work Environment

Project Manager Roles: in the course of managing a project, the project manager will hold many roles. Some of the most important roles include being a/an (from *Principles of Project Management*, pages 178 to 180):
- Integrator, who produces product with available resources within time, cost and performance constraints

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- Communicator, who interfaces with customers, stakeholders, upper management, project participants and functional managers
- Team leader, who is a team builder
- Decision maker, who makes or ratifies all required project decisions
- Climate creator or builder, who resolves conflicts

Project Manager Responsibilities: the project manager's tasks and responsibilities include:
- Planning, scheduling and estimating
- Analyzing costs and trends
- Reporting progress and analyzing performance
- Maintaining client-vendor relationships
- Managing logistics
- Controlling costs
- Handling organizational and resource issues
- Handling procedural, contractual, material and administrative issues

Project Manager Skills: in order to manage projects successfully, project managers require many skills. Some of the more important skills are (from Verma, *Human Resource Skills*, page 230):
- Communications skills
- Organizational skills
- Team-building skills
- Leadership skills
- Coping skills
- Technological skills

In addition to having the above skills, an effective project manager must be:
- Flexible
- An initiative taker
- A good communicator
- An integrator
- Organized
- A decision maker
- A problem solver
- Able to see the big picture

9

Project Manager Work Environment: time and stress are 2 factors that can enhance or diminish performance. The project manager faces greater time challenges than most functional or operational managers. A hold up of one or more critical tasks could delay the entire project; therefore, the project manager must be able to influence groups and individuals to get things done. The difficulty associated with assigning priorities for work can place managers under continuous stress. Stress can be used as a driving factor in enhancing productivity but long-term stress often leads to poor performance and ill health.

The common characteristics of a project manager's work environment are:
- Extensive contact with people. The project manager is an integrator, which requires intense interaction with people.
- Fast paced. The project manager is under high pressure to deliver within the defined schedule and cost requirements, often leading to working longer hours.
- Risk identification and vigilance. The project manager must constantly look to the future for upcoming factors or triggers that could positively or negatively impact project deliverables.

Leadership Styles

There are 4 basic leadership styles that are typically found in organizations today (from *Principles of Project Management*, pages 158 to 159). These are:
- **Autocratic and directing,** in which decisions are made solely by the project manager with little input from the team
- **Consultative autocratic and persuading,** in which decisions are still made solely by the project manager with large amounts of input solicited from the team
- **Consensus and participating,** in which the team makes decisions after open discussion and information gathering
- **Shareholder and delegating** (otherwise known

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as laissez faire or hands off), considered a poor leadership style in which the team has ultimate authority for final decisions but little or no information exchange takes place

Consensus building is the recommended style of leadership for the most effective style of managing projects. However, there may be situations in which another of the other 3 styles would be more appropriate in addressing the situation.

Authority and power are related yet different. Project managers cannot be effective with authority alone. A certain level of power, or influence, over others is needed.

Types of Power: there are 2 types of power a project manager can use: legitimate (positional) power or personal power. These types of power are further broken down as follows (from Verma, *Human Resource Skills*, page 233):

- **Formal**: a legitimate form of power based on a person's position in the organization
- **Reward**: a legitimate form of power based on positive consequences or outcomes the person can offer
- **Coercive (Penalty)**: a legitimate form of power based on negative consequences or outcomes the person can inflict
- **Referent**: a personal form of power based on a person's charisma or example as a role model (an earned power)
- **Expert**: a personal form of power based on the person's technical knowledge, skill or expertise on some subject (an earned power)

> **EXAM TIP**
> PMI recommends the use of reward and expert power and it recommends avoiding the use of coercive power.

The project manager may experience power and authority problems for a variety of reasons, including:

- Power and authority not being perceived in the same way by everyone
- Poor documentation or lack of formal authority for the project manager
- Dual or multiple accountability of team members

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- A culture that encourages individualism instead of teamwork
- Vertical or stove-pipe loyalties instead of cross-organizational structures
- The inability to influence or administer rewards and punishments

Team-Building Methods

Team-building activities are a technique in the team development process. Team building is one of the challenges faced by project managers. Teamwork improves overall performance, boosts team members' satisfaction and reduces stress. It must be practiced consistently and frequently throughout the life cycle of the project. Some ground rules for effective team building are:
- Start team-building activities early.
- Make sure all contributors to the project, whether full or part time, are included as part of the team.
- Plan team-building activities by phase or other major project or team change. Team building must be reinitiated and repeated after the occurrence of any serious risk events or change in project direction.
- Recruit the best possible people.
- Obtain team agreement on all major actions and decisions.
- Communicate as frequently and openly as possible.
- Recognize that team politics exist but do not take part or encourage them.
- Be a role model.
- Encourage and mentor team members.
- Evaluate team effectiveness often.
- Use proven and effective team-building techniques.
- Move ineffective team members to positions that match their skills quickly.

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Characteristics of an Effective Team are:
- Team members are interdependent.
- Team members have reasons for working together.
- Team members are committed to working together.
- The team as a whole is accountable.
- The level of competition and conflict is manageable.

The Team-Building Process: the project manager carries out the process of getting a group of individuals to work together effectively by utilizing the following methods:
- Planning for team building by clearly defining project roles and making sure project goals and members' personal goals coincide
- Negotiating for team members by obtaining the most promising members for technical knowledge and potential to be effective collaborators
- Organizing the team by matching assignments to skills, creating and circulating the project RAM
- Holding a kickoff meeting in which team members meet, technical and procedural guide lines are set and work relationships and communications plans are established
- Obtaining team member commitments
- Building open and frequent communications links
- Incorporating team-building activities into project activities

Barriers to Team Building include:
- Differing outlooks, priorities and interests
- Unclear project objectives or outcomes
- Dynamic project environments
- Lack of team definition and structure
- Role conflicts
- Poor credibility of project leader
- Lack of team members' commitment
- Communication problems
- Lack of senior management's support

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EXAM TIP

Whenever possible, plan team-building activities early on in the project life cycle and continue such activities throughout the project to maintain morale and momentum.

MANAGE PROJECT TEAM PROCESS

This process involves observing and tracking team behaviors and performance, providing feedback, managing issues and conflict and providing input to organizational performance appraisals. Progressing toward project deliverables, resolving conflicts and issues and project performance appraising are the responsibility of the entire project team.

The team performance assessment from the Develop Project Team process together with work performance information and performance reports are some of the key inputs to this process. Observation and conversation, project performance appraisals, conflict management and the use of an issues log are techniques used to manage the project team.

Sources of Conflict and **Ways to Manage Conflict:** conflicts are unavoidable on projects due to their temporal nature. These conflicts can arise from:
- Projects being carried out in high-stress environments
- Roles and responsibilities being unclear or ambiguous
- The multiple-boss syndrome in which the priority of work becomes an issue
- Technologies being new or complex
- Teams being brought together for the first time

The 7 main sources of conflict have been demonstrated to vary significantly depending on the phase of the project, but during a project's life cycle, the 7 sources of conflict can be ranked as follows (from Verma, *Human Resource Skills*, page 102):
- Schedule issues
- Priority of work issues
- People resource issues
- Technical options and performance tradeoff issues
- Administrative procedures
- Interpersonal relationship issues
- Cost and budget issues

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PMI considers schedule issues, priority of work issues, people resource issues, technical options and performance tradeoff issues as being the most likely to cause tension in project environments.

The contemporary view of conflict management is that conflict can have a positive or negative impact on the project and the organization. It can and should be managed. Whether it is beneficial or detrimental to the project depends on the way conflict is handled by the project manager. Conflict is also a natural result of change and is inevitable among people.

Should a disruptive conflict continue or escalate, the project manager must become involved and help find a satisfactory solution to the conflict. Managing a conflict of work priorities for team members in a matrix organizational structure is generally the responsibility of the project manager. The project manager needs to apply various motivational techniques to overcome any such issues.

Conflict resolution is situational. While there are preferred forms, project managers may handicap themselves by using a single resolution method in all circumstances. The 5 ways to manage conflict are (from Verma, *Human Resource Skills*, page 139):

- **Problem Solving (Confrontational)**: the project manager directly addresses the disagreement and gets all parties to work together and want to solve the problem. The problem is defined, information is collected, alternatives are identified and the most appropriate solution is selected. This method is considered win-win and is recommended by PMI.
- **Compromising**: various issues are considered and a solution that brings some degree of satisfaction to the conflicting parties is agreed on. Both parties give up something that is important to them. This method is considered lose-lose and is recommended by PMI as the second-best conflict resolution method, after problem solving (confrontational).

> **EXAM TIP**
>
> PMI views the process of managing conflict within the project team as initially being the responsibility of the project team members.

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- **Forcing**: one person's viewpoint (usually the project manager's) is exerted at the expense of another party. This method is considered win-lose and PMI recommends using forcing only as a last resort as it can build antagonism and cause additional conflicts.
- **Smoothing**: the opposing party's differences are deemphasized and commonalities are emphasized on the issue in question. This keeps the atmosphere friendly but this method does not resolve the conflict; it only delays it. Smoothing could be used with one of the above three methods.
- **Withdrawal**: retreating from the actual or potential issue or conflict situation. This method is appropriate only for situations in which a cooling off period is needed. Withdrawal does not resolve the conflict; it only delays it.

One-Party Conflict Management: when dealing with individuals on a 1-to-1 basis, there are 5 methods for handling conflict that relate more specifically to personal styles:

- **Integrative**: this method shows a high concern for personal goals and relationships; it is related to the problem-solving (confrontational) method of conflict management.
- **Compromise**: this method shows a moderate concern for personal goals and relationships; it is related to the compromising method of conflict management.
- **Win-Lose**: this method shows a high concern for personal goals and a low concern for relationships; it is related to the forcing method of conflict management.
- **Yield-Lose**: this method shows a low concern for personal goals and a high concern for relationships; it is related to the smoothing method of conflict management.
- **Lose-Leave**: this method shows a low concern for personal goals and relationships; it is related to the withdrawal method of conflict management.

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Motivational Theories

There are 6 motivational theories that PMI emphasizes in the PMP exam (from Verma, *Human Resource Skills*, pages 70 to 75). These 6 theories were developed by Maslow, Herzberg, McGregor (who developed 2), Ouchi, Vroom and the team of Hersey and Blanchard.

Maslow's Hierarchy of Needs Theory. Maslow developed a model of needs in the form of a pyramid with 5 levels. He suggests that within every person there resides a hierarchy of needs that duplicates the levels of the pyramid. The needs of the lower level of the pyramid must be satisfied before higher-level needs can be addressed. Motivation springs from needs that are not met, as the person strives to fulfill these needs. The levels of needs in this pyramid are, in order of the lowest to highest:
- **Physiological**, meaning the need for food, shelter and items for survival
- **Safety**, meaning the need to be safe from danger, threat and deprivation
- **Social**, meaning the need for association with humans, friendship and acceptance
- **Self-Esteem**, meaning the need for self-respect, status and respect from others
- **Self-Actualization**, meaning the need for self-fulfillment through the development of powers, skills and one's own creativity

Herzberg's Theory of Motivation. Herzberg related Maslow's needs to the job. He suggested that motivation on the job is the result of 2 factors:
- **Hygiene,** such as pay, the attitude of a supervisor or working conditions. Poor hygiene factors may destroy motivation but improving hygiene factors under normal circumstances is not likely to increase motivation. For example, a clean working environment does not motivate but a dirty work environment will demotivate.
- **Motivators,** such as interesting work, opportunities for personal growth, achievement

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and recognition. Such positive motivators offer opportunities to achieve and experience self-actualization. The worker must have a sense of personal growth and responsibility. Depending on the organizational culture, group success may be more important than individual achievement.

McGregor. McGregor has 2 well-known theories:
- **Theory X** assumes that workers need to be constantly watched and told what to do. Managers who subscribe to Theory X believe that the average worker dislikes work and avoids work whenever possible. This worker is only motivated by money, position and punishment. In addition, he or she avoids increased responsibility and seeks to be directed. Therefore, to induce adequate effort, the manager must threaten punishment and exercise careful supervision. The manager who accepts Theory X normally exercises authoritarian-type control over workers and allows little participation by workers in decision making.
- **Theory Y** assumes the opposite set of characteristics about human nature. Managers who subscribe to Theory Y believe that workers are self-disciplined and will do the job themselves. The average worker wants to be active in a supportive work climate and finds the physical and mental effort on the job satisfying. The greatest results come from willing participation, which will tend to produce self-direction towards goals without coercion or control. The average worker seeks opportunity for personal improvement and self-respect. The manager accepting Theory Y normally advocates a participation management-employee relationship.

Ouchi. Ouchi's Theory Z is built off McGregor's 2 theories. Ouchi postulated that quality does not lie with technology but rather with a special way of handling people. His theory is based on the Japanese cultural values

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of lifetime employment, slow promotions, nonspecialized career paths and collective decision making.

- **Theory Z** postulates that high levels of trust, intimacy, confidence and commitment to workers by management results in high levels of motivation and productivity by workers.

Victor Vroom. Vroom developed the Expectancy Theory.

- **Expectancy Theory** postulates that people think about the effort they should put into a task before they do it. If workers believe their efforts are going to be successful and rewarded, they will tend to be highly motivated and productive.

Hersey and Blanchard. Hersey and Blanchard developed the life cycle theory.

- In the **Life Cycle Theory**, the leadership style must change with the maturity of individual employees. Maturity is defined as the extent of job-related experience. In his theory, the situation drives the leadership style to be used to motivate each worker, but generally, the project manager's style should move from directing, to coaching, to supporting, then to delegating as the project moves through its life cycle.

Issues Facing the Project Manager Today

Motivating people to perform work to the best of their ability is a challenge faced by every project manager. Compensation in terms of money is not enough; other methods must be considered, some of which are:

- **Fringe Benefits** in education, profit sharing, medical benefits and FICA
- **Perquisites or Perks** such as a parking space, window office or company car
- **Arbitration** or dispute resolution using a third party to resolve conflict
- **Career Planning** outlining possibilities for growth
- **Training** in new skills
- **Productivity Incentives**
- **Team Camaraderie**

Time and stress are 2 factors that can enhance or diminish performance. The passage of time and the difficulty associated with assigning priorities for work can place managers under continuous stress. Stress can be used as a driving factor in enhancing productivity but long-term stress often leads to poor performance.

**SAMPLE PMP EXAM QUESTIONS ON
HUMAN RESOURCES MANAGEMENT**

Human Resources — Planning Questions

1. Within the project management context, RAM is
   the structure used for defining:

   a) Random access memory
   b) Rapid assignment methodology
   c) Responsibility assignment matrix
   d) Reliability and maintainability

2. Human resource planning constraints include all
   of the following except:

   a) Collective bargaining agreements
   b) Expected staff assignments
   c) Preferences of the project management team
   d) Impacts of bad weather

3. Historically, your company's information technology
   projects have had issues with the retention of key
   technical resources. As a new project kicks off, what
   should the project manager do to address these
   concerns?

   a) Identify the risk early in the project and
      implement steps to mitigate the risk
   b) Accept the risk and, if it occurs, develop a
      workaround
   c) Contract with a consulting organization
      immediately
   d) Hire three times more technical staff to
      accommodate attrition

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Human Resources — Executing Questions

4. What impact does a matrix organization have on project team development?

   a) Team development is simplified
   b) Team development becomes more complex
   c) No impact
   d) Team development does not take place in matrix organizations

5. Environmental factors that need to be considered during team selection are:

   a) Location, politics and knowledge
   b) Ability, cost and interests
   c) Skills, knowledge, tools and techniques
   d) Organizational structure, politics and cost

6. The motivational theory stating that management's high levels of trust, confidence and commitment to workers lead to high levels of motivation and productivity on the part of workers is:

   a) Theory X
   b) Theory Y
   c) Theory Z
   d) Contingency Theory

7. Historically, John Smith, a team member, has misinterpreted work package instructions and has not produced the appropriate deliverables on time without significant rework being required. This has impacted the overall schedule variance of the project. For the next work package to be assigned to John, the project manager should:

   a) Tell John's manager that John's work is substandard
   b) Talk to John and have him communicate his understanding of the work package deliverable
   c) Remove John from your team
   d) Discuss the issue in the weekly project status meeting and gain consensus of the entire team

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8. You are a project manager who knows that colocation of team members promotes optimum team performance. However, in certain projects in which teams are spread out across different regions, colocation is not possible. In such cases, you should:

   a) Build trust
   b) Establish a reward and recognition system
   c) Obtain the support of functional managers in other locations
   d) Exercise your right to control all aspects of the project

9. As a project moves through its life cycle, the project manager's style should change from:

   a) Directing to coaching to supporting to delegating
   b) Problem solving to persuading to participating to coaching
   c) Laissez faire to autocratic to forcing to problem solving
   d) Leadership styles should not change

Human Resources — Monitoring and Controlling Questions

10. You are a project manager who has been brought in to manage an ongoing project with high levels of conflict. Based on your experience, team members are probably under high levels of stress due to:

    a) Rain and thunderstorms causing team members to worry about bad traffic
    b) Lots of red tape and administrative procedures
    c) Team member personalities that produce under constant stress
    d) Priority of work issues

Notes:

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11. When negotiating with functional department managers, project managers find themselves using which of the following 2-party conflict management approaches?

    a) Win-Lose
    b) Win-Win
    c) Lose-Lose
    d) Project managers never deal with conflict

12. Conflict resolution techniques that may be used on a project include:

    a) Compromising, smoothing, forcing, withdrawing
    b) Controlling, directing, forcing, negotiating
    c) Compromising, controlling, organizing
    d) Confronting, smoothing, forcing, negotiating

Notes:

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ANSWERS AND REFERENCES FOR SAMPLE PMP EXAM QUESTIONS ON HUMAN RESOURCES MANAGEMENT
Section numbers refer to the PMBOK Guide.

1. C **Planning Section 9.1.2.1 Human Resources Planning, Figure 9-5**

2. D **Planning Section 9.1.1.1 Human Resources Planning**
Constraints are factors that limit the project team's options.

3. A **Planning, see Lewis — Project Planning, Scheduling and Control, page 32**
Using SWOT (strengths, weaknesses, opportunities and threats) analysis, identify weaknesses and think of ways to minimize their impact. Among the things to be considered are completion bonuses or other compensation incentives, various other perks (such as parking spaces and dress code lenience) or penalties.

4. B **Executing Section 9.3 Develop Project Team**
Team members are accountable to both the functional manager and the project manager. Also see Section 2.3.3

5. B **Executing Section 9.2.1 Acquire Project Team**

6. C **Executing, see Verma, *Human Resource Skills*, pages 71 to 73**
Motivational theory plays a big part in team development (see Ouchi).

7. B **Executing, see Lewis — Project Planning, Scheduling and Control, page 207**
As the project manager, assuming you cannot remove John from the team, the best answer is to ensure that the next task John works on is clearly communicated and John understands fully his responsibilities and deliverables. Talking to John's boss is not the best team-building response.

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8. **A   Executing Section 9.3.2.3 Develop Project Team**
Building trust with constant communication will bring earned power, such as referent or expert power. Choice B is the next best answer.

9. **A   Executing Implied in Section 9.3.2 Develop Project Team**
Projects first go through a forming stage, during which the project manager needs to make most of the decisions. Then the team goes through a storming phase during which people begin to start working as a team with the project manager as the coach. The team then begins a norming stage during which deliverables are produced and the project manager provides a supporting role. Finally, the team takes off and performs on its own, with the project manager delegating authority for decision making.

10. **D   Monitoring and Controlling Section 9.4.2 Manage Project Team**
Although interpersonal relationships can cause conflict within a team, priority of work issues are the primary source for project conflict.

11. **C   Planning, see Two-Party Conflict Management in this chapter**

12. **A   Planning, see Sources of Conflict and Ways to Manage Conflict in this chapter**
The 5 conflict resolution techniques are problem solving, compromising, smoothing, forcing and withdrawing.

CASE STUDY SUGGESTED SOLUTION

Exercise 9-1:
RAM for the Lawrence RV Garage Project

Responsibility Assignment Matrix									
	Project Management	Site Work	Foundation/Slab	Framing	Dry-in	Exterior	Rough Utilities	Interior	Grounds	Acceptance
Concrete crew			P						P	
Finish carpentry crew								P		
Lath & Plaster contractor						P				
General contractor	A	R	R	R	R	R	R	R	R	R
Architect	A	I	I	I	I	I	I	I	I	I
Owner	A	I	I	I	I	I	I	I	I	A
Inspector		A	A	A	A	A	A	A	A	A
Electric company		P					P			
Site excavation crew		P							P	
Electric contractor		P					P	P		
Plumbing contractor							P	P		
Framing crew				P	P	P	P			
Roofing contractor					P					
Heating and AC contractor							P	P		
Insulation contractor								P		
Drywall crew								P		
Painting crew								P		

P = Participant
R = Responsible
A = Approval
I = Input Required

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COMMUNICATIONS

CHAPTER 10 | **COMMUNICATIONS**

10

COMMUNICATIONS MANAGEMENT

Most of the questions in the communications management section of the PMP certification exam are taken from the PMBOK Guide. Common sense and your own experience will play a large role in your ability to answer the questions on this topic. There will be questions on specific PMI terms and concepts; however, there will also be many general questions that require you to choose the best answer. Apply good common sense to answer these.

You will most likely have questions related to formal and informal communication, verbal vs. written communication, conflict resolution and management styles. PMI considers management style to be an essential component of how a project manager communicates.

Things to Know

1. The 4 processes of communications management:
   - **Communications Planning**
   - **Information Distribution**
   - **Performance Reporting**
   - **Manage Stakeholders**
2. The **Communications Channels Formula**
3. What a **Communications Management Plan** contains
4. The **Communications Model**
5. **Communication Styles**
6. **Communication Types**
7. The different **Communication Methods**
8. **Barriers to Communication**
9. What an **Issues Log** contains

Key Definitions

Active Listening: the receiver confirms listening by nodding, eye contact and asking questions for clarification.

Effective Listening: the receiver attentively watches the sender to observe physical gestures and facial expressions. In addition, the receiver contemplates responses, asks pertinent questions, repeats or summarizes what the sender has sent and provides feedback.

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Feedback: affirming understanding and providing information.

Noise: anything that compromises the original meaning of the message.

Nonverbal Communication: about 55% of all communication, based on what is commonly called body language.

Paralingual Communication: optional vocal effects, the tone of voice that may help communicate meaning.

COMMUNICATIONS PLANNING PROCESS

During the communications planning process, the communications requirements of the stakeholders are determined. These stakeholders' informational needs are documented in the communications management plan and contain communication requirements such as:
- Who needs what information?
- When will they need it?
- How will it be given to them?
- Who will give it to them?

A **Communications Matrix** can help identify this information. Note that the organizational structure (functional, matrix or projectized) will influence the information and distribution channels of the project. There are many formats for communications matrices. No matter what the format, the objective is to identify who is being communicated to, when communication is needed, how communications will be distributed and who is responsible for their delivery.

In analyzing communications, you must also address the types of technologies available to facilitate communications and make their transfer more effective.

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Case Study Exercise

Exercise 10-1: Use the table below to develop a sample communications matrix for the Lawrence RV Garage Project. Identify the different kinds of communication vehicles, their frequency, who is responsible for creating each one and who receives each one.

Communications Matrix								

R = Report progress
P = Prepare Report
A = Attend meeting (* = when appropriate)
RR = Review Report

The Communications Channels Formula

There is a simple formula to determine the number of communication channels that exist on a project:

(n[n - l])/2 where n indicates the number of people

For example, if 5 people work on a project, n = 5, communication channels = 5(4)/2 = 10

With 7 people, n = 7, channels = 7(6)/2 = 21. The number of links has more than doubled with just 2 additional team members.

How many channels on a project with 50 people?

Communications Management Plan

The communications management plan is the only output of the communications planning process. It should be created by the project manager and becomes part of the project management plan. The communications management plan must also include the:
- Method used to gather and store information
- Reporting relationship
- Distribution schedule
- Performance reporting process
- Close project process

INFORMATION DISTRIBUTION PROCESS

The information distribution process involves the execution of the communications management plan by making the identified needed information available to stakeholders. It also involves responding to various ad hoc requests for information from stakeholders.

One of the primary and most important roles of the project manager is communication — of project objectives, management strategies and the project plan. A project manager's responsibility is to facilitate understanding, thereby enhancing the team's effectiveness.

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Inadequate communication, one-way communication, incomplete messages and unclear messages are common problems in many projects. Communications skills are both general management and project management skills necessary for effective exchange of information. The project manager has a responsibility to:
- Know what kind of message to send
- Know how to translate the message
- Build consensus and confidence, NOT compromise

There are many communication channels utilized by a project manager; these include:
- Upward communication to management
- Lateral communication to peers, other functional groups and customers
- Downward communication to subordinates and project office personnel

The Communications Model

PMI emphasizes the basic communication model (see the PMBOK Guide Figure 10-3) that consists of the following components: a sender, a receiver and a medium through which messages are sent and received.

The sender encodes the message, chooses the medium in which to send the message and attaches symbols, gestures or expressions to confirm that the message is understood. The receiver decodes the message based on background, experience, language and culture. The receiver should confirm that the message is understood.

Communication Styles

Verma (*Human Resource Skills*, page 49) notes that languages and culture emphasize communication styles differently. People use one (or more) of the following communication styles, partially shaped by their culture and partially shaped by their personal characteristics:
- **Concrete-Sequential**: focuses on tangible tasks listed in a systematic way; not open to change; "Mr. Fixit"

- **Abstract-Sequential**: relies on logical analysis and systematic planning to solve problems; effective team builders; focuses on people and tasks; "organizers"
- **Concrete-Random**: relies on people and technology; sees practical use for theories; "entrepreneurial types"
- **Abstract-Random**: intuitive; has the "vision thing"; focuses on big picture and long-term view; "brainstormers"

Communication Types

Verma (*Human Resource Skills*, pages 18 to 21) cites 3 major types of communication:
- **Written Communication:** use of representative symbols external to the communicator
- **Verbal Communication:** use of linguistic and paralinguistic sounds
- **Nonverbal Communication:** use of gestures, postures and movement for communication

Communication Methods

An effective communicator knows which method of communication to choose to obtain results.
- **Formal Written** communication methods should be used for key documents such as project plans, the project charter, communicating over long distances, complex problems, legal documents and long or technical situations to a wide or varied audience.
- **Formal Verbal** communication methods such as presentations and speeches should be used when persuading people to accept ideas and products.
- **Informal Written** communication methods such as memos, email and notes are used for status updates, information updates and day-to-day communication.
- **Informal Verbal** communication methods such as meetings, conversations, humor and inquiries are used for small informal groups, team building and day-to-day communication.

> **EXAM TIP**
>
> Email is an informal communication method according to PMI.

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Barriers to Communication

In addition to the large number of communication links required as the resources increase, other barriers also exist to deter effective communication. Some of these barriers are:

- Ineffective listening
- Improper encoding of messages
- Improper decoding of messages
- Naysayers
- Hostility
- Language
- Culture

Language and culture are also the source of problems in communication. Additional material on this topic is found in Chapter 13 on professional responsibility.

PERFORMANCE REPORTING PROCESS

Performance reporting is a key process in project communications management. This process involves collecting and disseminating project information, communicating progress and utilization of resources and forecasting future progress and status. The work results of other processes are analyzed and combined into performance reports. These performance reports should include:

- Performance and status reports
- Trend and forecasting reports
- Change requests and recommendations
- Process updates
- Risk monitoring and control outcomes

The methods for reporting project performance were discussed in the information distribution process section.

Earned value techniques are very helpful in providing answers to common time and cost performance questions such as:

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- Where are we in the project schedule?
- What is the percentage of completion?
- What is the estimated time to complete the project?
- Are we ahead or behind schedule and why?
- What are actual expenditures to date?
- What are the committed expenditures?
- What are the estimated remaining costs?
- Are we under budget or over budget and why?

MANAGE STAKEHOLDERS PROCESS

Managing stakeholders' communications, expectations and requirements are addressed in this process. It uses various methods to communicate effectively, such as frequent and regular meetings, developing and tracking issues via an issues log and resolving conflict.

Face-to-face meetings should be used as much as possible in the manage stakeholders process. When stakeholders' presence is virtual, other means such as phone calls, mail, teleconferencing, web meetings and other electronic tools must be used extensively to ensure effective communications. The communications management plan should contain the information exchange technology to be used and stakeholders should have the skills and resources to use these technologies effectively.

Issues Logs are a key tool in communicating about and monitoring a project. An issues log should contain the owner assigned to resolve the issue and the target date for the resolution of the issue. An **Action Item Log** is the same as an issues log when it is used as a control document of issue owner's resolution. The log of resolved issues together with the solution to the issue become primary outputs of this process. Any approved change requests, corrective actions, updates to the project management plan and the organizational process assets (including the lessons learned) are also outputs of this process.

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SAMPLE PMP EXAM QUESTIONS ON COMMUNICATIONS MANAGEMENT

Communications — Planning Questions

1. _____ is not a project communications management process.

   a) Manage stakeholders
   b) Performance reporting
   c) Information distribution
   d) Conflict resolution

Communications — Executing Questions

2 A project status report is an example of which form of communication?

   a) Formal written communication
   b) Formal verbal communication
   c) Informal written communication
   d) Informal verbal communication

3. When is formal written correspondence with the customer required?

   a) When defects are detected
   b) When the customer requests additional work not covered under the contract
   c) When the project has a schedule slippage
   d) When the project has cost overruns

4. The 3 major types of communication are:

   a) Written, verbal and nonverbal
   b) Upward, downward and lateral
   c) Written, verbal and graphic
   d) Written, verbal and electronic

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Communications — Monitoring and Controlling Questions

5. All of the following are true about earned value techniques except:

   a) They allow for an assessment of project performance
   b) They can be done at any level, work element, summary or project
   c) They are techniques to measure performance against the project plan
   d) They should only be done on high-value government projects

6 Outputs from performance reporting include all of the following except?

   a) Trend analysis
   b) Forecasts
   c) Performance reports
   d) Change requests

7. You are a new project manager assigned to a troubled project that is 20% into the planning phase. What is the first thing you should do?

   a) Hold a status meeting to assess project status
   b) Stop all tasks until a new approved project charter is established
   c) Review the project charter and supporting documents, including the current team status reports
   d) Close the project; it has no chance of succeeding

**ANSWERS AND REFERENCES FOR SAMPLE
PMP EXAM QUESTIONS ON
COMMUNICATIONS MANAGEMENT**
Section numbers refer to the PMBOK Guide.

1. D **Planning Section 10 Communications
    Management**
    Communicating is a general management skill
    that includes conflict management.

2. A **Executing Section 10.2.2.1 Information
    Distribution**

3. B **Executing Section 10.2 Information
    Distribution**
    This is an example of a question in which all
    the answers are correct. The exam taker has to
    choose the best answer based on experience
    and common sense.

4. A **Executing, see Verma, pages 18 to 21**

5. D **Monitoring and Controlling Section 10.3
    Performance Reporting**
    All the other answers are true. Earned value
    techniques are used to integrate the processes
    of time, cost and communication and to
    measure the performance of the project.

6. A **Monitoring and Controlling Section 10.3.3
    Performance Reporting**
    Trend analysis is a tool, not an output.

7. C **Monitoring and Controlling**
    Although there is nothing in the PMBOK Guide
    specifically addressing this issue, this is a good
    example of the situational question that requires
    that you understand the purpose and value of a
    project charter and regular performance
    reporting.

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CASE STUDY SUGGESTED SOLUTION

Exercise 10-1
Communications Matrix for the Lawrence RV Garage Project

Communications Matrix								
	Report Progress Weekly	Weekly Status Meeting	Weekly Earned Value Reports	Phase Review Meeting	Phase-end Earned Value Reports	Final Project EV Reports	Final Project Acceptance	Lessons Learned Report
Owner		A	RR	A	RR	RR	A	RR
Architect		A	RR	A	RR	RR	A	RR
General contractor	R	A	P	A	P	P	A	P
Site excavation crew	R	A*						
Concrete crew	R	A*						
Framing crew	R	A*						
Drywall crew	R	A*						
Painting crew	R	A*						
Finish carpentry crew	R	A*						
Electric contractor	R	A*	RR	A*	RR	RR		RR
Plumbing contractor	R	A*	RR	A*	RR	RR		RR
Roofing contractor	R	A*	RR	A*	RR	RR		RR
Insulation contractor	R	A*	RR	A*	RR	RR		RR
Heating and AC contractor	R	A*	RR	A*	RR	RR		RR
Lath & Plaster contractor	R	A*	RR	A*	RR	RR		RR
Inspector							A*	
Electric company							A*	

R = Report progress
P = Prepare Report
A = Attend meeting (* = when appropriate)
RR = Review Report

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RISK

CHAPTER 11 | **RISK**

RISK MANAGEMENT

Project risk management is considered by some to be the most difficult section of the PMP certification exam. Exam takers consider it demanding because it addresses many concepts that project managers have not been exposed to in their work or education. Questions, however, do correspond closely to PMBOK Guide material so you should not have much difficulty if you study the terminology found in this guide.

The mathematical questions are not very difficult; however, they do require you to know certain theories, such as expected monetary value and decision tree analysis. You should also expect questions related to levels of risk faced by both buyer and seller based on various types of contracts.

Things to Know

1. The 6 processes of risk management:
   - **Risk Management Planning**
   - **Risk Identification**
   - **Qualitative Risk Analysis**
   - **Quantitative Risk Analysis**
   - **Risk Response Planning**
   - **Risk Monitoring and Control**
2. **Utility Theory**
3. **Risk Categories**
4. **Brainstorming**
5. **The Delphi Technique**
6. **Interviewing**
7. **SWOT Analysis**
8. How to create a **Risk Register**
9. **Probability and Risk Impact**
10. **Sensitivity Analysis**
11. **Probabilistic Analysis**
12. **Decision Tree Analysis**
13. **Expected Monetary Value**
14. **Monte Carlo Simulation**
15. **Probability Theory**
16. **Tools and Techniques of Risk Response Planning**
17. **Insurable Risks**
18. **Probability and Impact Curve**

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Key Definitions

Business Risks: common risks found in doing business have opportunities for gain or loss.

Decision Theory: a technique for assisting in reaching decisions under uncertainty and risk. It points to the best possible course whether or not the forecasts are accurate.

Heuristics: rules of thumb for accomplishing tasks. Heuristics are easy and intuitive ways to deal with uncertain situations; however, they tend to result in probability assessments that are biased.

Management Reserves: reserves or contingencies comprise the amount of buffer needed to reduce the risk of overruns of project objectives. They must be controlled throughout the life cycle of the project. PMI recommends a reserve of 10% or more as calculated based on the level of project risks.

Opportunities: events that have a positive outcome, sometimes known as "good" risks.

Pure or Insurable Risks: risks providing only an opportunity for loss.

Residual Risk: in implementing a risk response plan, the risk that cannot be eliminated.

Risk: an uncertain event or condition that could have a positive or negative impact on the project. Therefore, the primary elements of risk that must be determined are:
- Probability of the risk event or condition occurring
- Impact of the occurrence, if it does occur
- Expected time the risk event may occur
- Anticipated frequency of the risk event occurring

Secondary Risk: in implementing a risk response, a new risk that is introduced as a result of the response.

Stakeholder Risk Tolerance: an enterprise environmental factor that must be considered in the risk management

> **EXAM TIP**
>
> When presented with a probability theory problem, come up with all possibilities and verify they sum to 1 to avoid simple errors in math.

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plan. Stakeholders who are more risk averse will require additional planning to minimize variances to the plan.

Workarounds: unplanned responses to risks that were previously unidentified or accepted.

RISK MANAGEMENT PLANNING PROCESS

The risk management planning process plans for risks occurring during the project. It is the process of deciding how to approach and plan for activities to handle project risks and documenting these decisions in a risk management plan, which is the primary output of the risk management process. This important document is a subsidiary component of the project management plan.

Key inputs to this process are the enterprise environmental factors, the project scope statement and the project management plan. The organizational culture and attitudes towards risk are factors that must be considered as part of the project environment. Organizational and individual tolerances for risk are not often considered an aspect of project management but they will make a difference to the approach toward project risks. This concept takes into account the fact that different organizations and individuals have varying levels of tolerance for risk. An appropriate method for describing risk tolerance is the utility theory.

Utility Theory

The project manager is usually called on to make decisions on dealing with project risk. These decisions will be based on the various stakeholders' tolerance for risk as described using the utility theory.

Figure 11-1 on the next page depicts the 3 structures of the utility theory. The x-axis denotes the money at stake and the y-axis denotes utility, or the amount of pleasure or tolerance the person obtains from the payoff.

> **EXAM TIP**
> The risk management plan contains:
> 1. Risk approach and methodology
> 2. Roles and responsibilities of the risk management team
> 3. Risk management budget
> 4. Timing of the risk management process
> 5. Scoring metrics for risk analysis
> 6. Threshold risk criteria
> 7. Risk response reporting formats
> 8. Tracking method of risk activities

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- **Risk Averter:** when there is more money at stake, the risk averter's pleasure diminishes. He or she prefers a more certain outcome and demands a premium to accept projects of high risk.
- **Risk Neutral:** straight line tolerance for risk as the money at stake increases.
- **Risk Seeker:** for the risk seeker, the higher the stakes, the better. As risk increases, the risk seeker's pleasure increases; he or she is even willing to pay a penalty to take on projects of high risk.

Figure 11-1
Risk Preference
and the Utility
Theory (from
Kerzner, page 655)

Risk Preference and the Utility Theory

Y - Axis: Utility/Satisfaction

Risk Averter   Risk Neutral   Risk Seeker

X - Axis: The amount of money involved
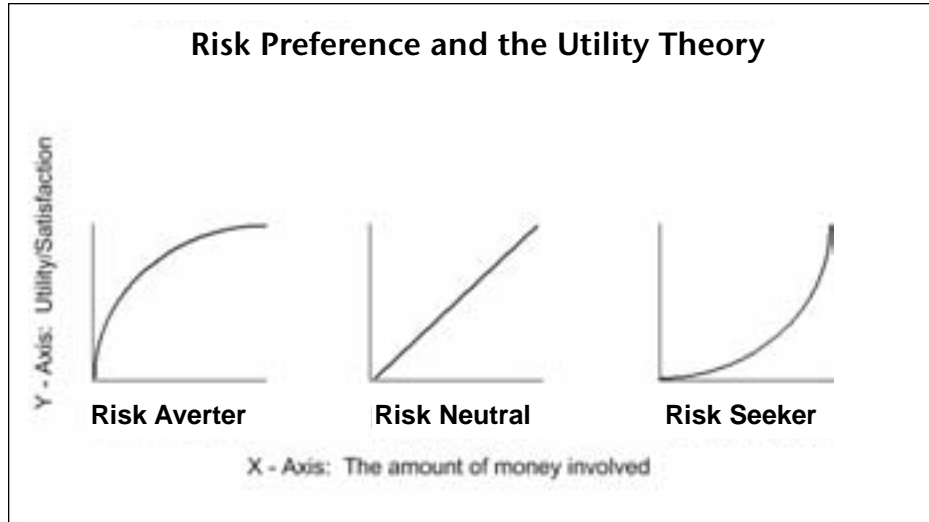
Risk Categories

Risk categories are included in the **Risk Management Plan**. An organization may have a standard set of risk sources that should be considered in advance of the risk identification plan. These sources of risk are defined in the **Risk Breakdown Structure** (RBS). There are many categories of risk, including:
- External risks that are unpredictable, such as labor disputes or bad weather (Note that *Force Majeure* risks such as earthquakes, floods, acts of terrorism, etc., should be covered under disaster recovery procedures instead of risk management.)

- External risks that are predictable but uncertain (For example, you know that snow storms will occur in the northwest but you do not know when and how many snow storms will occur.)
- Project management risks such as poor estimates of time and resources or the lack of skills and knowledge in project management concepts and discipline
- Internal risks or organizational risks such as resource conflicts, a delay or lack of funds
- Technical risk such as complex or new software technology, quality or performance issues or unrealistic project goals
- Legal risk such as new or modified legal requirements or regulations

RISK IDENTIFICATION PROCESS

The risk identification process involves identifying and documenting the types of risks that may occur during the project.

The identification of risks is an iterative process that occurs with the help of the project team, stakeholders and even people outside the organization. Information gathering is a tool or technique of this process. Information can be gathered by many means, including brainstorming, the Delphi Technique, interviewing and SWOT analysis.

Brainstorming

Information gathered through brainstorming is:
- Used extensively in project planning
- Possibly used to postulate risk scenarios for a particular project
- A technique that can be improved by the variety of participants' backgrounds
- Helpful in project team building
- Effective in finding solutions to potential problems

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The Delphi Technique

The Delphi Technique:
- Derives a consensus using a panel of experts to arrive at a convergent solution to a specific problem
- Is useful in arriving at probability assessments relating to future events in which the risk impacts are large and critical

Interviewing

Experienced project managers or subject matter experts are interviewed to:
- Identify project risks based on their knowledge (Their optimistic, most likely and pessimistic estimates used in three-point estimating for weighted averages.)

SWOT Analysis

SWOT analysis is a technique that:
- Examines potential risks from the perspectives of strengths, weaknesses, opportunities and threats — or SWOT

The only output of the risk identification process is the **Risk Register** that contains the identified risks with potential responses, root causes and an updated list of risk categories. This risk register is used to track the status, triggers, and responses to project risks. The identification, tracking and reviewing of project risks is ongoing throughout the life cycle of the project. The risk register is a component of the risk management plan and the project management plan. It is updated by each of the risk management processes. It is important to think of each risk event as having a 3-part anatomy:
- The future event or situation that poses the risk
- The consequence of that event or situation
- The source of the risk

An example of a risk register is shown in Figure 11-2 on the following page.

EXAM TIP

The risk register is a critical deliverable in any project. Every process within the risk management knowledge area includes updates to the risk register as part of the process outputs, reinforcing the concept of an iterative approach to risk planning.

Risk Events	Category	Probability	Impact	Score/ Priority	Risk Response Strategy	Risk Trigger
Contract Breach	Legal	1	1	1	Accept	Theft
Part Failure	Technical	2	2	4	Mitigate	Design
PM Removed	Internal	4	4	16	Transfer	Reorgani-zation
Shipping Delay	External	4	5	25	Avoid	Labor Dispute

Figure 11-2
Sample Risk Register

QUALITATIVE RISK ANALYSIS PROCESS

Once risks have been identified, they must be analyzed to determine the likelihood of the risk occurring (risk probability) and the consequences it could have on the project (risk impact) if and when it occurs.

Qualitative risk analysis involves the activities of:
- Assessing the impact and likelihood of identified risks
- Prioritizing risks
- Ranking risk events in order of importance of risks
- Determining which risks require additional analysis

Probability and Risk Impact

The probability-impact matrix is a tool or technique of qualitative risk analysis. It utilizes a matrix that can be constructed using the risk scores of the identified risks, as seen in PMBOK Guide Figure 11-8. By calculating the risk score, which is the product of the probability times the impact, it can be determined if the risk is considered a low, moderate or high risk as seen in Figure 11-3 on the following page.
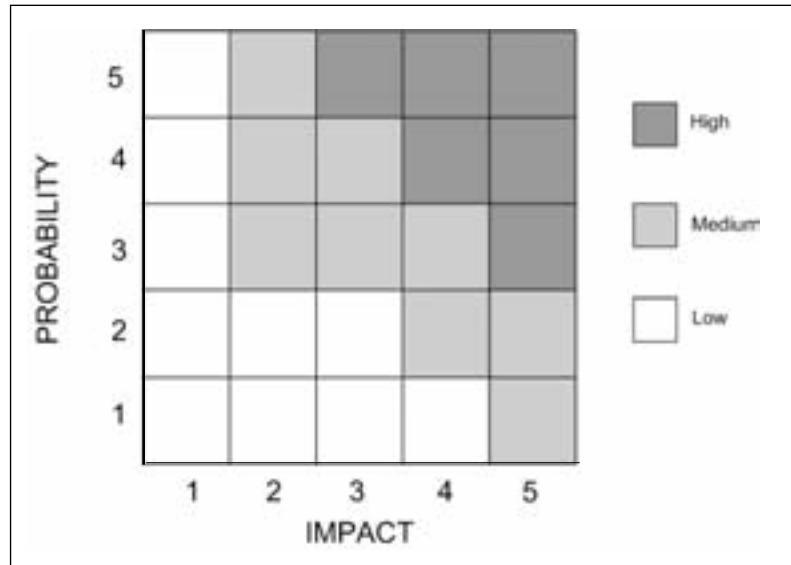
Figure 11-3
Prioritizing Risks

Example of a Risk Event: We have a year-long project in northern Maine and need to calculate the risk of snow impacting our schedule. The likelihood that a snowstorm will occur in Maine this winter is high. But since our workforce works virtually, the impact of a large storm on workforce productivity is low. This risk event would have a score of 5(high probability)X1(low impact) for a total of 5. It would be reflected in the upper left hand corner of the grid in Figure 11-3.

QUANTITATIVE RISK ANALYSIS PROCESS

Quantitative risk analysis involves further analyzing each risk event identified by:
- Analyzing numerically the probability of each risk
- Determining the consequences of the risks on project objectives, which entails a full probability analysis on costs and schedule
- Determining the extent of overall project risk, which entails calculating the probability of achieving objectives

Sensitivity Analysis

Sensitivity analysis is one tool for analyzing risk. It:
- Seeks to place a value on the effect of change of a single variable within a project by analyzing that effect on the project
- Is the simplest form of risk analysis
- Reflects uncertainty and risk by defining a likely range of variation for each component of the original base case estimate
- Analyzes the effect of change on the final cost or time criteria
- Is a weakness in that variables are treated individually, limiting the extent to which combinations of variables can be assessed

Probabilistic Analysis

Probabilistic analysis, another tool for analyzing risk:
- Overcomes the limitations of sensitivity analysis by specifying a probability distribution for each variable
- May have difficulty defining the probability of occurrence of any specific variable since every project is unique
- Has a subjective range of variation because of the optimism or pessimism of the estimator or because the interaction among variables is not clear

Decision Tree Analysis

Project managers may also use decision tree analysis to analyze risk. Decision tree analysis:
- Depicts, with a diagram, key interactions among decisions and associated chance events
- Considers the probability of each outcome
- Can be used with expected monetary value since risk events can occur individually or in groups and in parallel or in sequence
- Is usually applied to cost and time considerations

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Figure 11-4 shows a decision tree analysis of the impact being late for work (the risk) will have on whether or not an 8 am meeting will be held. Note the change in results if the initial probability is changed.
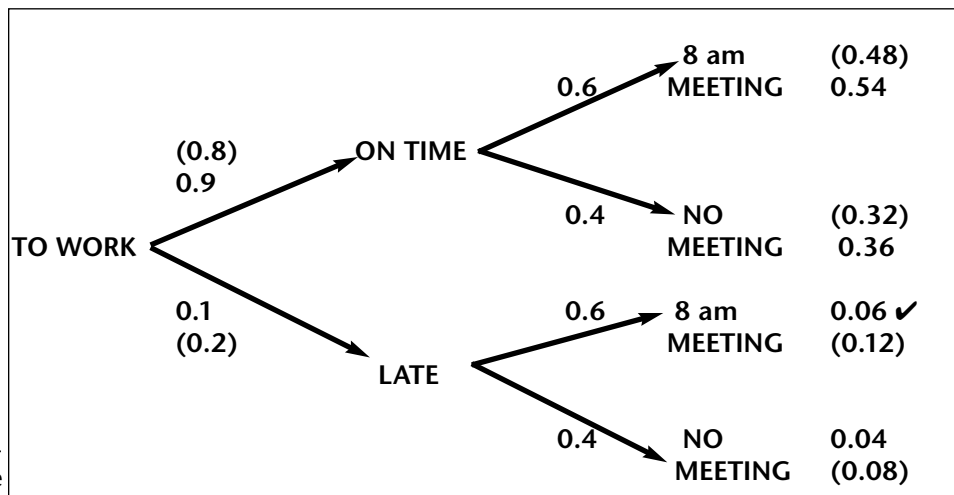
Figure 11-4
A Decision Tree

Expected Monetary Value

A decision usually can be quantified by an outcome or expected payback. This payback is the expected monetary value (EMV). Thus, each path within a decision tree could lead to the EMV of the combined decisions within the path. Therefore, EMV is:
- A risk quantification tool
- The product of the risk event probability and the risk event value
  - **Risk Event Probability:** an estimate of the probability that a given risk event will occur
  - **Risk Event Value:** an estimate of the gain or loss that will be incurred if the risk event does occur; reflects both tangibles and intangibles in order to compare risks (or else the risks are not equivalent)

EXAM TIP

EMV of a risk event is the product of probability and risk impact. If the probability of a tool breaking is 50% and the cost of the tool replacement is $1,000, the EMV of this risk event is $500.

Monte Carlo Simulation

A Monte Carlo simulation provides, by means of random numbers, a powerful yet simple method of incorporating

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probabilistic data. The steps of the method are:
- Step 1: assess the range for the variables being considered and determine the probability distribution most suited to each.
- Step 2: for each variable within its specific range, select a value randomly chosen, taking account of the probability distribution for the occurrence of the variable.
- Step 3: run a deterministic analysis using the combination of values selected for each one of the variables.
- Repeat steps 2 and 3 a number of times to obtain the probability distribution of the result.

Probability Theory

Probability theory is often used in combination with other types of probability analysis. Its basic tenets are:
- (Probability of event 1)X(probability of event 2) = probability of both events
- Probability of the event occurring + the probability of the event NOT occurring = 1 always

Example of Probability Theory: the probability of getting to work on time is 90% and the probability of a having a work meeting at 8 am is 60%. The probability that you will be at work on time on a day when there is an 8 am meeting is 54% (0.90X0.60 = 0.54), but only a 6% chance you will be late to an 8 am meeting. The other 40% of the time, it does not matter because there is no 8 am meeting. The total possible results can be shown in a table, such as in Figure 11-5, or in a decision tree as shown in Figure 11-4.

On time: 90%	Mtg @ 8 am: 60%	Total: 54%
On Time: 90%	No mtg: 40%	Total: 36%
Late: 10%	Mtg @ 8 am: 60%	Total: 6%
Late: 10%	No mtg: 40%	Total: 4%
Grand total		100%

Figure 11-5
Probability Table

RISK RESPONSE PLANNING PROCESS

During the risk response planning process, the action plans for how risks should be handled are determined. This process includes the activities of:
- Developing options
- Determining actions
- Enhancing opportunities
- Reducing threats
- Assigning responsibility for risks
- Determining appropriate responses based on the severity of risks

After risks have been prioritized as high, medium or low during the qualitative analysis process, allowable responses can be determined for planned responses to these risks.

The primary outputs of this process are the updates to the risk register, updates to the project management plan and any risk-related contractual agreements.

Tools and Techniques of Risk Response Planning

The tools and techniques for risk response planning have been divided into common strategies for threats and opportunities, unique strategies for threats or negative risks, unique strategies for opportunities or positive risks and contingent response strategies.

The strategy for both threats and opportunities is:
- **Acceptance:** acceptance means accepting the consequences of the risk. It can be active, such as developing a contingency plan should the risk occur. It can also be passive, such as accepting a lower profit if some activities overrun.

The strategies for negative threats or risks are:
- **Avoidance:** avoidance eliminates a specific threat, usually by eliminating the cause. Examples of avoidance include not doing the project or doing the project in a different way such that the risk no longer exists.

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- **Transference:** transference eliminates the direct risk by handing it off to a third party, such as insurance companies, clients or vendors. Transference does not eliminate the overall risk impact to the project if the event occurs.
- **Mitigation:** mitigation reduces the EMV of a risk event by reducing the probability of its occurrence or reducing the risk event value (impact of the risk). Examples of mitigation include using proven technology to lessen the probability that a product will not work. Mitigation includes transferring the risk by buying insurance.

The strategies for positive opportunities or risks are:
- **Exploitation:** exploitation increases chances of making the opportunity happen and it helps eliminate the uncertainty
- **Sharing:** sharing an opportunity is done with a third party, and so leverages that party's experiences.
- **Enhancing:** enhancing expands the positive opportunity and increases the probability of its occurrence.

The strategies for contingent response are:
- **Contingency Plans:** action according to plans for specific risk events whose expected value has not been reduced to an acceptable level.
- **Financial Reserves:** using previously allocated funds or signature authority to project manager's contingency reserve and sponsor's management reserve.
- **Staffing Reallocation Reserve:** reassigning, in an emergency, previously identified individuals with critical knowledge, skill and location availability.
- **Workarounds:** acting on an ad hoc basis to minimize loss, repair damage and prevent recurrence of a risk event.

Insurable Risks

Some risks may be reduced by purchasing insurance as a transference strategy. Examples of insurable risks are (from Wideman, pages VI to 2):

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- Direct property damage from auto collision, from other auto events or to equipment in transit, handling, etc.
- Indirect consequential loss that may be the result of costs of removing direct loss debris, equipment replacement, rental income loss, liquidated damages or business interruption
- Legal liability from public bodily harm, property damage arising from the negligence of others, personal injury arising from negligence of others or damage to the project entity due to design errors, execution errors or the project's failure to perform as specified
- Personnel related, and may come from employee bodily injury, cost to replace employees and any resulting business loss

Case Study Exercise

Exercise 11-1: Identify at least 3 potential risk events for the Lawrence RV Garage Project. Perform qualitative analysis on risk events and develop a response plan for each of the 3 events. Create a risk register summarizing your risk response planning.

RISK MONITORING AND CONTROL PROCESS

The risk monitoring and control process involves the tracking of identified risks that have or have not yet occurred, determining if new risks can be identified and recalculating risk scores for increased or decreased priority. Thus, the iterative steps of this process are to determine if:

- Risk responses have been implemented as planned
- Risk responses are effective
- Project assumptions are still valid
- Risk exposure has changed
- Risk triggers have occurred
- Policies and procedures have been followed
- New risks can be identified
- Any risk events have occurred that were previously not defined

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Variance or trend analysis is a tool or technique of the
risk monitoring and control process. EVT and other
techniques may be used to monitor project performance.
They may show a significant deviation from cost and
schedule baselines, thus increasing the risk of the project.
EVT is discussed in Chapters 6 (Time) and 7 (Cost).
Some tips in performing risk monitoring and control are:
- Work the top 10% of risk events.
- Appoint a risk management leader for each risk.
- Review weekly, as EVT may indicate deviations
  to investigate.
- Work all top risks concurrently.
- Revise the top 10 risks as risks are mitigated and
  as new risks occur and are prioritized.
- Make corrective actions or use contingency
  as necessary (minimize workarounds).
- Continue tracking and adjusting throughout
  the project's life.

Probability and Impact Curve

The probability and impact curve, which looks much
like the influence curve discussed elsewhere in this study
guide, is shown in Figure 11-6. It demonstrates that,
over the life of a project, the probability of a risk event
occurring decreases but the impact of that risk increases.
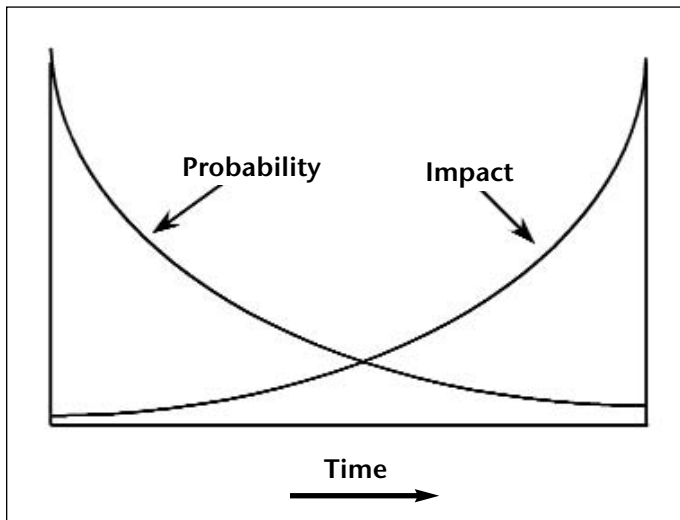
Figure 11-6
The Probability
and Impact Curve

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SAMPLE PMP EXAM QUESTIONS ON RISK MANAGEMENT

Risk — Planning Questions

1. Which of the following is NOT an input to risk management planning?

    a) Enterprise environmental factors
    b) Project scope statement
    c) Commonly used risk categories
    d) Risk management planning meetings

2. Project risk management consists of the following processes:

    a) Risk identification, qualitative risk analysis, quantitative risk analysis, risk response planning and risk decision tree analysis
    b) Risk management planning, risk identification, qualitative risk analysis, quantitative risk analysis, risk response planning and risk monitoring and control
    c) Risk identification, risk quantification, risk response development and risk response control
    d) Risk management planning, risk quantification, risk qualitative analysis, risk monitoring and control and risk plan development

Notes:

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3. Your systems development project has a 30% chance of being completed on time if an earthquake hits the facility in San Francisco. Purchasing business interruption insurance will allow the company to move the development team to Sacramento in 3 days; however, each developer will have to reduce his or her work hours to accommodate the longer commute by 2 hours each day. There is a 10% chance that the earthquake will hit San Francisco during the project. The project manager should:

   a) Hire all new staff in Sacramento as a contingency plan
   b) Accept the risk since it is a low probability of occurrence
   c) Mitigate the risk by purchasing insurance to ensure schedule and cost are not affected
   d) Transfer the risk to a subcontractor in Sacramento

4. In the chart below, any risk falling into the top right quadrant could be considered _____.

   a) Low risk
   b) Average risk
   c) High risk
   d) Neutral risk

Probability & Impact Score for a Risk					
Probability	Risk Score = P X I				
0.9	0.05	0.09	0.18	0.36	0.72
0.7	0.04	0.07	0.14	0.28	0.56
0.5	0.03	0.05	0.10	0.20	0.40
0.3	0.02	0.03	0.06	0.12	0.24
0.1	0.01	0.01	0.02	0.04	0.08
	0.05	0.10	0.20	0.40	0.80
	Impact (Ratio Scale)				

Notes:

11

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5. The theory related to how people respond to risk is called:

   a) Decision Theory
   b) Theory Y
   c) Utility Theory
   d) Maslow's Theory

6. A risk should be managed aggressively if:

   a) The probability of it occurring and the impact are low
   b) The probability of it occurring is high and the impact is low
   c) The risk is determined to be long term rather than short term
   d) The probability of it occurring and the impact are high

7. Someone who is _____ ___ risk would have a utility function that looks like this:

   a) Averse to
   b) Neutral to
   c) Seeker of
   d) Insured from

Notes:

8. A party is to be held. If the party is held inside, 100 people can attend at $10 each. If the party is outside, 200 people can attend at $10 each. There is a 40% chance of rain on the date of the party. If it rains and the party is held inside, only 80 people will attend. If it rains and the party is held outside, only 100 people will attend.
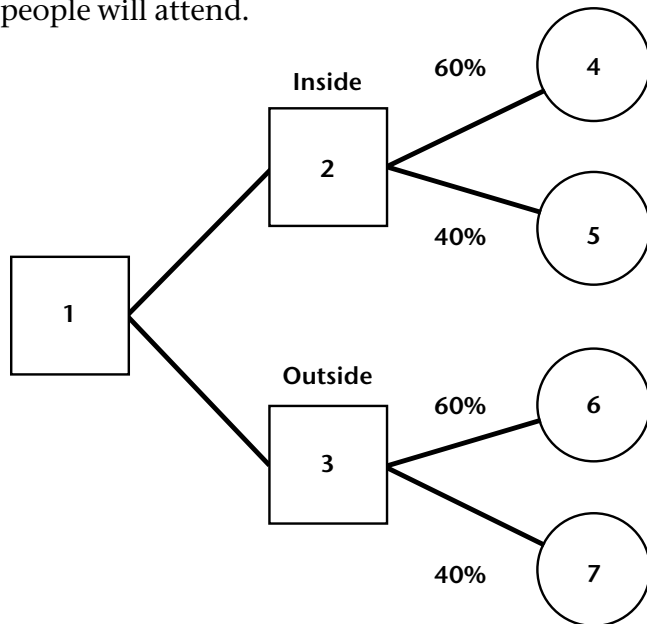
In the example above, the outcome and EMV of the party if it is held inside and rain occurs will be:

a) $800/$320
b) $1,000/$600
c) $2,000/$800
d) $100/$800

9. As part of your risk identification process, you feel one possible risk is the departure of a key team member who has special expertise that you need for your project. This risk is a:

a) Source of risk
b) Potential risk event
c) Trigger
d) Business risk

Notes:

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10. A project has an 80% chance of finishing on time and a 40% chance of finishing over budget. What is the probability that the project will finish on time and within budget?

    a) 16%
    b) 20%
    c) 32%
    d) 48%

11. All but which of the following is an input to the risk response planning process?

    a) Risk management plan
    b) Additional risk identification
    c) Risk register
    d) Risk thresholds

Risk — Monitoring and Controlling Questions

12. The following are all examples of risk monitoring tools and techniques except:

    a) Earned value analysis
    b) Periodic project risk audits
    c) Analysis of actual risk events, impact on budget and schedule
    d) Risk register updates

13. _____ are unplanned responses to emerging risks that were previously unidentified or accepted.

    a) Workarounds
    b) Expenses
    c) Contract changes
    d) Resource shifting

Notes:
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**ANSWERS AND REFERENCES FOR SAMPLE
PMP EXAM QUESTIONS ON RISK MANAGEMENT**
Section numbers refer to the PMBOK Guide.

1. **D   Planning Section 11.1.1 Risk Management**
   Risk management planning meetings are
   techniques, not inputs.

2. **B   Planning Section 11 Figure 11-1 Risk
   Management**

3. **B   Planning Section 11.5.2.4 Risk Response
   Planning**

4. **C   Planning Section 11.3.2 Figure 11-3 Qualitative
   Risk Analysis**

5. **C   Planning Implied in Section 11 Risk
   Management Planning**
   Decision theory and utility theory are part of risk.
   Theory Y and Maslow's theory are human
   resources concepts.

6. **D   Planning Section 11.3.2.5 Qualitative Risk
   Analysis**
   Choice C is incorrect because it does not consider
   urgency.

7. **A   Planning Implied in Section 11.1.1.1 Risk
   Management Planning**
   Stakeholder risk tolerances are an input to risk
   management planning. Risk-averse people will
   pay a lot to gain a small amount of utility or
   perceived value.

Decision tree diagram:
- Node 1 (decision) branches to:
  - $920 Inside → Node 2
    - No rain 60% → 600 → Node 4 → $1,000
    - Rain 40% → +320 → Node 5 → $800
  - $1,600 Outside → Node 3
    - No rain 60% → 1,200 → Node 6 → $2,000
    - Rain 40% → +400 → Node 7 → $1,000
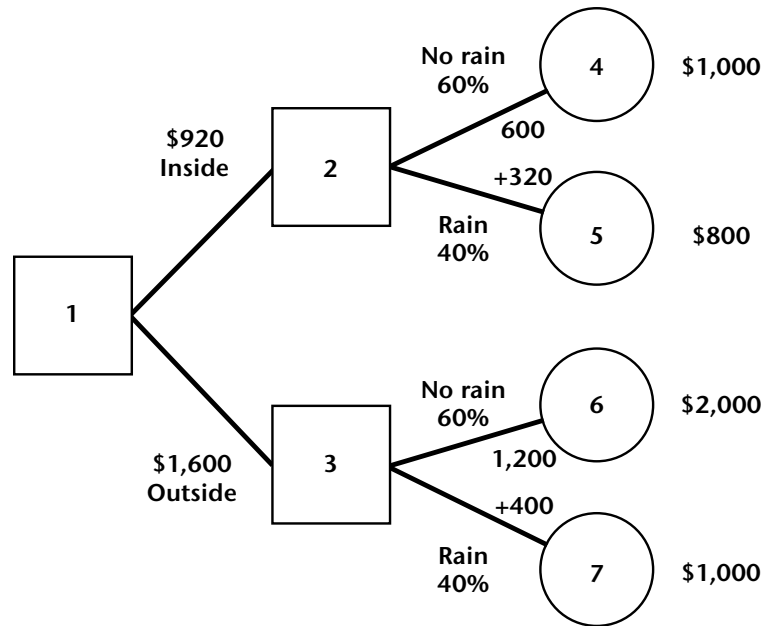
8. A   **Planning Section 11.4.2.2 Quantitative Risk Analysis**
Use decision tree analysis. Here is a secondary question: Should you plan the party inside or outside to maximize revenues? The EMV of the decision would be $920 or $1,600, as shown in the decision tree analysis above.

9. B   **Planning Section 11.2.3.1 Risk Identification**
Note that the source of the risk is personnel; the trigger is when he or she leaves; the business risk may be that it affects the organization financially.

10. D   **Planning Section 11.4.2 Quantitative Risk Analysis**
$80\% \times 60\% = 48\%$

11. B   **Planning Section 11.5.1 Risk Response Planning**
Risk thresholds are part of the risk management plan and are used in the qualitative risk analysis process.

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12. D Monitoring and Controlling Section 11.6.3 Risk Monitoring and Control
The risk register updates are an output of risk monitoring.

13. A Monitoring and Controlling Section 11.6.3.3 Risk Monitoring and Control
Plans to manage workarounds are a regular output of risk monitoring and control. They must be properly documented and incorporated into the project plan and risk response plan.

CASE STUDY SUGGESTED SOLUTION

Exercise 11-1
Risk Management Plan for the Lawrence RV Garage Project

Some possible risk events:

Permit delays
Permit(s) not granted
Subcontractor bids over (or under) expectations
Schedule overruns
Weather delays
Materials delays
Labor delays
Schedule delays other than weather, materials or labor
Budget overruns due to materials, labor or subcontractor invoices
Owner or architect change requests
Inspection denials
Quality problems

Response plan:

If permit is delayed, react to knowledge that permit is delayed or may be delayed by assuring access to site by inspector.

Risk register:

Risk Event	Category	Probability	Impact	Score/ Priority	Risk Response Strategy	Risk Trigger
Permit Delayed	External	3	2	6	Accept	Site Inaccessible

The qualitative estimates will vary greatly depending on personal experiences. The key is to get the project manager to think about risks BEFORE they happen and to have a plan for dealing with risk events. Although we have indicated a possible response plan and risk register for only one of the many possible risk events, a project manager would have to devise a response plan and risk register for all valid risks to a project.

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CHAPTER 12 | **PROCUREMENT**

PROCUREMENT MANAGEMENT

Project procurement management questions on the PMP certification exam tend to be more process oriented than legally focused. You do not need to know any country's specific legal code; however, the nature of many of the questions requires an understanding of United States contract law. In the United States, a contract is a formal agreement, all changes must be in writing and formally controlled and a court system is used for handling disputes. You must have a firm understanding of the procurement process in order to answer these questions accurately.

You must know the basic differences between the primary categories of contracts (cost reimbursable, fixed price and time and material) and the risks inherent in each category for both the buyer and the seller. Several questions will also test your knowledge of various contract types within each category. International contracting is also within the limits of exam questions; the timing of foreign currency exchange and duty on goods delivered to foreign countries may also come up.

Things to Know

1. The 6 processes of procurement management:
    • **Plan Purchases and Acquisitions**
    • **Plan Contracting**
    • **Request Seller Responses**
    • **Select Sellers**
    • **Contract Administration**
    • **Contract Closure**
2. **Make-or-Buy Analysis**
3. Factors influencing **Contract Type Selection**
4. The types of contracts **(Cost Reimbursable, Fixed Price** and **Time and Material)** and their relative risks to buyer or seller
5. The types of **Statements of Work (SOW)**
6. The types of procurement documents: **RFP**, **IFB** (also called **RFB**) and **RFQ**
7. **Evaluation Criteria** for selecting sellers
8. The stages and tactics of **Negotiation**
9. The functions and requirements of **Contracts**

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> **EXAM TIP**
> PMI discusses procurement management from the perspective of the buyer in the buyer-seller relationship. The seller is external to the buyer's organization. The type, terms and conditions of the contract become a key input in the contract administration process. Memorize the key contract types — **Cost Reimbursable, Fixed Price** and **Time and Material** — and who bears the burden of risk in each type of contract.

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10. How to conduct **Performance Reporting**
11. What a **Contract Change Control System** is
12. How **Contract Closure** and **Administrative Closure** differ

Key Definitions

Buyer: the performing organization seeking to acquire goods and services from an external entity (the seller). The buyer becomes the customer and key stakeholder.

Contract: the binding agreement between the buyer and the seller.

Definitive Contract: a contract entered into following normal contracting procedure — i.e., negotiation of all contractual terms, conditions, costs and schedules prior to initiation of performance.

Letter Contract: a written preliminary contract authorizing the seller to begin work immediately although price has not yet been negotiated.

Letter of Intent: this is NOT a contract but simply a letter, without legal binding, that says the buyer intends to hire the seller.

Privity: the contractual relationship between the 2 parties of a contract. If party A contracts with party B and party B subcontracts to party C. There is no privity between party A and party C.

Seller: the subcontractor, vendor or supplier who will provide the goods and services to the buyer. The seller generally manages the work as a project, utilizing all processes and knowledge areas of project management.

PLAN PURCHASES AND ACQUISITIONS PROCESS

The plan purchases and acquisitions process is the first step in procurement management. It identifies which

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project requirements can be met by purchasing products or services from vendors or contractors outside the organization. Planning purchases should be accomplished as part of the scope definition process. The project scope statement is a critical input to this process. The **Procurement Management Plan** is the key output.

The 2 primary tools and techniques of procurement planning are make-or-buy analysis and contract type selection.

Make-or-Buy Analysis

In make-or-buy analysis, the project organization evaluates the alternatives of making everything needed and procuring nothing, procuring all goods and services from a single source, procuring all goods and services from multiple sources or procuring some portion of goods and services. Cost is a major factor in the make-or-buy decision. PMI advocates that the actual or direct out-of-pocket costs to purchase the product as well as the indirect costs of managing the procurement must be considered in any make-or-buy decision. Other factors to be considered in the make-or-buy decision are the:

- Availability of human resources and skills (if unavailable, the performing organization needs to "buy")
- Direct control or customization required (if a high level of control or customization is needed, the performing organization needs to "make")
- Design secrecy (if high levels of security are required, the performing organization needs to "make")
- Unavailability or reliability of suppliers (if the product or service is not available in the market, the performing organization needs to "make")
- Small volume requirements (for low quantities, the performing organization should "buy")
- Limited capacity or time (if the product is already available, it is quicker to "buy")

> **EXAM TIP**
>
> All procurement processes except the plan purchases and acquisitions process are the only PMBOK processes that are truly optional. These processes are only used if procurement is determined to be necessary to the project.

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Contract Type Selection

If an organization decides to "buy" from one or more outside sources, it must select the type of contract it needs. In selecting what type of contract to use, the primary objective is to have risk distributed between the buyer and seller so that both parties have motivation and incentives for meeting the contract goal.

The following factors may influence the type of contract selected:
- Overall degree of cost and schedule risk
- Type and complexity of requirement
- Extent of price competition
- Cost and price analysis
- Urgency of requirement or performance period
- Frequency of expected changes
- Industry standards of types of contracts used
- Whether or not there is a well-defined statement of work

If the product is not well defined, both the buyer and seller are at risk, therefore PMI advocates the statement of work (SOW) as an all-important document of the procurement management process. The SOW is discussed in more detail later in this chapter.

There are generally 3 types of bilateral (signed by 2 parties) contracts: cost reimbursable, fixed price and time and material contracts.

Cost Reimbursable Contracts

Cost reimbursable (CR) contracts involve payment based on sellers' actual costs as well as a fee or incentive for meeting or exceeding project objectives. Therefore, the buyer bears the highest cost risk. Common forms of cost reimbursable contracts include:
- **Cost Plus Percentage of Costs (CPPC):** this is an illegal form of contract for the United States government. The buyer bears 100% of the risk. This type of cost reimbursable contract requires

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the buyer to pay for all costs plus a percent of costs as a fee. Sellers are not motivated to control costs because the seller will get paid a larger profit as project costs increase, without a limit.

Example of CPPC: estimated cost = $100,000 and the percentage of cost (10%) = $10,000. Estimated total cost = $110,000. If project costs increase to $150,000, the percentage of cost (10%) increases to $15,000. The total actual cost the buyer pays is $165,000.

- **Cost Plus Fixed Fee (CPFF):** this is a very common form of cost reimbursable contract. The buyer bears a higher burden of the risk in a CPFF contract because the buyer pays all costs. The fee of the seller is fixed at a specific dollar amount. This fee is usually based on a percent of the original estimated cost. The seller's costs are kept in line because any cost overruns will not generate any additional profit. The only time the fee in a CPFF contract could change is when the buyer approves change orders that increase or decrease the scope of the project. This type of contract is used in research projects and projects in which the outcome is uncertain.

  Example 1 of CPFF: original estimated cost = $100,000 and the fixed fee as a percentage of cost (10%) = $10,000. Estimated total cost = $110,000. If project cost increases to $150,000, the fixed fee stays at $10,000. The total actual cost the buyer pays is $160,000.

  Example 2 of CPFF: original estimated cost = $100,000 and the fixed fee as a percentage of cost (10%) = $10,000. Estimated total cost = $110,000. If project scope increases as approved by the buyer and cost increases to $120,000, the fixed fee could increase to $12,000. The total actual cost the buyer pays is $132,000.

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- **Cost Plus Incentive Fee (CPIF):** this type of contract is becoming more popular. Risk is shared by both buyer and seller. The seller is paid for allowable performance costs plus an agreed on fee, plus an incentive bonus. If the final costs are less than the expected costs, both the buyer and seller benefit by splitting the cost savings on a prenegotiated sharing formula. This type of contract is used in long-performance period types of contracts.

  Example of CPIF: estimated cost = $100,000 and predetermined fee = $10,000. Estimated total cost = $110,000. The sharing formula is 80/20 (buyer takes 80% of risk and seller takes 20% of risk). If project actual cost is $80,000 with a $20,000 savings, buyer pays seller ($80,000 + $10,000 fee + 20% [$20,000 savings]) = $94,000. The buyer realizes a savings of $16,000.

- **Cost Plus Award Fee (CPAF):** an award pool is created and managed by an award committee. The buyer has more flexibility than in a CPIF contract as subjective judgments can be used to determine the award. Administrative costs are high.

  Example of CPAF: estimated cost = $100,000 and an award pool of $10,000 is set up. At the completion of the project, the award committee composed of the buyer, the seller and an arbitrator determine to award the seller $5,000 in recognition of special effort and initiatives taken to hold the final cost to just $110,000.

Fixed Price Contracts

Fixed price (FP) contracts (also called lump-sum contracts) involve a predetermined fixed price for the product and are used when the product is well defined. Therefore, the seller bears a higher burden of the cost risk than the buyer. There are 2 types of contracts in this category:

- **Firm Fixed Price (FFP):** also called a lump-sum contract. In an FFP contract, the seller bears the greatest degree of risk. This is a common type of contract when the seller agrees to perform a service or furnish supplies at an established price.

  Example 1 of FFP: estimated cost = $100,000. If project actual cost outcome is $70,000 with a $30,000 savings, buyer pays seller $100,000 and the seller makes a profit of $30,000.

  Example 2 of FFP: estimated cost = $100,000. If project actual cost increases to $130,000 with a $30,000 overrun, buyer pays seller $100,000 and the seller loses $30,000 on the contract.

- **Fixed Price Incentive Fee (FPIF):** this is a complex type of contract in which the seller bears a higher burden of risk. For every dollar the seller can reduce cost below the target, the cost savings are split between the seller and buyer based on a share ratio (similar to CPIF). There is also a ceiling price. The buyer does not pay more than the ceiling price; therefore if costs exceed the ceiling, the seller receives no profit.

  Example 1 of FPIF: estimated cost = $100,000 and target profit (seller's fee) = $10,000. Target price = $110,000 and the ceiling (maximum payout to seller) = $120,000. The share ratio is 80/20. If project actual cost decreases to $80,000 with a $20,000 savings, the buyer pays the seller $94,000 ($80,000 + $10,000 fee + 20% [$20,000 savings]) and the buyer realizes a savings of $16,000.

  Example 2 of FPIF: same targets and ceiling as above. If project actual cost increases to $130,000 with a $30,000 overrun, buyer pays seller $120,000 (ceiling amount). The seller gets no profit and a $10,000 loss on costs. The buyer loses $10,000 over target project cost of $110,000.

> **EXAM TIP**
> Buyers' risk from the various contract types (from highest to lowest):
>   CPPC → CPFF→ CPIF
>   → FPIF → FFP

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- **Fixed Price Economic Price Adjustment (FPEPA):** sometimes a fixed price contract will allow for price increases if the contract is for multiple years.

  Example of FPEPA: a 5-year contract states that starting in the second year, the amount of the fixed price paid in that and subsequent years will be increased by the Federal Cost of Living Adjustment (COLA). The bid requested that bidders bid in constant dollars so that the buyer could face consistent potential increased costs across all contracts.

Time and Material Contracts

Time and material (T&M) contracts (sometimes called **Unit Price Contracts**) contain characteristics of both FP and CR contracts and are generally used for small dollar amounts. These contracts may be priced on a per-hour or per-item basis (fixed price) but the total number of hours or items is not determined (open-ended cost type arrangements like CR contracts). A **Purchase Order** is a simple form of unit price contract that is often used for buying commodities. It is a unilateral contract and only signed by 1 party instead of the above bilateral contracts that are signed by both parties.

- **Example of T&M:** in anticipation of a hurricane forecast for the site of a construction job, the buyer's project manager asks the contractor to prepare for high winds on a time and materials basis to be invoiced after the work is completed. The seller buys 20 8X4- ft. plywood panels for a total of $1,000 and hires local labor for 15 hours at $10 per hour for a total of $150. The seller submits an invoice for $1,150.

The Types of Statements of Work

Statements of work (SOW) are key outputs of the plan purchases and acquisitions process. An SOW is written to describe the procurement item in sufficient detail to allow prospective sellers to determine if they are capable

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of providing the item. Key details to know about an SOW are:

- It describes the portion of the product to be contracted.
- It must be detailed enough for prospective sellers to determine if they can produce the item.
- If the seller is producing the entire product then the SOW = the product description, otherwise the product description is a broader definition of the project.
- In government terms, the SOW describes a procurement item that is a clearly specified product or service and a **Statement of Objective (SOO)** is used for procuring an item that is presented as a problem to be solved.
- Each procurement item needs its own SOW.
- Multiple products and services may be grouped as one procurement item.

Types of SOW can include:

- **Performance SOW:** this type of SOW describes the final product or objective to be accomplished, leaving it up to the seller to decide how the item should be built or what its design characteristics should be. This type of SOW is usually used in new technology, research or complex developmental contracts.
- **Design SOW:** this type of SOW describes how the work is to be done in close detail. It is usually used in construction equipment purchasing contracts.
- **Statement of Requirements (SOR):** this is a type of SOW used for a procurement item that is presented as a problem to be solved. (Note that there is no reference to the SOR in the PMBOK Guide 2000 edition.)

PLAN CONTRACTING PROCESS

Once the decision has been made to obtain products or services from outside the performing organization and the types of contracts have been selected, the 5 remaining

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procurement processes, beginning with plan contracting, are performed. This process involves the preparation of the documents needed for the solicitation of potential sellers.

Standard forms such as those for a standard contract or expert judgment from internal or external organizations are the 2 tools and techniques. The key outputs of this process are procurement documents and evaluation criteria.

Procurement Documents

Procurement documents are a primary output of the plan contracting process. These documents are prepared by the buyer to tell the seller its needs and to solicit proposals. Procurement documents provide information for prospective sellers that generally include:
- The SOW
- Background information for the product
- Procedures for replying
- Guidelines for preparation of the proposal
- Pricing forms
- A target budget or maximum
- Proposed terms and conditions of the contract
- Evaluation criteria for how proposals will be rated or scored

Procurement documents need to provide enough detail to ensure consistent, comparable responses from the sellers, yet allow potential sellers the flexibility to provide creative, viable solutions. Well-designed procurement documents enable:
- More complete proposal responses
- Facilitated comparisons of the sellers' responses
- Pricing that is close to objectives
- Increased understanding of the buyer's need and scope of work
- Decreased number of changes to project work

Procurement documents may take any of the following forms and are sources of bilateral contracts:

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- **Request for Proposal (RFP)**: requests a detailed proposal on price, how the work will be accomplished, skills and experience of the people to be included and various other details. Items of service are usually high dollar value and are nonstandard.
- **Invitation for Bid (IFB)** or **Request for Bid (RFB)**: requests a single price for the entire package of work. Items of service are usually high dollar value and are standard.
- **Request for Quotation (RFQ)** or **Request for Proposal (RFP)**: requests a price quote per item, hour, etc. Items are relatively low dollar value.

The choice of which type of procurement document to use depends on the form of SOW and contract type selected.

Evaluation Criteria

Evaluation criteria for how sellers will be selected are determined during the plan contracting process. Additional weight may be given to one or more criteria depending on the needs of the project. Evaluation criteria generally include:
- Seller's price or cost criteria
- Seller's understanding of the project need and requirements
- Seller's technical ability and management approach
- Seller's financial capacity and reputation

Case Study Exercise

Exercise 12-1: Plan the purchases for the Lawrence RV Garage Project. There are 4 building supply vendors that can provide our materials, 2 local roof truss manufacturing companies and several potential stucco subcontractors we can choose from. For the purchase plan, list the various vendors and determine 1) how we should solicit each vendor and 2) which type of contract would be best to use in each situation.

REQUEST SELLER RESPONSES PROCESS

After the procurement documents are sent out to prospective sellers, the request seller responses process involves obtaining responses from these sellers. The key outputs of this process are the proposals that are created by the prospective sellers.

Organizations and industries will vary greatly in the tools and techniques used to identify and distribute requests for seller responses. The Internet is offering new ways to expand an organization's reach to prospective sellers.

SELECT SELLERS PROCESS

Proposals from prospective sellers are received and evaluated to select the single seller to provide the product or service in the select sellers process. Preliminary steps may involve having the top 2 or 3 prospective sellers carry out negotiation, weighing or screening systems to select the final seller before signing a contract.

Negotiation

Negotiation is a general management skill that comes up frequently in project management. It is a key tool in the select sellers process. The exam may contain questions about negotiation stages and different negotiation tactics.

Although the primary objective of negotiation is to reach agreement on a fair and reasonable price, PMI advocates the importance of a win-win situation in which a good relationship is developed with the seller. A win-lose situation will result in contract issues and problems for either the buyer or the seller.

There are 5 stages of negotiation:
- **Protocol:** negotiators meet and get to know each other
- **Probing:** each side brings up issues and concerns and identifies common interests, weaknesses and

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differences
- **Scratch Bargaining**: points of concession are identified and actual bargaining begins
- **Closure**: final concessions are reached and positions are established, summarized and documented
- **Agreement**: both sides are assured they have an identical understanding of the agreements reached and in which plans are drawn up for the written contract

There are several negotiation tactics, including (from *Principles of Project Management*, pages 238 to 239):
- **Imposing a Deadline**: a powerful tactic since it emphasizes the schedule constraints of the project and implies a possible loss to both parties
- **Surprises**: one party springs a surprise on the other, such as a change in dollar amount
- **Stalling**: one party claims it does not have the authority, that the person with authority is not available or that it needs more information
- **Fair and Reasonable**: one party claims the price is equitable because another organization is paying it
- **Delays**: necessary when arguments are going nowhere, tempers are short or one party is off on a tangent
- **Deliberate Confusion**: either distorting facts and figures or piling on unnecessary details to cloud the issues
- **Withdrawal**: either the negotiator is so frustrated he or she does not continue or one side makes an attack and then retreats
- **Arbitration**: a third party is brought in to make decisions, including a decision on the final outcome
- **Fait Accompli**: one party claims "What is done is done" and cannot be changed

Some of the key items to be considered in negotiation are:
- Responsibilities and roles
- Technical and business management approaches and methodologies

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- Who has final authority
- Any applicable laws
- Price
- Contract financing and payment terms

Contracts

A contract is the key output of the select sellers process. A contract has the following characteristics:
- Agreement formalized
- All requirements specifically stated
- All contract requirements met before formal acceptance by the buyer
- Changes in writing and formally controlled
- Disputes backed by government court systems

Some organizations frequently have **Standard Contracts** that are preprinted. If signed as is, these are legally sufficient and will form a valid contract. At times, these standard contracts can be modified slightly to fit the requirements of project. These are called **Special Provisions** and can be arranged by the project manager together with the contract administrator and a lawyer (if necessary). A legally enforceable contract must have:
- Mutual assent (offer and acceptance)
- Sufficient cause (consideration to both parties)
- Legal capacity (signing parties must have legal right to contract)
- Legal purpose
- No violation of public policy

> **EXAM TIP**
>
> A contract, offer or acceptance may be oral or written, though written is preferred.

At times, a contract may be awarded to a company without competition. This noncompetitive form of procurement is used when:
- The project is under extreme schedule pressure.
- A seller has unique qualifications.
- The seller has already been selected as the organization's single source (preferred seller).
- The seller is the only supplier or sole source (seller holds a patent on the product).

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CONTRACT ADMINISTRATION PROCESS

The contract administration process involves making sure that the seller is performing the work according to contractual requirements. The following key processes must be applied to contracts in this process:

- Direct and manage project execution (authorizing seller's work according to the project schedule)
- Integrated change control (ensuring changes are properly managed and communicated; contested changes are called claims, disputes or appeals)
- Perform quality control (inspection and verification of results for compliance; nonconformance may lead to breach of contract)
- Performance reporting (monitor costs, schedule and seller's performance; note that scheduled payments or seller's compensation must be linked to seller's performance)
- Risk monitoring and control (ensure risks are mitigated)

Performance Reporting

Performance reporting is a key tool or technique in contract administration. Some performance controls that could impact contract administration are:

- **Waivers**, which relinquish rights under the contract (The **Waiver Pitfall** occurs when the project manager for the buyer knowingly accepts incomplete, defective or late performance without objection, thereby waiving his or her right to strict performance.)
- Contract breach, which is the failure to perform a contractual obligation
- Material breach of contract, which is when the nonfaulted party is discharged from any further obligations under the contract
- Time is of the essence, which, when explicitly stated in the contract, is the seller's failure to perform within the allotted time and which constitutes a material breach of contract
- Subcontract management, which is when, if the seller subcontracts to a third party, the buyer has

> **EXAM TIP**
>
> A verbal contract is not worth the paper it is written on.

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no control over the performance of the third party
- Termination, which, when early, is a special case of contract closeout

Effects of default for nonperformance by the seller are:
- The seller is not entitled to compensation for work in process not yet accepted by the buyer.
- The buyer is entitled to repayment from the seller of any advance or progress payments applicable to such work.
- The buyer may order delivery of completed or partially completed work.
- The seller must preserve and protect property the buyer has an interest in.
- The seller is liable for excess procurement costs.

Contract Change Control System

Some buyer organizations may utilize a centralized group whose specific function is to handle contract administration. This group may contain one or more contracting officers or contract administrators who are assigned to various projects. In such cases, this person is the only one with authority to change the contract. A contract change control system is a key tool or technique of the contract administration process. It defines the process by which the contract may be modified.

Since project managers are often faced with multiple or ambiguous interpretations of the contract in deciding on the scope of work involved, there is high potential for conflict between the contracting officer and the project manager.

Contract change modifications fall into 3 categories:
- **Administrative Change**: a unilateral contract change, in writing, that does not affect the substantive rights of the parties
- **Change Order:** a written order, signed by the contracting officer, directing the seller to make a change
- **Legal Change:** requires mutual agreement to modifications with supporting consideration

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CONTRACT CLOSURE PROCESS

Contract Closure is similar to **Administrative Closure**. Both involve product verification to ascertain that work was completed correctly and satisfactorily and both require administrative closure (documenting project records for future use). However, contract closure could have unique terms and conditions specified in the contract.

Outputs of the contract closure process consist of the closed contracts and updates to the organization's process assets which include:

- **Contract File:** a complete set of indexed records to be included with the final project archives when administrative closure for the phase or project is performed. The contract file includes documentation from procurement audits, lessons learned and an evaluation of the seller for future reference. The contract file also contains contract documents for documenting work and work performance.
- **Deliverable Acceptance :** deliverable acceptance includes a formal written notice to seller that the deliverables have been accepted or rejected. The terms for acceptance or nonacceptance of deliverables should have been defined in the contract.
- **Lessons Learned:** lessons learned, including process improvement recommendations, are kept for future reference in managing procurement of products or services.

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SAMPLE PMP EXAM QUESTIONS ON PROCUREMENT MANAGEMENT

Procurement — Planning Questions

1. As a project manager, you determine that you do not have a need to purchase anything for your project. With that decision, which processes will not be performed on your project?

   a) Plan contracting and communications planning
   b) Quality assurance and select sellers
   c) Request seller responses and risk identification
   d) Plan contracting, request seller responses and select sellers

2. A project manager was in the process of identifying which project scope and activities could be met by procuring products and services from prospective sellers. This project manager was in the midst of which planning process?

   a) Plan purchases and acquisitions
   b) Scope planning
   c) Resource planning
   d) Activity sequencing

3. Which of the following is not part of the plan contracting process?

   a) Evaluation criteria
   b) SOW
   c) RFP
   d) Negotiation notes

Notes:

4. _____ is the source of a type of bilateral contract used for high dollar, standard items.

   a) PO
   b) RFP
   c) IFB
   d) RFQ

Procurement — Executing Questions

5. During which step of the procurement process are the proposals received?

   a) Select sellers
   b) Request seller responses
   c) Plan contracting
   d) Plan purchases and acquisitions

6. During which step of the procurement process does contract negotiation occur?

   a) Select sellers
   b) Request seller responses
   c) Plan contracting
   d) Plan purchases and acquisitions

7. Stating that you only have 3 hours to make your flight is a good example of what type of negotiation technique?

   a) Deadline
   b) Extreme demands
   c) Delay
   d) Good guy, bad guy

Notes:

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Procurement — Monitoring and Controlling Questions

8. As the project manager of the purchasing organization, you enter into a contract with the seller, known as XYZ Co. The type of contract is CPFF. As the project progresses, the scope of the project is increased with approved change orders. The cost of the project also increases. In such a case, the fee in a CPFF contract:

   a) Is small
   b) Never changes
   c) Always decreases as the seller absorbs the increased costs
   d) Could change if change orders are issued and approved

9. Which one of the following change control statements is correct?

   a) Changes seldom provide real benefits to the project
   b) An FP contract will minimize the need for change control
   c) Contracts should include procedures to accommodate changes
   d) More detailed specifications will eliminate the most common causes of changes

10. Which of the following is not part of contract administration?

    a) Answering questions of potential sellers
    b) Evaluating risks
    c) Confirming submittals have been sent
    d) Confirming that changes to the contract are made

Notes:

Procurement — Closing Questions

11. A contract that is terminated early is a special case of:

    a) Unhappy customers
    b) Close project
    c) Contract closure
    d) Contract-related inspection

12. At contract closure, who informs the seller with formal written notice that the contract has been completed?

    a) The project manager
    b) The project sponsor
    c) The administrative assistant
    d) The person or organization responsible for contract administration

Notes:

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ANSWERS AND REFERENCES FOR SAMPLE PMP EXAM QUESTIONS ON PROCUREMENT MANAGEMENT

Section numbers refer to the PMBOK Guide.

1. **D   Planning Section 12**
   When the project does not buy products and services from outside the performing organization, the processes from plan contracting to contract closure are not performed.

2. **A   Planning Section 12.1 Plan Purchases and Acquisitions**

3. **D   Planning Section 12.2.3 Plan Contracting**
   Negotiation does not take place until the select sellers process.

4. **C   Planning Section 12.2.3.1 lan Contracting**
   It is important to know the differences in the types and uses of procurement documents: request for proposal, invitation for bid and request for quotation.

5. **B   Executing Section 12.3.3.3 Request Seller Responses**
   Keep in mind that proposals are prepared by the prospective sellers.

6. **A   Executing Section 12.4.2.4 Select Sellers**

7. **A   Executing Implied in Section 12.4.2.4 Select Sellers**

8. **D   Monitoring and Controlling Section 12.5.3 Contract Administration**
   A fee is assumed to be based on a percent of cost for approved change orders to the scope of the project. If change orders are not approved, choice B is the correct answer.

9. C   **Monitoring and Controlling Section 12.5.2.1**
       Contract Administration

10. A **Monitoring and Controlling Section 12.5**
       Contract Administration
       Choice B would be included in the performance
       reporting process within the contract
       administration process.

11. C **Closing Section 12.6 Contract Closure**

12. D **Closing Section 12.6.3.2 Contract Closure**

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CASE STUDY SUGGESTED SOLUTION

Exercise 12-1:
Purchase Plan for the Lawrence RV Garage Project

General Building Materials Vendors

These are commonly available commodities and should be solicited via an invitation for bid (IFB). We will supply the bill of material (BOM) from the architect. Selection will be based solely on price. Once selected, we will send the winner a purchase order (PO) for the materials listed in the BOM and set up a delivery schedule based on our plan.

Truss Manufacturers

Trusses are essentially custom made for each building, so we should solicit via a request for proposal (RFP). Because the proposed solutions may be significantly different, we will have to evaluate each for its impact on our budget and schedule. Once we decide, a firm fixed price (FFP) contract should be issued since we will know exactly how many trusses are needed.

Stucco Contractors

We expect the stucco subs to supply all their own materials including tarpaper, rigid foam insulation, chicken wire and the ingredients that make up the stucco. We should solicit via a request for proposal (RFP) for all work and materials. Because the prices of some of the materials used are going up rapidly, the contract should be a combination of cost reimbursable for the materials and a firm fixed price for the balance.

RESPONSIBILITY

CHAPTER 13 | **PROFESSIONAL RESPONSIBILITY**

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PROFESSIONAL RESPONSIBILITY

A major portion of professional responsibility questions on the PMP certification exam is based on ethics. Common sense, ethical values and your own experience will play a large role in your ability to answer the questions on this topic. The PMI Project Management Professional Code of Professional Conduct (available at www.pmi.org) and the PMP Role Delineation Study (available at the PMI bookstore) are source material for this part of the exam. In addition, you should have an understanding of cultural and global values necessary to manage projects in today's multinational environment.

Things to Know

1. The 6 performance domains of project management and the percentage of test questions in each domain appearing on the exam:
   - **I: Initiating the Project**   20 questions   (11.6%)
   - **II: Planning the Project**   40 questions   (22.7%)
   - **III: Executing the Project**   48 questions   (27.5%)
   - **IV: Monitoring and Controlling**
        the Project   37 questions   (21.0%)
   - **V: Closing the Project**   15 questions   (8.6%)
   - **VI: Professional Responsibility** 15 questions   (8.6%)
2. Background and findings of the **Role Delineation Study**
3. The definition of **Culture**
4. The **Changing Business Environment**
5. **Driving Forces in Global Businesses**
6. How to apply professional responsibility concepts to **Working on Multicultural Project Teams**
7. **Professional Responsibility and PMBOK Guide Knowledge Areas**

Key Definitions

Communication Context: languages generally fall on a sliding scale of high to low context. Recipients of high-context language messages need to know the situation and environment of the message in order to understand it. An example of a high-context message is poetry, in which

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rhyme, meter, allegory and similar poetic devices enhance one's experience of the poet's intent. Recipients of low-context language messages understand the message as received. An example of a low-context message is a statement of fact, such as "you have a dozen eggs."

Culture: everything that people have, think and do as members of their society and that is shared by at least one other person.

Performance Domains: 6 primary areas of project manager performance. These areas are initiating, planning, executing, monitoring and controlling, closing and professional responsibility.
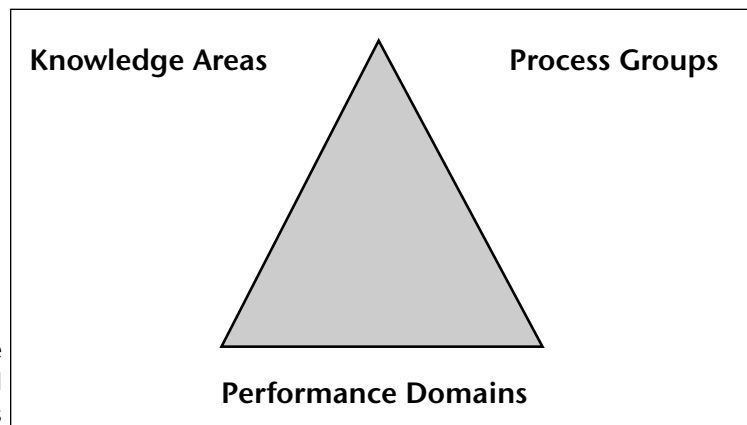
Figure 13-1
Interrelation of Knowledge Areas, Process Groups and Performance Domains

ROLE DELINEATION STUDY

Knowledge areas, process groups and performance domains are equally important in the field of project management, as depicted in Figure 13-1. In 1999, PMI assembled a group of 13 experts, together with representatives from Columbia Assessment Services (CAS), with a charter to delineate the field of project management. They analyzed how each of these 3 aspects of project management defined the job of a project manager. This role delineation or job analysis was then used to ensure that PMI's Project Management Professional (PMP) certification exam's content was valid

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and that it contributed to improving the profession by evaluating how project managers:
- Ensure individual integrity and professionalism
- Contribute by sharing lessons learned, best practices, research, etc.
- Enhance individual competence
- Balance stakeholders' interests
- Interact with team members and stakeholders in a professional and cooperative manner

The role delineation study consisted of 4 phases.
- Phase 1: Initial Development and Validation. The domains, tasks, knowledge and skills essential for project manager performance were determined.
- Phase 2: Pilot Study. Two prototype studies were conducted.
- Phase 3: Validation Study. A survey was sent out to 972 individuals working as project managers in the United States and to 365 individuals working as international project managers. A total of 826 responses was obtained, reviewed and validated.
- Phase 4: Development of Test Specifications. Based on the pilot studies and ratings received from the survey, test specifications were developed.

The role delineation study resulted in an overall analysis of how each domain impacts the success of a project and the frequency with which current practitioners use each domain, as noted in Figure 13-2 on the following page. Note in the figure that ratings were as follows:
- Importance: 1 = Not Important (performance of this task is not essential to the job performance of the project management professional), 2 = Of Little Importance, 3 = Important, 4 = Very Important and 5 = Extremely Important
- Criticality: 1 = No Harm (inability to perform tasks would have no adverse consequences), 2 = Minimal Harm, 3 = Moderate Harm, 4 = Significant Harm and 5 = Extreme Harm
- Frequency: respondents' estimates of the percent of projects in which the project manager would perform duties associated with each domain

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Domain	Importance	Criticality	Frequency
Initiating	Important (3.6)	Moderate Harm (3.2)	32.2 %
Planning	Very Important (4.6)	Significant Harm (4.3)	53.1 %
Executing	Very Important (4.2)	Significant Harm (4.15)	61.1 %
Controlling	Very Important (4.4)	Significant Harm (4.24)	56.1 %
Closing	Important (3.3)	Minimal Harm (2.7)	35.2 %
Prof. Resp.	Important (3.8)	Moderate Harm (3.5)	50.0 %

Figure 13-2
Performance Domain
Importance, Criticality
and Frequency Chart
(from the PMP Role
Delineation Study, 2000)

CULTURE

Culture is an important concept in the professional responsibility domain. In today's society where the global economy is influencing more and more organizations, it is important for the project manager to understand how culture can impact the project and what can be done to ensure success in a multicultural project environment.

Culture is everything that people have, think and do as members of their society and is shared by at least one other person. It is important to understand that culture is learned and it is not bred into a particular ethnicity. Culture is a cluster of related values that individuals have in common and believe in. Can people's beliefs be influenced? Of course they can. What an individual believes in his or her childhood is influenced by experiences and encounters throughout his or her life, which will shape his or her value system.

Culture is very complex yet dynamically stable. By this we mean that culture evolves over time. Cultural changes do not happen overnight; they are adaptations to human learning, environmental conditions and the interactions between them.

Cultures are integrated wholes; they are coherent and logical systems, the parts of which to a degree are interrelated. Cultures are integrated from the perspective

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that a particular value may be related to other values within the culture; cultures are not random assortments of values.

Cultural differences require different management approaches by the project manager. Knowing what values each project participant has will greatly improve the overall effectiveness of the project manager. Cultural differences should also be considered a value-add to the project. Diversity provides an opportunity for new solutions to old problems. Do not shy away from a culturally diverse project. You may learn a lot!

EXAM TIP

All cultures experience continual cultural change.

THE CHANGING BUSINESS ENVIRONMENT

The business environment of today is changing particularly quickly. Whereas many businesses used to remain primarily in their countries of origin today:

- 36 of the top 50 industrial companies are headquartered OUTSIDE the United States.
- 38 of the top 50 service companies are headquartered OUTSIDE the United States.
- Only 161 of the Global 500 industrial and 135 of the Global 500 service companies are based in the United States.

DRIVING FORCES IN GLOBAL BUSINESSES

The basic assumptions driving business changed during the 1990s. Before, we heard things like continuity, planning, diversification, scale, security, uninformed customers and national borders as driving business factors. Now we hear about change, coping with the unexpected, focus, segmentation, flexibility, responsiveness, speed, demanding customers and freedom of movement as the most prevalent factors driving business.

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WORKING ON MULTICULTURAL PROJECT TEAMS

All cultures of the world face a number of common problems and share a number of common features. Project managers must understand the:

- Economic systems and how they meet the basic physiological human needs of their people
- Family systems that develop over time
- Educational systems that determine how children are taught the way of life of the society
- Social control systems and how social order is preserved
- Supernatural belief systems that explain the unexplainable

In addition, a project manager must consider the variations in thinking styles between countries.

- Inductive thinking is based on analysis.
- Deductive thinking is based on logically deriving principles from theoretical constructs rather than raw data.

Cultural differences set the stage for conflict and misunderstanding. As a project manager, the ability to identify these barriers and overcome them is critical in a successful project execution. Some such barriers are:

- Ethnocentrism, or the belief that our own beliefs are inherently superior
- Incorrectly attributing a cause when witnessing a behavior that is different from one's own
- Stereotypes and other negative preconceived ideas
- Misunderstanding the meanings associated with particular gestures, facial expressions and body positions
- Misunderstanding the appropriate time and place for talking business
- Inappropriately having conversations on topics such as politics, sex, religion and age
- Not recognizing status and power differences
- Not knowing the communication styles of the culture
- Inability to understand native languages

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To overcome these barriers, a project manager should:
- Pay attention to feedback
- Actively communicate
- Be aware of conflict escalation and not let misunderstandings or ignorance get out of control
- Apply damage control before things get out of hand
- Maximize his or her influence to facilitate the flow of communications

PROFESSIONAL RESPONSIBILITY AND PMBOK GUIDE KNOWLEDGE AREAS

The professional responsibility domain touches both knowledge areas and process groups detailed within the PMBOK Guide. The next few pages address each of these knowledge areas and how professional responsibility may be applied to each one.

Integration Knowledge Area

The development of and execution of the project plan is directly impacted by the diverse nature of the project team. Often it is only the project manager who has the responsibility to maintain a vision of the whole project and its outcome, while project participants work on small project work packages and sponsors deal with larger, enterprise perspectives.

Scope Knowledge Area

Defining the scope of the project requires that the project manager and sponsor look historically and use expert judgment to detail the work for the project accurately. Understanding where the project is or potentially will be performed is critical in defining the scope of the project. The project manager's responsibility is to ensure that only what is agreed to by the sponsors is produced and that no one promises more than he or she can deliver.

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13 - 7

Time Knowledge Area

Understanding the various countries involved and their orientation toward time is important in accurately estimating effort and duration. Professional responsibility extends to ensuring common understanding of the precision and accuracy of time objectives and performance among potentially different cultural expectations.

Cost Knowledge Area

In evaluating costs, the project manager must address and review the different political and business issues facing organizational costs such as taxes, resource availability and salaries. In enterprise reporting, a project manager has an obligation to differentiate how costs are reported in a project management system, paying particular attention to the interface with the accrual expectations underpinning commonly accepted financial accounting practices.

Quality Knowledge Area

Different cultures may approach quality in much different ways. It is important to define clearly the expected quality level. Professional responsibility involves working with and identifying variances in such a way that individuals are not discouraged from reporting because of a fear of being individually blamed.

Human Resources Knowledge Area

Globalization adds new challenges to human resource management. Some of theses challenges are:
*   Identifying and retaining highly qualified people
*   Improving the quality and quantity of management
*   Sustaining and improving performance at all levels
*   Increasing the talent within the organization
*   Providing competitive and technically competent management
*   Emphasizing total quality management

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13 - 8

- Establishing training as part of the management culture
- Ensuring top management's commitment to global human resources initiatives
- Making human resources management part of the strategic business objectives

Project managers are responsible for anticipating potential conflicts in cultural and business practices and for gaining acceptance of the project's norms.

Risk Knowledge Area

Understanding cultural differences is critical in effectively assessing and managing risk in an organization. It is essential to gain the sponsor's informed consent for the relative importance of risk events and the actions to be taken to avoid, transfer, mitigate or accept them.

Communications Knowledge Area

Communicating across cultures has many challenges for organizations as well as team members.
- High-context language messages require the reader or listener to know the situation — the context — that the message is discussing. Low-context language messages do not require this knowledge; they contain all the information needed to understand them in the message itself.
- Low-context communication is the more explicit and straightforward communication pattern.

Figure 13-3 shows how some languages fall on a scale of low- to high-context languages.

Swiss German	English	Italian	Arabic	Japanese
Low Context				High Context

Figure 13-3
Low to High
Context Languages

Factors complicating effective communication across cultures include:

- Slang
- Euphemisms
- Proverbs, or wise sayings
- Humor
- Nonverbal communication
- Personal space
- Personal contact
- Individualism vs. group cohesion

In addition, the project manager has a responsibility to ensure that no illegal, offensive, inaccurate or incomplete communication is conducted.

Procurement Knowledge Area

Negotiating across cultures requires strategies to deal effectively with unique issues. When thinking cross-culturally, the project manager should:
- Concentrate on long-term relationships
- Determine what each part has at stake
- Know that timing can make a difference
- Try to make the experience a win-win; be flexible
- Do his or her homework and prepare
- Learn to listen

In such a diverse environment, the project manager's responsibility and exposure to liability is significant. He or she must ensure legal, ethical and fair financial dealings.

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SAMPLE PMP EXAM QUESTIONS ON PROFESSIONAL RESPONSIBILITY

1. Cultures are thought of as:

   a) Illogical ethnic practices
   b) Integrated wholes
   c) Unrelated hobbies and customs
   d) A set of related belief practices

2. Effective verbal communication is expected to be:

   a) Always high context
   b) Implicit and direct
   c) Direct, low context and explicit
   d) Explicit, direct and unambiguous

3. As part of your project, you hold a focus group to determine the perceived benefits of the product of your project. You wish to publish these results to your customer, so you post the results and the participants on your team's website. Before doing this, you should do all of the following except:

   a) Make sure there are appropriate firewalls to protect the participants of the focus group
   b) Make sure all participants of the focus group have signed an authorization to post the results
   c) If any participants decline posting the information, remove any reference of the participant
   d) If only one participant declines posting the information, post the results as is

Notes:

13

4. Performance domains include:

   a) PDCA cycles, control charts and histograms
   b) Communications, schedule development, risk management and performance improvements
   c) Initiating, planning, scheduling, tracking, implementing, closing and professional responsibility
   d) Planning, executing, controlling and professional responsibility

5. Professional responsibility is a domain that covers aspects such as:

   a) Knowledge, skills, tools and techniques
   b) Planning, organizing, staffing, executing and controlling ongoing operations
   c) Legal, ethical and professional behavior
   d) Impacts of bad weather, global business and professional behavior

6. Performance domains together with their _____, _____ and _____ statements define the project management profession.

   a) Tasks, knowledge, skill
   b) Schedules, costs, scope
   c) Performance reports, control charts, skill
   d) Organization charts, domain impact, project plan

Notes:

7. All of the following tasks are tasks in the performance domain of professional responsibility except:

   a) Measure project performance continually by comparing results to the baseline
   b) Enhance individual competence by increasing and applying professional knowledge to improve services
   c) Balance stakeholders' interests by recommending approaches that strive for fair resolution in order to satisfy competing needs and objectives
   d) Interact with a team in a professional manner by respecting personal, ethnic and cultural differences

8. The task, "Ensure individual integrity and professionalism by adhering to legal requirements and ethical standards in order to protect the community and all stakeholders," requires knowledge of all of the following except:

   a) Legal requirements
   b) Ethical standards
   c) Community and stakeholder values
   d) Staff age

9. Skills needed in interacting with the team and stakeholders in a professional and cooperative manner are:

   a) Planning projects, communicating effectively and negotiating
   b) Exercising self-control, communicating effectively and embracing diversity
   c) Gathering, assessing and integrating project information
   d) Sporting ability, compromising and exhibiting empathy

Notes:

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10. Of the 6 performance domains, which are considered to be important?

    a) None of them; only process groups and knowledge areas are important
    b) All of them
    c) Planning, executing and controlling are important; the other 3 are of little importance
    d) Professional responsibility is the most important; the other 5 domains are handled by the process groups

11. Managing risks, building and motivating teams, budgeting and estimating are skills used in the _____ performance domain.

    a) Scoping the project
    b) Initiating the project
    c) Planning the project
    d) Executing the project

12. When submitting your application for the PMP exam, you should do all of the following except:

    a) Document all experiences truthfully
    b) Ask a friend to be your reference as a supervisor since you are not sure where your previous supervisor works
    c) Keep records of all project management training attended
    d) Do your best to obtain appropriate contacts who can verify your background

13. Team motivation, gathering, assessing and presenting information are skills used in the _____ performance domain.

    a) Scoping the project
    b) Initiating the project
    c) Planning the project
    d) Executing the project

Notes:

13 - 14

14. Auditing, gathering and assessing information and exercising judgment are skills used in the _____ performance domain.

   a) Closing the project
   b) Controlling the project
   c) Planning the project
   d) Executing the project

15. You have just been invited to present your product to a Japanese company's senior executives in Japan for 2 days. On initial meeting, the first thing you should do is:

   a) Introduce yourself and discuss the agenda for the meetings
   b) Hug each participant in the meeting
   c) Be passive in your presentation
   d) Spend time with participants and get to know them personally

Notes:

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ANSWERS AND REFERENCES FOR SAMPLE PMP EXAM QUESTIONS ON PROFESSIONAL RESPONSIBILITY
Section numbers refer to the PMBOK Guide.

1. **B** **Ferraro**
   Cultures are coherent and logical systems, the parts of which to a degree are interrelated.

2. **D** **Trompenaars and Hampden-Turner**
   Speech patterns in some cultures are considerably more ambiguous, inexact and implicit than in others. Restricted codes use shortened words, phrases and sentences and rely heavily on hidden, implicit, contextual cues. However, the project manager should always be as explicit, direct and unambiguous as possible given the cultural conditions.

3. **D** **Code of Conduct — Responsibilities to Customers and the Public — B.3**

4. **D** **Role Delineation Study, page 6**

5. **C** **Role Delineation Study, page 7**

6. **A** **Role Delineation Study, page 6**

7. **A** **Role Delineation Study, page 60**

8. **D** **Role Delineation Study, page 59**

9. **B** **Role Delineation Study, page 60**

10. **B** **Role Delineation Study, page 20**

11. **C** **Role Delineation Study, page 44**

12. **B** **Code of Conduct — Responsibilities to the Profession — A.1**

13. D Role Delineation Study, pages 48 to 49

14. B Role Delineation Study, page 52

15. D Brake, Walker and Walker page 97
In a Japanese cultural context, project managers would do best to focus on personal contact and relationship building before getting down to business.

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CHAPTER 14 | **FINAL EXAM**

SAMPLE FINAL EXAM

If you take this sample final exam, you should spend 80 minutes answering these 60 sample questions. This timing is similar to the average time per question used by PMI in the actual PMP exam. A passing score is 70% or 42 correct answers.

1. Once initiated, a project should be halted if:

   a) The project manager leaves
   b) The statement of work by the buyer is incomplete or ambiguous
   c) The project is found to be supportive of the organization's strategic goals
   d) The business need no longer exists

2. _____ coordinate(s) people and other resources to carry out the plan.

   a) Resource planning
   b) Resource leveling
   c) Controlling processes
   d) Executing processes

3. Configuration management is NOT:

   a) The cause of variances and the reasoning behind the corrective action taken
   b) Any documented procedure used to identify the functional characteristics of an item
   c) A documented procedure used to record and report change
   d) A subset of the overall project management system

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14 - 1

4. As a project is carried out and slack time is consumed on individual tasks, the slack left over for the remaining tasks is:

   a) Insignificant
   b) Reduced
   c) Unchanged
   d) Increased

5. Communication is enhanced from the sender to the receiver when the sender_____.

   a) Shows concern for the perspective of the receiver
   b) Speaks up to the receiver
   c) Uses more physical movements
   d) Speaks slowly to the receiver

6. Culture is:

   a) Taught
   b) Learned
   c) Hereditary
   d) Genetic

7. Project risk includes:

   a) Threats to the project's objectives and opportunities to improve on those objectives
   b) Threats to the project's objectives and contingency plans to manage those risks
   c) Known risks that can be quantified
   d) All known risks to the project's objectives

8. All of the following are information gathering techniques except:

   a) Interviewing
   b) Sampling
   c) The Delphi Technique
   d) SWOT analysis

Notes:

9. An input to human resource planning includes:

   a) PDCA cycles
   b) Individuals or groups who are external to the project
   c) Performance improvements
   d) Collective bargaining agreements
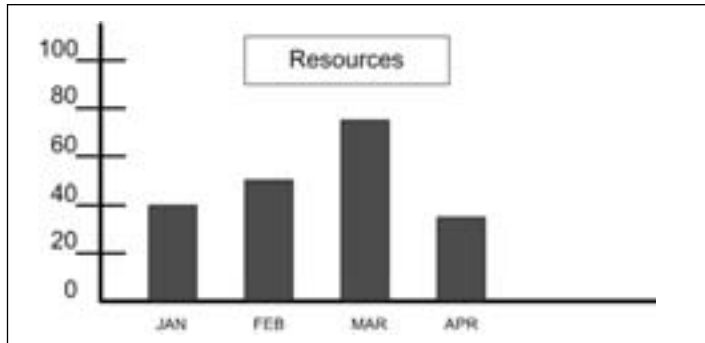
10. The above chart is an example of a (an):

    a) Resource histogram
    b) Work assignment chart
    c) RAM
    d) Organization chart

11. In crashing a task, you would focus on:

    a) As many tasks as possible
    b) Noncritical tasks
    c) Accelerating performance of tasks on critical path
    d) Accelerating performance by minimizing cost

Notes:

14 - 3

12. The major competencies needed for leadership in the 21st century are:

    a) Global mindset, personal stability, professional confidence and successful leadership
    b) Corporate mindset, personal stability, professional education and general leadership skills
    c) Global mindset, advanced education degree, leadership experience and technical skills
    d) Global experience, professional confidence, advanced education degree and leadership knowledge

13. Successful projects are defined by all of the following except:

    a) Meeting stakeholders' needs, wants and expectations
    b) Meeting project objectives
    c) Producing a quality product
    d) Managing teams effectively

14. Which of the following are outputs of the scope verification process?

    a) Work results
    b) Formal acceptance of deliverables
    c) Inspection results
    d) WBS

15. Generalizations become destructive when they:

    a) Degenerate into stereotypes
    b) Are untrue
    c) Are true
    d) Are believed by people

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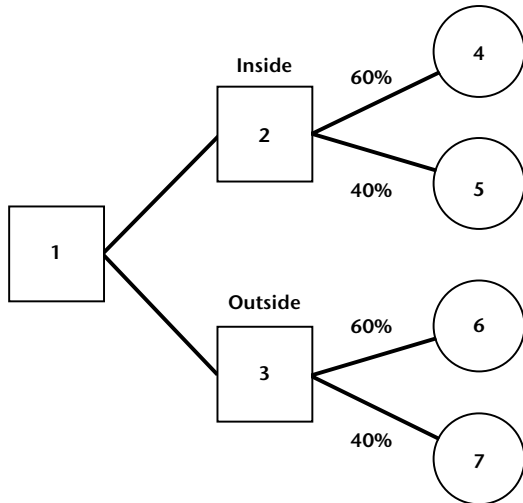
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14 - 4

Notes:

Inside
60% 4
2
40% 5

1

Outside
60% 6
3
40% 7

A party is to be held.
- If the party is held inside, 100 people can attend at $10 each.
- If the party is outside, 200 people can attend at $10 each.
- There is a 40% chance of rain on the date of the party.
- If it rains and the party is held inside, only 80 people will attend.
- If it rains and the party is held outside, only 100 people will attend.

16. In the example above, if the goal of the project is to maximize revenue, which of the 2 options maximizes revenue and why:

a) Held inside because expected monetary value is $1,800
b) Held inside because expected monetary value is $920
c) Held outside because the expected monetary value is $3,000
d) Held outside because the expected monetary value is $1,600

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17. A contract is legally binding once signed unless:

    a) It is declared null and void by one party
    b) It is in violation of applicable law
    c) One party is unable to finance its part of the work
    d) One party is unwilling to perform the work

18. What is the probability of completing the project within +/- 2 standard deviations of the mean?

    a) 96.3%
    b) 68%
    c) 99.9%
    d) 95.45%

19. A modification of a logical relationship that allows an acceleration of the successor task is called:

    a) Free float
    b) Early start time
    c) Lead time or negative lag time
    d) Lag time

20. A network diagram that uses nodes to represent activities, arrows to show the activity dependencies and where no loops are allowed is a (an):

    a) Critical chain method
    b) ADM
    c) AOA
    d) AON

21. During the negotiation process, once an agreement is reached, you should do all of the following except:

    a) Stay positive and respectful
    b) Define the agreement as specifically as possible
    c) Continue negotiating
    d) Express your desire for a long and prosperous relationship

Notes:

14

22. Which of the following project scope management processes involves subdividing the major project deliverables into smaller, more manageable components?

    a) Create WBS
    b) Scope definition
    c) Scope verification
    d) Decomposition

23. Which of the following statements concerning plan contracting is correct?

    a) Well-designed procurement documents can facilitate accurate and complete responses from prospective sellers
    b) Procurement documents must be rigorous with no flexibility to allow consideration of sellers' suggestions
    c) Procurement documents should be standardized
    d) Creation of procurement documents is performed in the plan purchases and acquisitions process

24. The primary objective of incentive clauses in a contract is to:

    a) Reduce risk for the seller by shifting risk to the buyer
    b) Help bring the seller's objectives in line with those of the buyer
    c) Help the seller control costs
    d) Reduce costs for the buyer

25. The bidders' conference is a part of which process?

    a) Plan contracting
    b) Request seller responses
    c) Contract administration
    d) Select sellers

Notes:

14

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26. Outputs from the communications planning process include:

    a) Project records
    b) Communications management plan
    c) Performance reports
    d) Formal acceptances

27. The 4 layers of culture include:

    a) World, national, business and leadership
    b) Political, geographic, social and religious
    c) Technology, economics, history and knowledge
    d) Networks, tools, personal and change

28. A project has a 60% chance of finishing on time and a 30% chance of finishing over budget. What is the probability that the project will finish on time and within budget?

    a) 12%
    b) 18%
    c) 42%
    d) 48%

29. The critical path in a schedule network is the path that:

    a) Takes the longest time to complete
    b) Must be done before any other tasks
    c) Allows some flexibility in scheduling a start time
    d) Is not affected by schedule slippage

Notes:

Excavation Budget (in person days)

Task	Planned Value	Actual Cost	Earned Value
Survey	500	2,000	400
Remove Debris	2,000	3,500	2,000
Dig Hole	3,000	2,000	2,800
Emplace Forms	1,200	1,000	1,100
Pour Concrete	5,000	3,000	2,500

30. In the above table, which task has been completed?

    a) Survey
    b) Remove debris
    c) Dig hole
    d) Emplace forms

31. All of the following are techniques that can be used to measure the total income of a project compared to the total money expended at any period of time except:

    a) IRR
    b) NPV
    c) DCF
    d) EVT

32. An example of a contingency response is:

    a) Provide allowances to account for price changes that can occur over the life of the project due to inflation
    b) Provide incentive fees paid to managers for good performance
    c) Allocate funds to offset poor cost or schedule estimates
    d) Hire contract labor if it is determined that our current team is not sufficient to support the work defined

Notes:

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33. Which of the following describes a role of the project manager during the contract negotiation process?

    a) He or she should try to be involved
    b) He or she is not involved
    c) He or she supplies an understanding of the requirements of the project
    d) He or she tells the contracts manager how the contracting process should be handled

34. Risk _____ will help guide risk _____.

    a) Score, responses
    b) Rank, updates
    c) Plan, reporting
    d) Plan, identification

35. A performance domain:

    a) Describes the processes required to ensure that the various elements of the project are properly coordinated
    b) Is a category of a project that has common elements significant in a given project but is not needed or present in all projects
    c) Is a broad category of performance
    d) Is important for competent performance by the project team

36. Forcing as a means of managing conflict is one in which:

    a) The person retreats from the conflict situation
    b) A viewpoint is exerted at the potential expense of the other party
    c) Both parties give up something to get to an acceptable form of resolution
    d) The disagreement is directly addressed

Notes:

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37. In which type of organization is project team building generally most difficult?

    a) Functional
    b) Matrix
    c) Projectized
    d) Project expediter

38. A contractor completes work as clearly specified within the SOW but the buyer is not pleased with the results. In this case, the contract is considered to be:

    a) Complete because the contractor met the terms and conditions of the contract
    b) Incomplete because formal acceptance has not been provided by the buyer
    c) Incomplete because the specs are incorrect
    d) Complete because the contractor is satisfied and work results follow the SOW

39. Extensive use of _____ communication is likely to assist in solving complex problems.

    a) A project management information system (PMIS)
    b) Written
    c) Formal
    d) Verbal

40. What is the sender responsible for?

    a) Confirming that the message is understood
    b) Ensuring the receiver agrees with the message
    c) Scheduling communications exchange
    d) Presenting the message in the most agreeable manner

Notes:
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41. Interviewing, meeting facilitation and effective communication are skills most often needed in the _____ performance domain.

    a) Initiating the project
    b) Planning the project
    c) Closing the project
    d) Professional responsibility

42. Legitimate power is:

    a) Derived from a person's formal position in the organization
    b) Bestowed due to a person's personal qualities and abilities
    c) Based on a person's charisma
    d) Acquired based on technical knowledge, skill or expertise on some topic or issue

43. A tool or technique for risk monitoring and control is:

    a) Additional risk identification
    b) Additional risk planning
    c) Corrective action
    d) Risk reassessment

44. A procurement audit is:

    a) A complete set of indexed records to be included in the final project files
    b) A structured review of the compliance with organizational policies and procedures
    c) A structured review of the procurement process from plan purchases and acquisitions through contract administration
    d) A process to assess the magnitude of any variations that occur

Notes:

Task	PV	AC	EV	SPI	CPI
1	95	100	95	1.00	0.95
2	150	130	110	0.73	0.84
3	130	130	130	1.00	1.00
4	80	80	90	1.10	1.10

Notes:

45. In the chart above, which task is ahead of schedule and under cost?

   a) Task 1
   b) Task 2
   c) Task 3
   d) Task 4

46. All of the following statements are generally true about scope control except:

   a) Scope control is concerned with influencing the factors that create scope changes to ensure the changes are beneficial
   b) Part of scope control is determining that a scope change has occurred
   c) Scope control must be integrated with other control processes
   d) Scope control describes how project scope will be managed

47. All of the following are common characteristics of project life cycle descriptions except:

   a) Cost and staffing levels are low at the start, higher towards the end and drop rapidly as the project ends
   b) Risk and uncertainty are highest at the end of the project
   c) The probability of successfully completing the project is low at the start and gets progressively higher as the project continues
   d) The ability of stakeholders to influence the final characteristics of the project product is highest at the start of the project

14

14 - 13

48. The Delphi Technique is:

    a) A numbering system to identify each element of the WBS uniquely
    b) A forecasting technique that relies on gathering expert opinions
    c) An analytical technique similar to the design of experiments
    d) A variation of Monte Carlo analysis

49. A project manager incorporates a Pareto diagram because it helps to _____.

    a) Determine if a process is out of control
    b) Focus on stimulating thinking
    c) Explore a desired future outcome
    d) Focus on the most critical issues to improve quality

50. Close project is a process within which knowledge area?

    a) Cost
    b) Communications
    c) Procurement
    d) Integration

51. An example of cost of conformance to quality is:

    a) Quality training
    b) Scrap
    c) Warranty costs
    d) Rework

52. In a just in time (JIT) environment, what is the inventory on hand?

    a) 45%
    b) 10%
    c) 12%
    d) 0%

Notes:

14

Case	PV	AC	EV
1	10,000	10,000	10,000
2	10,000	8,000	10,000
3	10,000	8,000	8,000
4	9,000	12,000	10,000
5	10,000	12,000	12,000
6	10,000	10,000	12,000
7	12,000	12,000	10,000
8	10,000	8,000	9,000
9	12,000	10,000	11,000

53. Based on the chart above, what is the CPI of Case 9?

   a) 1.10
   b) 1.91
   c) 0.83
   d) 1.20

54. Based on the chart above, what is the SV for Case 8?

   a) 1,000
   b) 2,000
   c) -1,000
   d) -2,000

55. The normal risk of doing business that involves the chance of both a profit and a loss is called:

   a) Business risk
   b) Pure risk
   c) Chance
   d) Opportunities risk

56. Which of the following is considered a method of accelerated depreciation:

   a) Sum of the years digits
   b) Straight line
   c) Double declining balance
   d) a and c

Notes:

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57. The procurement management plan describes how the procurement processes will be managed. It includes all of the following except:

    a) Constraints
    b) Metrics for evaluating sellers
    c) Types of contracts to be used
    d) Terms and conditions

58. As the project manager, you are scheduling some activities in which there is a delay between the finish of the activity and the start of the successor activity. These dependencies would be reflected in the schedule with a _____.

    a) Finish-to-start relationship
    b) Lag
    c) Start-to-finish relationship
    d) Lead

59. After the 5th month on her project, a project manager found that the cumulative actual expenditures totaled $120,000. The planned expenditures for this length of time were $100,000. How is the project doing?

    a) It is ahead of schedule
    b) It is in trouble because of a cost overrun
    c) It will finish within the original budget
    d) The information is insufficient to make an assessment

Notes:

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60. A project manager practices cost control for his projects by calculating an EAC. Calculating the EAC by adding the remaining project budget (modified by a performance factor) to the actual cost to date is used most often when the:

a) Current variances are viewed as atypical ones
b) Original estimating assumptions are no longer reliable because conditions are changing
c) Current variances are viewed as typical of future variances
d) Original estimating assumptions are considered to be fundamentally flawed

SAMPLE FINAL EXAM ANSWERS with explanations and references can be found in Chapter 15, Appendix B.

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CHAPTER 15 | **APPENDICES**

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APPENDIX A

**SAMPLE ASSESSMENT EXAM ANSWERS
AND REFERENCES**
Section numbers refer to the PMBOK Guide.

1. **D Section 4.3 Integration Management**
   Know the purpose and contents of the project
   management plan.

2. **A Section 4.1 Integration Management**
   A project should not be initiated for personal
   gain. Projects are formally initiated after some
   sort of needs assessment or feasibility analysis
   has been completed.

3. **A Section 6.5.2 Time Management**
   The forward pass yields early start and early finish
   dates and the backward pass yields late start and
   late finish dates. Float or slack is calculated from
   late finish minus early finish. The path with zero
   float is the critical path.

4. **C Section 1.1 Introduction**
   In general, project management is supposed to
   increase the quality of the products of projects,
   so costs for rework and warranties should be
   reduced.

5. **B Section 4.5 Integration Management**
   The monitoring and controlling project work
   process is concerned with comparing actual project
   performance against the project management plan.

6. **D Section 7.3 Cost Management**
   Earned value technique using planned value,
   actual cost and earned value can be used to
   calculate cost variance, schedule variance, cost
   performance index and schedule performance
   index. Variance analysis and trend analysis are
   techniques used in performance reporting.

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7. A **Section 1.6 Introduction**
   Subprojects are typically referred to as projects and managed as such. They can utilize a less-experienced project manager.

8. A **Section 2.3.3 Implied in Project Life Cycle and Organization**
   Unlike functional organizations in which each employee has a clear supervisor, employees in matrix organizations have 2 bosses. This is often a source of conflict.

9. C **Section 1.5 ntroduction**
   Negotiating, motivating and being familiar with health and safety are interpersonal or general management skills.

10. A **Section 6.5.2 Time Management**
    The critical path consists of activities with zero float that cannot be delayed without impacting the project schedule.

11. D **Section 12.5 Procurement Management**
    Initial tasks performed by the project manager pertain to putting together the project management plan. Contract administration is an executing process under procurement management and will only be performed on projects in which items are being procured.

12. A **Section 2.1.1 Project Life Cycle and Organization**
    Know the common characteristics of project life cycles, especially as depicted in Figures 2-1 and 2-2 of the PMBOK Guide. Cost of changes and error correction generally increase as the project continues.

13. B **Section 11 Risk Management**
    Although risk management is the process of identifying, analyzing and responding to project risk, it includes minimizing the probability and consequences of adverse events to project

objectives and increasing the probability and impact of positive events.

14. B   Section 1.3 Introduction
PMI often emphasizes the overall importance of quality management in projects. The triple constraints of schedule, cost and scope (sometimes referred to as quality of performance) are all equally important. Common practice often sets 1 of the triple constraints as primary, allowing a relaxation of the other 2.

15. D   Section 11 Risk Management
The inherently temporary nature of projects invites uncertain events or conditions to occur; if these events do occur, they could have a positive or negative effect on the project objectives.

16. B   Section 4.3.2 Integration Management
The project manager needs to coordinate change requests across the knowledge areas; e.g., a scope change request can impact project cost, risk, quality and staffing requirements.

17. B   Section 1.2 Introduction
A project has a definite beginning and a definite end to create a unique product or service.

18. C   Section — Professional Responsibility
The best choice is to give the customer some value for the money already spent and close out the project.

19. B   Section 4.1 Integration Management
Although choices A, C and D can be considered correct, they are only a subset of the project. A project should be initiated to address a specific need of the organization.

20. C Section 3.2.1.2 Project Management Processes for a Project
See Figure 3-7 of the PMBOK Guide. Acceptance criteria are part of the scope statement. The WBS feeds activity definition, communications planning and cost budgeting, which all feed schedule development

21. A Section 2.3.3 Project Life Cycle and Organization
A project-based organization derives its revenue from performing projects. Once the project is complete, there may not be another project to move to.

22. A Section 12.1.2.3 Procurement Management
Although the PMBOK guide does not go into the burdens of risk, it is important to know that the seller bears the heaviest burden of risk in fixed price contracts and the buyer bears the heaviest burden of risk in cost reimbursable contracts.

23. C Section 5.3.3 Scope Management
Project objectives should already have been defined as part of the scope statement, an output of the scope planning process. Scope planning precedes scope definition, where the WBS is created.

24. C Section 9 Human Resources Management
Both parties give up something; therefore, it is a compromise.

25. D Section 9.1 Human Resources Management
The project manager's responsibilities include obtaining project-specific training for the development of team members.

26. B Section 1.3 Introduction
Strong project management can assist an organization in profitability, competitive advantage, etc., but its main purpose is to meet project requirements.

27. D   Section 4.1 Integration Management
The project management process does not assume that projects are fiscally sound. Projects are initiated to support organizational strategies.

28. D   Section 7.1.1 Cost Management
Parametric modeling is a tool or technique used in calculating cost estimates.

29. C   Section 5.2.3 Scope Management
Objectives should be SMART (specific, measurable, attainable or assignable, realistic and time based).

30. B   Section 4.7 Integration Management
An important output of the close project process is the confirmation that the project's product has met customer requirements and there is formal acceptance by the customer.

31. B   Section 10 Communications Management
Communication skills are an important part of general management as well as project management. Effective communication only occurs if the receiver has decoded and understands the message.

32. A   Section 6.5.2 Time Management
Critical path method requires calculating slack or float to determine the path with least scheduling flexibility.

33. A   Section 5.3.2 Scope Management

34. B   Section 11 Risk Management
Not all projects are capital projects or require procurement processes to be executed.

35. B   Section 6.5.2 Time Management
Precedence diagramming method is an example of a schedule networking technique.

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36. A   Section 6.5.2 Time Management
Resource leveling smoothes out resource requirements from period to period, often resulting in an extension of the schedule.

37. C   Section 6.5.2 Time Management
Since the critical path is the longest amount of time to complete a project, only the tasks on the critical path should be crashed in order to shorten the project schedule. Crashing usually results in higher cost.

38. D   Time is a resource that cannot be inventoried or renewed in any circumstance, not just on projects.

39. A   Section 5.5 Scope Management
The project manager must first determine if the requested changes impact the business need the project was undertaken to address. If the project justification, product, deliverables or objectives are impacted, the request is valid and the project sponsor must be notified.

40. C   Verma, *Human Resource Skills,* page 28
Project management reports should identify problems and propose solutions, not just catch people's attention.

APPENDIX B

SAMPLE FINAL EXAM ANSWERS AND REFERENCES
Section numbers refer to the PMBOK Guide.

1. **D   Section 4.1 Integration Management**

2. **D   Section 3.2 Project Management Processes for a Project**

3. **A   Section 4.3.2 Integration Management**
    Choice A is lessons learned. Pay special attention to negatives.

4. **B**   As slack is consumed, there is less slack available for the remaining noncritical tasks.

5. **A   Section 10 Communications Management**

6. **B   Professional Responsibility**
    Culture is transmitted through the process of learning and interacting with one's environment, rather than being something inherent.

7. **A   Section 11 Risk Management**

8. **B   Section 11.2.2.2 Risk Management**
    Consensus building using a panel of experts is part of the Delphi Technique.

9. **D   Section 9.1.1 Human Resource Management**
    Choice A is the underlying concept for the interactions among the project management processes. Choice B may be defined within the RAM as team members or stakeholders. Choice C is an output of the develop project team process.

10. **A   Section 9.1.3 Human Resource Management**

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11. C Section 6.5.2 Time Management
Only by accelerating the performance of the critical path tasks can project duration be shortened. Accelerating performance of noncritical tasks does not affect project duration.

12. A Professional Responsibility, see Ferraro, page 172

13. D Section 3 Project Management Processes for a Project

14. B Section 5.4 Scope Management
The primary focus of the scope verification process is acceptance of completed deliverables.

15. A Professional Responsibility, see Brake, Walker and Walker, page 45

16. D Section 11.4 Risk Management
Held outside because the expected monetary value if the party is held outside is $1,600 which is greater than $920 if it is held inside. Of course, you can only choose whether to hold the party inside or outside; you cannot choose whether it rains or not.

```
                                        No rain
                                          60%      ( 4 )    $1,000

                          ┌─────┐                 600
              $920        │  2  │
              Inside      └─────┘                 +320
                                        Rain
                                         40%       ( 5 )    $800
          ┌─────┐
          │  1  │
          └─────┘
                                        No rain
                                          60%      ( 6 )    $2,000

                          ┌─────┐                1,200
              $1,600      │  3  │
              Outside     └─────┘                 +400
                                        Rain
                                         40%       ( 7 )    $1,000
```
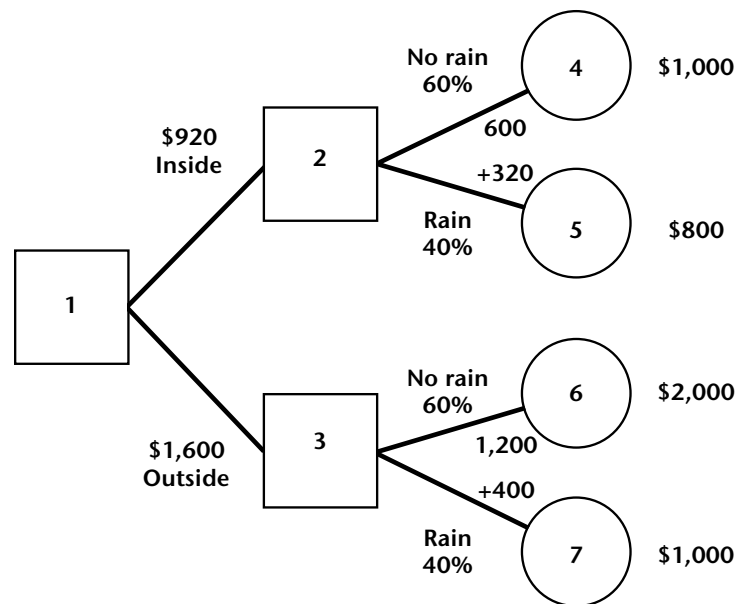
17. B   Section 12.5 Procurement Management
Both the buyer and seller must understand the
legal implications of action taken when
administering the contract.

18. D   Time Management, see Lewis, page 181
Memorize the percentages for 1, 2 and 3 standard
deviations from the mean and know what the
bell-shaped curve looks like.

19. C   Section 6.2.2 Time Management
See lead and lag definitions in the glossary.

20. D   Section 6.2.2 Time Management
Choice A is a schedule development tool and
technique which uses arrows to represent the
activities; ADM and AOA are the same.

21. C   Section 12.4.2.4 Procurement Management
You should stop negotiating when an agreement
has been reached. Over negotiating may lead to
agreement failure.

22. A   Section 5.3 Scope Management
Decomposition is a tool and technique of the
create WBS process

23. A   Section 12.2.3 Procurement Management
The objective of procurement documents is to
seek proposals from prospective sellers.

24. B   Section 12.1.2 Procurement Management
The different types of contracts bear various risks
to the buyer and the seller. An incentive clause
helps share the risk.

25. B   Section 12.3.2.1 Procurement Management

26. B   Section 10.1.3 Communications Management

**27. A   Professional Responsibility, see Brake, Walker
and Walker**
The other answers are all subsets of these 4.

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28. C Section 11.4.2 Risk Management
60%X70% = 42% probability to finish on time and within budget.

29. A Section 6.5 Time Management
The critical path is defined as the path that takes the longest to complete or the path with no slack or float. It has no room for schedule flexibility because any slippage along the critical path will cause project delay.

30. B Section 7.3 Cost Management
For "remove debris," schedule variance = earned value - planned value = 2,000 – 2,000 = 0. Zero schedule variance means that a task is complete.

31. D see Kerzner, page 554
Earned value technique (EVT) does not include any income data.

32. D Section 11.5.2.4 Risk Management
One of the more commonly used risk response techniques is a contingent response strategy, which is designed for use only if certain predefined conditions occur.

33. C Section 12.4.2.4 Procurement Management
While A is true, C is more descriptive of the project manager's role in negotiating.

34. B Section 11.3.2.2 Risk Management
The results of the qualitative risk analysis process identify the relative priority of risks and drive the selection of responses.

35. C Professional Responsibility Role Delineation Study, pages 5 to 6
Choice A is the definition of integration management; choice B defines an application area.

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36. B **Section 9.3 Human Resource Management and see Verma, *Human Resource Skills***
Choice A is withdrawal (nothing solved), choice C is compromising (lose-lose) and choice D is problem solving (confrontational) and considered win-win. Forcing is win-lose.

37. B **Section 9.3.2 Human Resource Management**
Team building is easiest in choice A and is next easiest in choice C. The organizational structure of the performing organization is a constraint in organizational planning that crosses over to team building.

38. B **Section 12.6.3.2 Procurement Management**
Although the contract work is complete, the contract is not closed. The buyer must provide written notice to the contractor that the contract has been completed. Without this formal acceptance and closure, the contract cannot be closed. However, the contractor can demand that the buyer close out the project as work was done to the agreed-on specifications of the SOW.

39. B **Section 10.2.2 Communications Management**

40. A **Section 10 Communications Management**

41. A **Professional Responsibility, Role Delineation Study, page 38**

42. A **see Verma, *Human Resource Skills*, page 233**
The team's influencing skills play an important role in negotiating staff assignments as do the politics of the organizations involved. Other legitimate forms of power are reward and coercive (penalty). Choice C is referent power (a form of personal power) and choice D is expert power (also a form of personal power).

43. D **Section 11.6.2.1 Risk Management**
Choice D is more specific than choices A or B.

44. C   **Section 12.6.2.1 Procurement Management**
Choice A defines a contract file; choice B
defines a quality audit and choice D defines a
performance measurement.

45. D   **Section 7.4.2.3 Cost Management**
Both SPI (1.1) and CPI (1.1) are greater than 1
for task 3.

46. D   **Section 5.5 Scope Management**

47. B   **Section 2.1.1 Project Life Cycle and Organization**
Understand Figure 2-1 and Figure 2-2 in the
PMBOK Guide.

48. B   **see the Glossary to this study guide**
The Delphi Technique is sometimes used in
project selection methods.

49. D   **Section 8.3 Quality Management**

50. D   **Section 4.7 Integration Management**

51. A   **Section 8.1.2 Quality Management**
Choices B, C and D are costs of nonconformance.

52. D   **Section 8.1 Quality Management**
JIT was instigated by a Japanese automobile
manufacturing company to streamline the
manufacturing cost and processes to bring in
inventory at the time it is needed.

53. A   Cost Performance Index (CPI) = Earned Value/
Actual Cost
CPI = $11,000/$10,000
CPI = 1.10

54. C   Schedule Variance (SV) = Earned Value -
Planned Value
SV = $9,000 - $10,000
SV = -$1,000

55. A   Risk Management, see Wideman, *Project and Program Risk Management*
Know the types of risk (pure, business, known and unknown).

56. D $100,000 depreciated over 4 years using straight line (SL), double declining balance (DDB) and sum of the years digits (SYD) yields:

YEAR	SL	DDB	SYD
1	$25,000	$50,000	$40,000
2	$25,000	$25,000	$30,000
3	$25,000	$12,500	$20,000
4	$25,000	$12,500	$10,000

Thus, since DDB and SYD have higher deductions in the early years, they are considered accelerated methods of depreciation.

Definitions and explanations for question 56:

Straight line depreciation: asset value divided by number of years.

Double declining balance: first year depreciation from straight line method = 25% (25,000/100,000), so DDB percent is 50.
DDB   year 1 = 50% of 100,000 = 50,000
        year 2 = 50% of 50,000 = 25,000
        year 3 = 50% of 25,000 = 12,500
        year 4 = 50% of 12,500 = 6,250
but this is last year so take all of the remainder, or 12,500.

Sum of the years digits: 4 + 3 + 2 + 1 = 10
        Total asset value/10XTotal years of depreciation (4) = 40,000
        Total asset value/10Xnumber of years remaining (3) = 30,000
        Total asset value/10Xnumber of years remaining (2) = 20,000
        Total asset value/10Xnumber of years remaining (1) = 10,000

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57. D **Section 12.1.3.1 Procurement Management**
Terms and conditions are part of the contract.

58. B **Section 6.2.2.5 Time Management**
Although the activities described have a
finish-to-start relationship, the delay in the start
of the successor is a lag.

59. D **Section 7.3.2 Cost Management**
The earned value or the value of the work
physically accomplished needs to be known.

60. C **Section 7.3.2 Cost Management**

APPENDIX C

GLOSSARY

This is a supplement to the PMBOK Guide. These terms are not in the PMBOK Guide's Glossary but may be used in test questions.

Allocate: designate funds for a specific project objective.

Appropriate: set money aside for a specific project purpose.

Authorize: grant formal or legal permission to do something.

Concurrent Engineering: generally speaking, an approach to project staffing that calls for the implementers to be involved in the design phase (sometimes confused with fast tracking).

Culture: everything that people have, think and do as members of their society.

De facto: usually referring to standards or rules. A de facto standard is one which is widely accepted but not required by laws or regulations.

De jure: in contrast to de facto, de jure means "by law." A de jure standard is specified in a law or regulation.

Elapsed Time (ET): duration of an activity; sometimes designated as TE.

Fixed Costs: costs that do not change based on the number of units. These costs are nonrecurring.

Management By Objective: a system of managerial leadership that defines individual managerial responsibilities in terms of corporate objectives.

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Management Reserve: a separately planned quantity used to allow for future situations that are impossible to predict (the unknown unknowns). Management reserves are intended to reduce the risk of missing cost or schedule objectives. Use of management reserves requires a change to the project's cost baseline.

Payback Period: the number of time periods it takes until the cumulative revenues exceed cumulative costs and, therefore, the number of time periods it takes until the project has turned a profit.

Phase End Reviews: project reviews done at the end of a phase.

Phased Implementation (also called **Rolling Planning)**: use of planning horizons to segregate planning efforts into sequential phases.

Politics: competition between interest groups or individuals for power and leadership.

Power: the ability to influence others in order to achieve project goals.

Project Notebook: a detailed project plan; the notebook is updated throughout the life of the project.

Project Phase: a collection of logically related project activities, usually culminating in the completion of a major deliverable.

Quality Plan: a document setting out the specific quality practices, resources and sequence of activities relevant to a particular product, service, contract or project.

Quality Policy: the overall quality intentions and direction of an organization regarding quality, as formally expressed by top management.

Resource Balancing: the process by which a project manager attempts to achieve a uniform distribution of effort across the entire project.

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Resource Loading: the summation of the percentage of effort required from a resource across all of the individual tasks of a project (or across multiple projects within a program).

Resource Profile (also called a **Resource Histogram**): vertical bar chart that depicts resource load over time.

Responsible Party: person with primary responsibility for an activity; also sometimes called the point of contact, especially when a support group or contractor performs the work.

Tracking: comparing plan vs. actual or current vs. baseline.

Value Analysis: a cost reduction tool that involves careful analysis of a design or item to identify all the functions and the cost of each. It considers whether the function is necessary and whether it can be provided at a lower cost without degrading performance or quality.

Variance: a difference between plan and actual.

Work Authorization: the process of sanctioning all project work.

Work Authorization or Release: in cases where work is to be performed in segments due to technical or funding limitations, work authorization/release authorizes specified work to be performed during a specified period.

Working Capital: current assets minus liabilities.

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APPENDIX D

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