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# **PMP**

**Fifth Edition**

**Michael G. Solomon**

## **PMP Exam Cram, Fifth Edition**

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# About the Author

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# Dedication

*The content of this book would not have been possible without the unyielding support of my family. I'd like to dedicate this work to three people. First, my best friend and wife, Stacey, who constantly brings out more in me than I thought possible. Second, two guys who challenge me each day to be the best I can be: my sons, Noah and Isaac.*

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# Introduction

The Project Management Professional (PMP) certification is a valued asset in the ever-evolving professional project management field. PMP certification in the professional arena ensures that employers are hiring a project manager with thorough, tested knowledge in project management principles; years of hands-on, specific experience performing project management tasks; and a commitment to continuing education in the field of project management. In addition, PMP certification gives colleagues a commonality of experience and provides opportunities for networking. PMPs share the same frame of reference in project management, regardless of the field of endeavor.

PMP-certified individuals work in a wide array of industries, from aerospace to telecommunications. Many hiring supervisors specify PMP certification as a preferred skill set when soliciting project managers.

Both private- and public-sector employers recognize the value that a PMP-certified employee brings to a project. Corporations embrace the consistent application of project management methodologies for initiating, planning, executing, controlling, and closing projects. The Project Management Institute (PMI) Project Management framework is highly praised by companies and government entities, whether they are engaged in large-scale development projects or simply undertaking small reengineering initiatives. In both scenarios, the PMI approach offers a consistent project management methodology that can be tailored to the size and complexity of the project. This framework, coupled with the PMP certification program, ensures that PMP-certified practitioners are in high demand in the workforce.

PMI has brought the art and science of project management full circle through its PMP certification program and methodology, the Project Management Body of Knowledge (PMBOK). PMI seeks to evaluate project management professionals through the application of the certification process to ensure a dependable workforce with solid credentials. The PMP certification examination tests for comprehensive project management knowledge as well as a thorough understanding of the PMBOK. This approach ensures that PMP-certified practitioners have comparable qualifications and strategic competencies in all aspects of project management. PMI advocates the practice of project management as a discipline, not unlike engineering or any other precise, science-based course of study. As such, PMI developed the PMBOK as a comprehensive framework of best practices for the implementation of project management, regardless of the specific industry.



# The Project Management Institute

PMI is the premier project management organization in the world. It is a nonprofit educational group intent on advancing the practice of project management through the promotion and promulgation of widely accepted standards. It has more than 420,000 members in more than 170 countries with more than 250 charter-based local chapters. This is quite a feat for an organization that started in 1969 with five volunteers!

PMI establishes professional standards, provides continuing education opportunities for members, engages in industry-specific research, and offers certifications aimed at unifying and strengthening the discipline of project management.

If you consider yourself a project management professional and want to earn your PMP certification, consider joining PMI. You will receive a reduced rate when sitting for your PMP examination, as well as all the other benefits of PMI membership, including seminars, workshops, and other continuing education opportunities. These benefits include a community of peers that provides valuable information exchange about industry trends and access to the latest knowledge through a monthly magazine and quarterly research journals. To learn more about PMI and membership, visit PMI's website, at [www.pmi.org](http://www.pmi.org).

## What's New in the *PMBOK Guide*, Fifth Edition

PMI, as a member-driven organization, is continually evolving to meet the needs of its membership and the project management profession. To this end, the PMBOK has been revised to incorporate feedback from members and to reflect current industry practice and developments since the previous edition. If you are familiar with the previous edition—the *PMBOK Guide*, Fourth Edition—you will want to acquaint yourself with the changes in the Fifth Edition. This is particularly important if you used an earlier edition of the PMBOK to prepare for the PMP certification examination.

The new edition of the PMBOK pursues greater consistency and clarity over the Fourth Edition. The Fifth Edition also focuses on ensuring alignment with PMI standards and ISO 21500, the project management standard of the International Organization for Standardization. In addition, the *PMBOK Guide*, Fifth Edition introduces business rules to define how to handle the order and detail of information within procedure inputs, tools and techniques,

and outputs. The PMBOK now incorporates redefined terms such as *Work Performance Data*, *Work Performance Information*, and *Work Performance Reports*. The new consistent terms align with the Data, Information, Knowledge, Wisdom (DIKW) model developed in the field of knowledge management.

New material has been added to this edition to reflect changes, adaptations, and additions to tools and techniques used in the current practice of project management. The number of processes in the PMBOK has increased from 42 to 47. These five processes were added:

- ▶ **Plan Scope Management**—Section 5.1
- ▶ **Plan Schedule Management**—Section 6.1
- ▶ **Plan Cost Management**—Section 7.1
- ▶ **Plan Stakeholder Management**—Section 13.2
- ▶ **Control Stakeholder Engagement**—Section 13.4

In addition, one process was moved to the new Stakeholder Management knowledge area:

- ▶ **Identify Stakeholders**—Section 10.1 moved to Section 13.1

Finally, the names of 12 processes were changed to promote consistency and clarity:

- ▶ **Direct and Manage Project Execution**—Section 4.3 changed to Direct and Manage Project Work
- ▶ **Verify Scope**—Section 5.5 changed to Validate Scope
- ▶ **Plan Quality**—Section 8.1 changed to Plan Quality Management
- ▶ **Perform Quality Control**—Section 8.3 changed to Control Quality
- ▶ **Develop Human Resource Plan**—Section 9.1 changed to Plan Human Resource Management
- ▶ **Plan Communications**—Section 10.2 changed to Plan Communications Management—Section 10.1
- ▶ **Distribute Information**—Section 10.3 changed to Manage Communications—Section 10.2
- ▶ **Report Performance**—Section 10.5 changed to Control Communications—Section 10.3
- ▶ **Monitor and Control Risks**—Section 11.6 changed to Control Risks

- ▶ **Plan Procurements**—Section 12.1 changed to Plan Procurement Management
- ▶ **Administer Procurements**—Section 12.3 changed to Control Procurements
- ▶ **Manage Stakeholder Expectations**—Section 10.4 changed (and moved) to Manage Stakeholders Engagement—Section 13.3

The *PMBOK Guide*, Fifth Edition defines a new Knowledge Area, Project Stakeholder Management. This new Knowledge Area was added to highlight the importance of stakeholders to the project management process. While PMI has always placed emphasis on stakeholders, a separate Knowledge Area makes it clear that managing stakeholders is fundamental to good project management.

All these changes resulted from PMP input that was used to streamline and clarify the PMBOK. A complete listing of all changes to the *PMBOK Guide*, Fifth Edition, is available in Appendix X1 of the PMBOK, and we also discuss these changes in more detail in Chapter 1, “Project Management Framework Fundamentals.” Each change is identified in its respective chapter in the PMBOK.

The new PMP certification examination went into effect on July 31, 2013, and is based on the *PMBOK Guide*, Fifth Edition.

## The PMP Certification Process

PMP certification involves a number of steps, beginning with an application to PMI that details the prospective PMP candidate’s qualifications, experience, and training. After a candidate has received approval from PMI to sit for the examination, he or she registers for the examination and must comply with various procedures set forth for the examination. The PMP certification process concludes with passage of the examination and issuance of PMP credentials by PMI.

## Registering for the PMP Certification Exam

Prior to actually taking a PMP certification examination, you must submit an application to PMI for approval, including detailed documentation supporting your professional project management experience and training in specific areas of expertise.

## Application Submission

PMI provides an online application, as well as a downloadable application form on its website. You can find valuable information about the PMP application process in the *PMP Handbook* that is also available on PMI's website. This handbook provides detailed information on every step of the application process. If you believe you meet the requirements for applying for PMP certification, you are ready to apply to PMI.

### Note

Read the *PMP Handbook* prior to applying for PMP certification. Much of the information in this section can be found in this handbook, which is available at [www.pmi.org/Certification/~media/PDF/Certifications/pdc\\_pmp handbook.ashx](http://www.pmi.org/Certification/~media/PDF/Certifications/pdc_pmp handbook.ashx).

Candidates for PMP certification must meet both the educational and experience requirements for one of two categories. You must submit verification forms showing compliance with these criteria with your application for either category. The two categories are detailed in Tables I.1 and I.2.

Category One, shown in Table I.1, is for applicants possessing a bachelor's degree or equivalent. In this category, less personal project management experience is necessary, although you must possess a minimum of 4,500 hours of hands-on project management activity. Category Two, shown in Table I.2, is ideal for candidates with longer work histories who do not hold a bachelor's degree. In this category, you can use 7,500 hours of project management performance to substitute for a college degree.

TABLE I.1 **Category One Applicants**

Criteria	Minimum	Explanation
Bachelor's degree or equivalent from a university		
Personal project management	4,500 hours	Within the past three years from the date of application.
Nonoverlapping months of personal project management experience	36 months	Individual months count toward the 36 months requirement once, even if you worked on multiple projects during the same month.
Specific instruction that addresses learning objectives in project management	35 contact hours	Must include instruction on project quality, scope, time, cost, human resources, communications, risk, procurement, and integration management.

TABLE 1.2 **Category Two Applicants**

Criteria	Minimum	Explanation
Personal project management experience within five process groups	7,500 hours	Within the past five years from the date of application.
Nonoverlapping months of personal project management experience	60 months	Individual months count toward the 60 months requirement once, even if you worked on multiple projects during the same month.
Specific instruction that addresses learning objectives in project management	35 contact hours	Must include instruction on project quality, scope, time, cost, human resources, communications, risk, procurement, and integration management.

Additional information related to the educational and experience requirements for PMP certification eligibility are provided in the PMP Handbook.

## Application Fee and PMI Membership

The application also requires an application fee, tiered for PMI members and non-PMI members, with the latter paying a higher rate. For computer-based testing (CBT), members of PMI pay \$405 for the examination, while non-members pay \$555. The prices for paper-based testing (PBT) are \$250 for PMI members and \$400 for non-members. The annual cost for PMI membership is \$129, which means that membership is actually cheaper than the difference between the examination cost for non-members and members. The total cost for joining PMI and sitting for the PMI examination is \$534. (This does not include chapter, special interest groups, and college memberships, which require additional fees.)

## Audit

A random sample of applicants are chosen for audit prior to issuing eligibility letters. If you are selected for an audit, you are asked to provide additional information supporting your work experience, including supporting documentation from your supervisors that details your work on specific projects.

## Examination Administration

The PMP certification examination is offered globally. CBT is the standard method used to administer the PMP exam. PMI administers CBT through Prometric. A complete list of testing sites and vendors is available on the PMI

website. PBT is available if a candidate lives more than 300 km (186.5 miles) from a Prometric CBT site or if a corporate sponsor wishes to administer the exam to its own employees.

Prometric requires a PMI Eligibility ID code to register. PMI provides this code to a PMP candidate when approval is granted to sit for an examination. After you've been approved to sit for the exam, you can register online or use Prometric's interactive voice-response telephone registration system.

Specific instructions for registering are also included in your approval letter from PMI.

To learn more about Prometric and its administration of the PMP certification examination, visit Prometric's website, at [www.prometric.com](http://www.prometric.com).

After your application has been approved by PMI, passing the PMP certification examination is your final step in becoming a PMP.

## Re-Examination

Candidates who do not pass the PMP certification examination on their first attempt may take the exam up to two more times within one year from the original eligibility date.

## Cancellation

Candidates can cancel and reschedule an examination at any time more than two business days prior to the scheduled testing. Cancellations within 30 days of the scheduled test date will carry a fee of \$70. There are no refunds for any tests cancelled within two days of the scheduled test date.

Candidates unable to appear for a scheduled examination due to a medical emergency must submit written notification to the PMI Certification Program Department within 72 hours of the scheduled exam. A rescheduling fee is charged. All circumstances are reviewed on a case-by-case basis.

## Refund

You have one year from the date of your eligibility letter in which to take the PMP certification examination. A refund can be obtained by written request to PMI one month before your exam eligibility expires. A \$100 processing fee will be retained from your original application fee.

## Arriving at the Exam Site

To be admitted into the test site, you are required to present a current form of government-issued identification that includes a picture and a signature. If your government-issued identification does not display a photograph or a signature, you may use a secondary form of identification with your government-issued identification. The *PMP Handbook* contains a list of acceptable identification types. Your approval letter from PMI and your registration confirmation from Prometric also detail what forms of identification are acceptable. You are not allowed to bring anything to the exam. An examiner provides you with a calculator and scrap paper.

Wear comfortable clothing and layer your clothing. You will spend up to four hours in the examination room, and your ability to concentrate and focus on the task at hand can be dramatically affected by the room temperature and your sense of comfort.

Get to your exam site early so you can review the PMP Cram Sheet provided in this book and any additional notes you create to quickly focus your mind on specific topics prior to the test. An early arrival ensures that you have ample time to relax and mentally prepare for the examination.

## In the Exam Room

Do not start the examination immediately. Sit down at your computer terminal and acclimate to the examination room and your immediate environment. Organize your peripherals for your comfort. Are the mouse and keyboard set correctly? Does your chair need to be adjusted? Is the monitor at the correct eye level for you? A few minor corrections can make a big difference during the next few hours.

Prior to the start of the examination, the test administrator will review any specific instructions and tell you what is and is not allowed during the examination period. You are allowed to take breaks and use the restrooms as necessary.

## Pretest Tutorial

Prior to beginning the examination, you are provided with a briefing and 15-minute online tutorial designed to familiarize you with the computer and operational procedures for the test. If you have taken a computer-based test previously or have participated in computer-based training, you will feel comfortable in this environment. The pretest tutorial will show you how to navigate through the test using your computer mouse. You'll be shown how

to select an answer to a question, move forward to a new question, return to a previous question, and similar functions. The clock begins after you've completed the tutorial, so if you feel comfortable with the information presented, move forward to the actual examination.

## Time Allotted for the Test

You have up to four hours to complete the examination. Pace yourself. There are 200 multiple-choice questions, which breaks down to 50 questions per hour, so you have a little more than 1 minute per question. But not all questions require equal time. Don't agonize over every question; do read the question and each possible answer in its entirety prior to selecting an answer.

## Answer the PMI Way

More than one answer can seem plausible and correct. You are not asked to select the correct answer but rather the *best* answer from those provided. Attempt to rule out any obviously wrong choices immediately to narrow your field of best answers. You should strive to select the best answer based on how you believe PMI and the PMBOK would respond, given the question, and not necessarily from your own project management experience.

### ExamAlert

It cannot be emphasized enough that the PMI answer is the correct answer. You might do a task a certain way in real practice, and that method might even be one of the answer choices, but for purposes of the PMP certification examination, the PMBOK answer is the only correct answer. Don't get caught off guard here!

The best answer as determined by PMI is provided as one of the four possible responses. Be suspicious of answers offering definitive responses like *never* and *always*. Some answers might tout non-PMI methods and reflect common project management misconceptions. Some answers might offer correct information, but the information is not pertinent to the question at hand. Similarly, some questions might contain factually correct information that has no bearing on the possible answers.

## Pace Yourself During the Exam

After the first hour, you will be able to determine your speed and make adjustments as necessary. It is important to be aware of your time so you won't have to rush at the end to complete the examination. You should leave adequate time to review any responses you were unsure of and to return



to unanswered questions. If you are spending more than one minute on a question, it is better to skip over the question and mark it for review later than to agonize over the question and lose the opportunity to answer other questions whose answers you know.

The examination allows you to mark questions for later review and make multiple passes through the exam. Mark every question you are unsure of, even if you have selected an answer. This approach saves you time when you review your responses because you will not need to review any unmarked questions. If, on a second review, you determine an answer, unmark the question. Continue this process of going through all the marked questions until you have answered all the questions or are nearing the end of the allotted time period.

Save the last 20 minutes or so of the test to finalize any unmarked answers and ensure that you have provided an answer to each question. Try to make a best guess by ruling out definitely wrong answers, as discussed earlier, but do not give up. Select an answer for each question—even if you have to guess. There is no penalty for guessing.

### ExamAlert

Remember, there is no penalty for guessing. So be sure all questions have been answered—even if you have to guess. You at least give yourself an opportunity to get it right if you have an answer marked!

Throughout the testing period, keep an eye on the clock or use your watch timer to remind you at discreet intervals to take a break. It is amazing what simply standing up and stretching for a few minutes can do for your concentration.

At the conclusion of the test, candidates can opt to complete a satisfaction survey.

## Exam Room Surveillance

You might be under surveillance during the examination. Some testing centers use both video and human monitors to ensure the validity of the test. After you get under way with your examination and start to concentrate on the task at hand, you will be unaware of any other activity. Any monitoring by the testing center will be unobtrusive.

## Grading Your Exam

At the end of the examination period, you will receive a printed copy of your results indicating your status—either pass or fail. The scores are submitted to PMI by the end of the business day. If you have passed the examination, PMI will mail a PMP credential packet to you within six to eight weeks.

If you are taking a PBT, answer sheets are scored when they are returned to the test administrator. You can request that your exam be hand scored for an additional \$45 fee.

Any questions regarding your score from either the CBT or PBT should be addressed to PMI's exam supervisor.

## About This Book

This book offers you tools, techniques, tips, and other information to assist you in passing the PMP certification examination and becoming PMP certified. The emphasis is on reconciling your approach to the exam with PMI's viewpoint and perspective on the examination. This book is not a guide to general project management but rather a specific study tool aimed at distilling PMI's approach to project management as set forth in the *PMBOK Guide*, Fifth Edition. Project initiation, planning, execution, control, and closing are the core topics in this book and are parallel to those same key areas in the PMBOK.

## Using This Book and CD

This book and CD prepare you to pass the PMP certification examination by highlighting important project management principles, providing insight into proven test-taking strategies, emphasizing key information you can expect to see on the examination, and providing exam practice questions. You get guidance and clarification on PMBOK concepts and understand their relationship to other project management methodologies. You have many opportunities to apply your knowledge through practice examinations and test questions.

This book provides a practice examination as well as practice questions at the beginning and end of each section. The Cram Saver questions before each section help you decide how well you already know the material. If you answer all of the Cram Saver questions correctly, you can choose to skim a section before going to its Cram Quiz at the end. After you complete a section,

answer the Cram Quiz questions to determine how well you comprehended the information in the section. If you missed more than one or two questions, work your way through the section again, focusing on the concepts that you missed.

Similarly, you can test your knowledge and evaluate your level of preparation for the PMP certification examination by taking the practice exam under real conditions. After you've worked your way through this book, take the practice exam. Evaluate your results and then reread the chapters of this book related to any areas of the practice examination where you were less certain or did not select the correct answer.

Finally, the Cram Sheet condenses all the concepts, knowledge areas, processes groups, terminology, and formulas presented throughout this book into a tear-out sheet you can take with you to the exam site for quick review prior to entering the testing facility. The Cram Sheet is also a valuable tool for use in quick daily reviews after you have completed this book. Review the Cram Sheet every day; if any terms seem vague, go to the appropriate topic in the book for a refresher.

## Pearson IT Certification Practice Test Engine and Questions on the CD

The CD in the back of the book includes the Pearson IT Certification Practice Test engine, software that displays and grades a set of exam-realistic multiple-choice questions. This book comes with three practice exams for use with the Pearson IT Certification Practice Test engine. Using the Pearson IT Certification Practice Test engine, you can either study by going through the questions in Study Mode or take a simulated exam that mimics real exam conditions.

The installation process requires two major steps: installing the software and activating the exam. The CD in the back of this book has a recent copy of the Pearson IT Certification Practice Test engine. The practice exam—the database of exam questions—is not on the CD.

### Note

The cardboard CD case in the back of this book includes the CD and a piece of paper. The paper lists the activation code for the practice exams associated with this book. Do not lose the activation code. On the opposite side of the paper from the activation code is a unique, one-time-use coupon code for the purchase of the Premium Edition eBook and Practice Test.

## Installing the Software from the CD

The Pearson IT Certification Practice Test is a Windows-only desktop application. You can run it on a Mac using a Windows virtual machine, but it was built specifically for the PC platform. The minimum system requirements are as follows:

- ▶ Windows XP (SP3), Windows Vista (SP2), Windows 7, or Windows 8
- ▶ Microsoft .NET Framework 4.0 client
- ▶ Pentium-class 1-GHz processor (or equivalent)
- ▶ 512 MB RAM
- ▶ 650 MB hard disk space plus 50 MB for each downloaded practice exam
- ▶ Access to the Internet to register and download exam databases

The software installation process is relatively routine. If you have already installed the Pearson IT Certification Practice Test software from another Pearson product, there is no need for you to reinstall the software. Simply launch the software on your desktop and proceed to activate the practice exam from this book by using the activation code included in the CD sleeve.

The following steps outline the installation process:

1. Insert the CD into your PC.
2. The software that automatically runs is the Pearson software to access and use all CD-based features, including the exam engine and the CD-only appendixes. From the Practice Exam tab, click the option Install Practice Exam.
3. Respond to the prompts as you would with any typical software installation process. The installation process gives you the option to activate your exam with the activation code supplied on the paper in the CD sleeve. This process requires that you establish a Pearson website login. You need this login to activate the exam, so please do register when prompted. If you already have a Pearson website login, there is no need to register again. Just use your existing login.

## Activating and Downloading the Practice Exam

After the exam engine is installed, you should then activate the exam associated with this book (if you did not do so during the installation process) as follows:

1. Start the Pearson IT Certification Practice Test software from the Windows Start menu or from your desktop shortcut icon.
2. To activate and download the exam associated with this book, from the My Products or Tools tab, click the Activate button.
3. At the next screen, enter the activation key from the paper inside the cardboard CD holder in the back of the book. Then click the Activate button.
4. After the activation process downloads the practice exam, click Next and then click Finish.

When the activation process is complete, the My Products tab should list your new exam. If you do not see the exam, make sure you have selected the My Products tab on the menu. At this point, the software and practice exam are ready to use. Simply select the exam and click the Open Exam button.

To update a particular exam you have already activated and downloaded, simply click the Tools tab and click the Update Products button. Updating your exams ensures that you have the latest changes and updates to the exam data.

If you want to check for updates to the Pearson IT Certification Practice Test software, simply click the Tools tab and click the Update Engine button. You can then ensure that you are running the latest version of the software engine.

## Activating Other Exams

You must complete the exam software installation process and the registration process only once. Then, for each new exam, you have to follow only a few steps. For instance, if you buy another new Pearson IT Cert Guide or Cisco Press Official Cert Guide, extract the activation code from the CD sleeve in the back of that book. From there, all you have to do is start the exam engine (if it's not still up and running) and perform steps 2 through 4 from the previous list.

## Chapter Formats

Each chapter follows a regular structure and provides graphical cues about especially important or useful material. The structure of a typical chapter is as follows:

- ▶ **Topical coverage**—Each chapter begins by listing the exam topics covered in that chapter.

- ▶ **Cram Saver questions**—You get a short list of questions related to the specific section topic. Each question is followed by explanations of both correct and incorrect answers. The Cram Saver questions help you decide how well you already know the material covered in the section.
- ▶ **Exam Alerts**—Throughout the topical coverage section, Exam Alerts highlight material most likely to appear on the exam by using a special exam alert layout that looks like this:

### ExamAlert

This is what an Exam Alert looks like. An Exam Alert stresses concepts, terms, or activities that are likely to appear in one or more exam questions. For that reason, any information offset in Exam Alert format is worthy of extra attention on your part.

Even if material isn't flagged as an Exam Alert, all the content in this book is associated in some way with test-related material. What appears in the chapter content is critical knowledge.

- ▶ **Cram Quiz questions**—Each section ends with a short list of test questions related to the specific topics of that section. Each question is followed by explanations of both correct and incorrect answers. These practice questions highlight the most important areas on the exam.

The bulk of the book follows this chapter structure, but there are a few other important elements:

- ▶ **PMP Practice Exam**—There is a full practice test at the end of this book. The questions are designed to challenge your knowledge and readiness for the PMP exam.
- ▶ **Answers to the PMP Practice Exam**—This book provides the answers to the practice exam, complete with explanations of both the correct responses and the incorrect ones.
- ▶ **Cram Sheet**—This tear-out sheet inside the front cover is a valuable tool that represents a collection of the most critical items you should memorize before taking the test. Remember, you can dump this information out of your head onto the margins of your test booklet or scratch paper as soon as you enter the testing room.

You might want to look at the Cram Sheet in your car or in the lobby of the testing center just before you walk into the testing center. The Cram Sheet's information is grouped together under headings, so you can review the appropriate parts just before the test.

## Using the CD

The CD contains two elements that help you prepare for the PMP exam:

- ▶ **Exam Practice Engine**—This exam engine software includes all the questions from the book's practice exam in electronic format. You can take a full, timed exam or choose to focus on particular topics in study mode. Use your feedback and the topics listed in the book to zero in on the areas where you need more study.
- ▶ **Cram Quizzes**—All of the book's Cram Quizzes and their answers have been compiled into one convenient document on the CD for you to have another portable practice option.

## About the PMP Exam

The PMP certification examination consists of 200 four-option, multiple-choice questions developed by PMPs. According to the *PMP Handbook*, "The passing score for all PMI credential examinations is determined by sound psychometric analysis" and is not based on a fixed number of correct answers.

There are no prescribed guidelines for a course of study because the examination is objective in scope and intended to test your knowledge of the project management field; however, emphasis is strongly placed on the PMBOK.

Do note that the PMP exam includes a performance requirement specific to professional responsibility in the practice of project management. The PMI Code of Ethics and Professional Conduct is not a component of the PMBOK; rather, it is a standalone document available on the PMI website that you will be tested on as part of the examination. The PMI Code of Ethics and Professional Conduct can also be found in the *PMP Handbook*.

The PMP certification examination tests for professional responsibility and five process groups:

- ▶ Initiating
- ▶ Planning
- ▶ Executing
- ▶ Monitoring and Controlling
- ▶ Closing

The most significant knowledge areas are

- ▶ **Planning**—This knowledge area accounts for 24% of the test material.
- ▶ **Executing**—This knowledge area accounts for 30% of the test material.
- ▶ **Monitoring and Controlling**—This knowledge area accounts for 25% of the test material.

Overall, 79% of the examination deals exclusively with planning, executing, and monitoring and controlling projects.

Initiating accounts for 13% of the exam, and closing accounts for 8%.

A new PMP certification examination went into effect on July 31, 2013, based on the *PMBOK Guide*, Fifth Edition.

## PMP Exam Topics

Table I.3 lists all the PMP exam topics covered in this book. Use this table to find where a topic is covered in the book. For example, if your CD exam feedback indicates that you scored poorly in a particular topic, find that topic in this table so you can find where it is covered in the book.

In general, the chapters are organized by process group. Within each process group, the sections are organized by knowledge area. As much as possible, the flow is consistent with the project flow defined in the PMBOK. The section references in the following table and throughout the book refer to the specific sections in the *PMBOK Guide*, Fifth Edition. At any time you can go directly to the PMBOK to see the section that corresponds to the topic in this book that you are reading.



TABLE I.3 **PMP Exam Topics**

Topic	Chapter
Understand the Project Management Framework	1
Explain Organizational and Environmental Factors	1
Describe the Project Life Cycle	1
PMI Code of Ethics and Professional Conduct	2
Responsibility	2
Respect	2
Fairness	2
Honesty	2
Initiating Process Group—3.3	3
Develop Project Charter—4.1	3
Identify Stakeholders—13.1	3
Planning Process Group—3.4	4
Develop Project Management Plan—4.2	4
Plan Scope Management—5.1	4
Collect Requirements—5.2	4
Define Scope—5.3	4
Create WBS—5.4	4
Plan Schedule Management—6.1	4
Define Activities—6.2	4
Sequence Activities—6.3	4
Estimate Activity Resources—6.4	4
Estimate Activity Durations—6.5	4
Develop Schedule—6.6	4
Plan Cost Management—7.1	4
Estimate Costs—7.2	4
Determine Budget—7.3	4
Plan Quality Management—8.1	5
Plan Human Resource Management—9.1	5
Plan Communication Management—10.1	5
Plan Risk Management—11.1	5
Identify Risks—11.2	5

<b>Topic</b>	<b>Chapter</b>
Perform Qualitative Risk Assessment—11.3	5
Perform Quantitative Risk Assessment—11.4	5
Plan Risk Responses—11.5	5
Plan Procurement Management—12.1	5
Plan Stakeholder Management—13.2	5
Executing Process Group—3.5	6
Direct and Manage Project Work—4.3	6
Perform Quality Assurance—8.2	6
Acquire Project Team—9.2	6
Develop Project Team—9.3	6
Manage Project Team—9.4	6
Manage Communications—10.2	6
Conduct Procurements—12.2	6
Manage Stakeholder Engagement—13.3	6
Monitoring and Controlling Process Group—3.6	7
Monitor and Control Project—4.4	7
Perform Integrated Change Control—4.5	7
Validate Scope—5.5	7
Control Scope—5.6	7
Control Schedule—6.7	7
Control Costs—7.4	7
Control Quality—8.3	7
Control Communications—10.3	7
Control Risks—11.6	7
Control Procurements—12.3	7
Control Stakeholder Engagement—13.4	7
Close Project or Phase—4.6	8
Close Procurements—12.4	8

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## CHAPTER 4

# Examine Project Planning

### **This chapter covers the following PMP exam topics:**

- ▶ Planning Process Group—3.4
- ▶ Develop the Project Management Plan—4.2
- ▶ Plan Scope Management—5.1
- ▶ Collect Requirements—5.2
- ▶ Define Scope—5.3
- ▶ Create WBS—5.4
- ▶ Plan Schedule Management—6.1
- ▶ Define Activities—6.2
- ▶ Sequence Activities—6.3
- ▶ Estimate Activity Resources—6.4
- ▶ Estimate Activity Durations—6.5
- ▶ Develop Schedule—6.6
- ▶ Plan Cost Management—7.1
- ▶ Estimate Costs—7.2
- ▶ Determine Budget—7.3

(For more information on the PMP exam topics, see “About the PMP Exam” in the Introduction.)

In Chapter 1, “Project Management Framework Fundamentals,” we introduced the PMI concepts of processes, process groups, and knowledge areas. Recall that PMI defines a total of 47 project processes that describe activities throughout a project’s life cycle. These processes are organized into 10 knowledge areas and represent 5 process groups. One of the most prominent of the process groups is project planning. Over half of the processes occur in this group; 24 of the 47 processes are in this group. You might think that planning processes are localized to a particular area of your project, but note that processes in the planning group span all 10 knowledge areas. Let’s look at project planning in more detail.

# Understanding PMI's Planning Process Group

## ► Planning Process—3.4

### CramSaver

If you can correctly answer these questions before going through this section, save time by skimming the Exam Alerts in this section and then completing the Cram Quiz at the end of the section.

1. What are the two main inputs (outputs from processes in the initiating process group) that you need to start planning a project? (Remember that you can't start planning a project from scratch; planning is not the starting point.)
2. Which planning process group process output is the result of project deliverable decomposition into manageable components called work packages?

### Answers

1. The two outputs from initiating process group processes necessary to start planning are the project charter and the stakeholder register. These two documents provide the starting point for planning a project.
2. The work breakdown structure (WBS) is the result of decomposing work into smaller, more manageable components until the work and deliverables are defined to the work package level.

After you have completed the *initiating processes*, you are ready to start planning your project. Remember what that means? It means that you possess formal authorization to conduct the work of the project. But you don't know what to do without a plan. Planning answers a few very important questions, such as What work will you do? and What exactly are you trying to accomplish?

To answer these questions, start from what you know. There are two outputs from the initiating process group processes. Always start with the information necessary to proceed. Recall that PMI refers to this initial information for each process as the process's inputs. There are two outputs from the initiating processes:

- The project charter
- The stakeholder register

Armed with these initiating documents, you can start the planning processes. In a nutshell, you follow each of the planning processes to refine the project documents from these outputs. As you develop the planning documents, always remember how the various processes are related.

Think of the initiating process group as the processes that answer the “what” and “why” questions. The planning processes answer the “how” questions. The planning processes result in outputs that explain how the project will progress toward reaching its goals.

Figure 4.1 shows how the processes in the planning group are related in the *PMBOK Guide*, Fifth Edition.

### ExamAlert

Planning includes many processes, so be prepared to answer many questions in this area on the exam. Planning process group questions make up 24% of the PMP exam. As with all other process groups, make sure you know the inputs, tools and techniques, and outputs of each process. It helps to draw your own process flow. Just the act of physically drawing the process flow in each process group helps you remember how the processes relate to one another.

PMI is explicit in stressing the importance of planning. Far too many projects suffer from the poor practice of starting work before anyone really knows what needs to be done. This almost always results in wasted effort and lost time. Proper planning requires good communication among the team and sound leadership from the project manager. The result of solid planning is a project team that is more informed and prepared to carry out the work required to meet the project's goals. You should expect to see several questions on the exam that require you to understand the importance of fully planning before starting work.

Because planning is such a large process group, the material is divided into two separate chapters. This chapter covers the general concepts of planning and the processes that relate to the development of project baselines, including the following topics:

- ▶ Integration
- ▶ Scope
- ▶ Time
- ▶ Cost

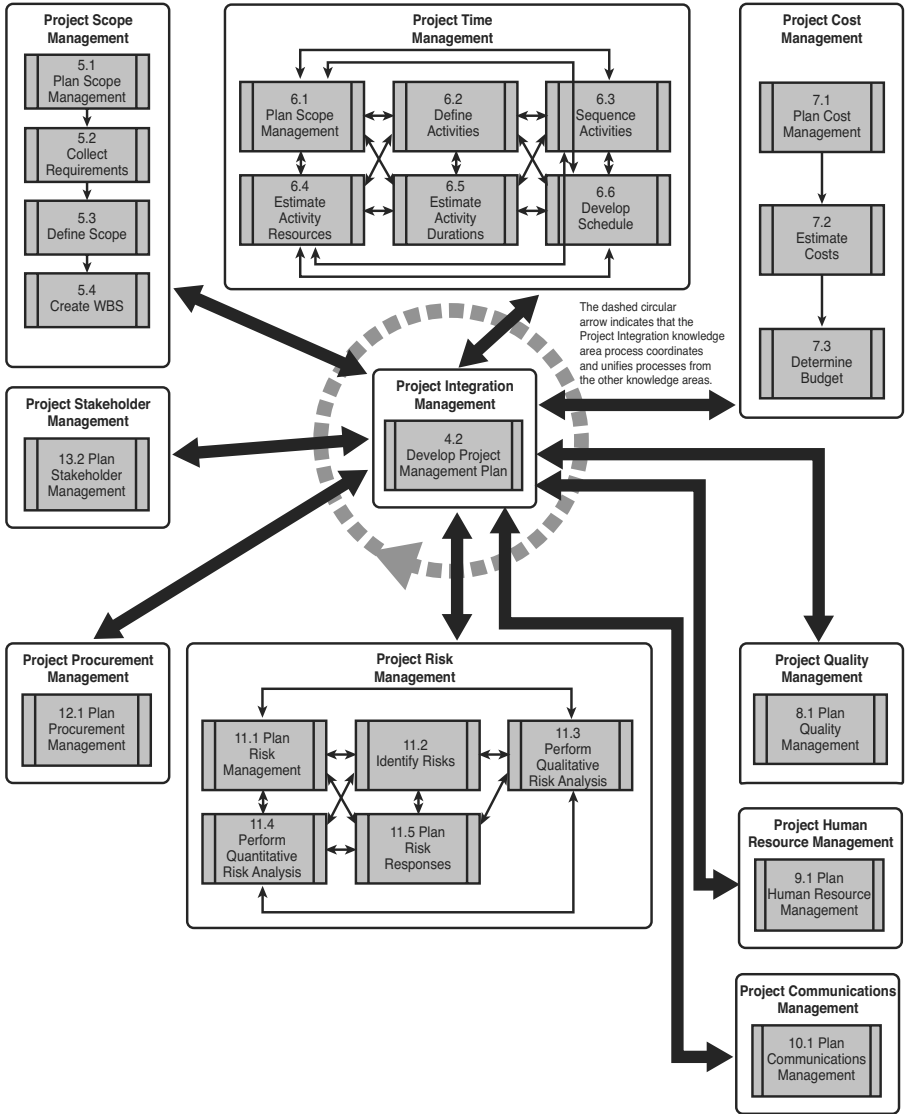


FIGURE 4.1 The planning process group process interactions.

Chapter 5, “Explore More Elements of Project Planning,” covers the remaining project planning processes that support project planning by applying more details to the baselines. Topics covered in Chapter 5 include these:

- ▶ Communications
- ▶ Risk

- ▶ Quality
- ▶ Procurement
- ▶ Human resources
- ▶ Stakeholders

The main purpose of planning is to provide a framework to gather information to produce a project management plan. In fact, the plan itself is really a collection of other plans. The majority of activities in the planning group center around developing the supporting documents that comprise the final project management plan. As more detailed information is learned about the project, the overall plan becomes more complete, and the stakeholders' confidence in the project increases.

Planning is an iterative group of processes. As a project progresses, it often becomes necessary to modify the plan for a number of reasons. Unexpected results, delays, outside factors, and internal factors can all require additional planning. Any scope changes are likely to require one or more planning processes to be revisited. Don't assume that planning is accomplished only once. The exam requires that you understand how planning is iterative throughout a project.

The following are some fundamental planning process items you need to understand for the exam:

- ▶ **Project management plan**—One process in the planning group addresses the project management plan. The develop project management plan process is the high-level process that provides direction for developing subsidiary plans and compiling their information into the final project plan.
- ▶ **Scope**—Four processes address scope planning. These direct the refinement of the preliminary scope statement and break down the high-level goals of the project into smaller, more manageable chunks.
- ▶ **Activity**—Six processes deal with activity planning. After the work of the project is expressed in small, manageable chunks, the activity-related processes focus on defining the activity details, integrating with project resources, and sequencing the project activities.
- ▶ **Cost**—Three processes address cost planning. These processes collect estimates and organize them into a project budget.

We examine each of these processes in the next section.



## Cram Quiz

Answer these questions. The answers follow the last question. If you cannot answer these questions correctly, consider reading this section again until you can.

1. What is a common result of poor project planning?
  - A. Wasted effort
  - B. Lost time
  - C. Increased cost
  - D. All of the above
  
2. Which of the following aspects of planning has the most processes and is concerned with decomposing the work of a project into manageable chunks?
  - A. Scope
  - B. Time
  - C. Cost
  - D. Quality

## Cram Quiz Answers

1. Answer D is correct. Poor project planning almost always results in wasted effort, lost time, and increased cost.
  2. Answer B is correct. There are six time-related planning processes. Time management processes provide the mechanism to decompose work into small, manageable chunks.
-

# Integration Management

## ► Develop Project Management Plan—4.2

### CramSaver

If you can correctly answer these questions before going through this section, save time by skimming the Exam Alerts in this section and then completing the Cram Quiz at the end of the section.

1. According to the PMBOK, what is the basic purpose of the project management plan?
2. Name three of the subsidiary plans to the project management plan.

### Answers

1. The project management plan is the result (output) of the develop project management plan process that documents the actions necessary to define, prepare, integrate, and coordinate all subsidiary plans.
2. The subsidiary project management plans could include
  - Project scope management plan
  - Requirements management plan
  - Schedule management plan
  - Cost management plan
  - Quality management plan
  - Process improvement plan
  - Human resource plan
  - Communication management plan
  - Risk management plan
  - Procurement management plan

The *project management plan process* covers all activities that identify and direct the actions of many other processes in the planning process group. Developing the project management plan includes coordinating the development of the subsidiary plans and incorporating them into the complete project plan. The main purpose of the project management plan is to define how the project is to progress from its beginning to completion.

In short, the project management plan provides the high-level game plan for how the project moves through its life cycle. PMI defines many potential subsidiary plans that make up the overall project management plan. These

subsidiary plans provide the specific details for managing each aspect of the project from initiation through closure. The subsidiary project management plans could include

- ▶ Project scope management plan
- ▶ Requirements management plan
- ▶ Schedule management plan
- ▶ Cost management plan
- ▶ Quality management plan
- ▶ Process improvement plan
- ▶ Human resource plan
- ▶ Communication management plan
- ▶ Risk management plan
- ▶ Procurement management plan

#### Note

This list of subsidiary plans is a great outline of a project. Use the list as a table of contents when you consider what should be in a project management plan.

One of the most common mistakes inexperienced project managers make is to confuse a project plan with a project schedule. The output from many common project management software packages does not qualify as a project plan. This output is a good start, but a true project plan is made up of much more information than just scheduling information. This process requires a focused effort to create a plan that incorporates all known information about a project. Table 4.1 shows the inputs, tools and techniques, and outputs for the develop project management plan process.

**TABLE 4.1 Develop Project Management Plan Inputs, Tools and Techniques, and Outputs**

Inputs	Tools and Techniques	Outputs
Project charter	Expert judgment	Project management plan
Outputs from planning processes	Facilitation techniques	
Enterprise environmental factors		
Organizational process assets		

**ExamAlert**

You will see expert judgment listed as a tool and technique for several processes. The meaning of *expert judgment* is specific to each process. In the context of the develop the project management plan process, expert judgment includes

- ▶ Tailoring the process to meet the project needs
- ▶ Developing technical and management details to be included in the project management plan
- ▶ Determining resources and skill levels needed to perform project work
- ▶ Defining the level of configuration management to apply to the project
- ▶ Determining which project documents are subject to the formal change control process

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## Cram Quiz

Answer these questions. The answers follow the last question. If you cannot answer these questions correctly, consider reading this section again until you can.

1. You are a project manager newly assigned to a large project for your organization. The project charter has been signed, and the stakeholders have been identified. What should you do next?
  - A. Ask appropriate team members to submit WBS input
  - B. Initiate the scope planning process
  - C. Start the develop project management plan process
  - D. Begin the activity definition process
  
2. Which of the following is NOT part of the expert judgment tool and technique for the develop project management plan process?
  - A. Tailor the process to meet the project needs
  - B. Hold planning meetings to develop the risk management plan
  - C. Determine resources and skill levels needed to perform project work
  - D. Define the level of configuration management to apply to the project

## Cram Quiz Answers

1. Answer C is correct. The first process in the planning group is develop project management plan. Answers A, B, and D skip the first process and start subsequent processes prematurely.
  2. Answer B is correct. Holding planning meetings to develop the risk management plan is a tool and technique for the plan risk management process. Answers A, B, and D all refer to valid components of the expert judgment tool and technique for the develop project management plan process.
-

# Scope Management

- ▶ **Plan Scope Management—5.1**
- ▶ **Collect Requirements—5.2**
- ▶ **Define Scope—5.3**
- ▶ **Create WBS—5.4**

## CramSaver

If you can correctly answer these questions before going through this section, save time by skimming the Exam Alerts in this section and then completing the Cram Quiz at the end of the section.

1. The project scope management plan, as a component of the project management plan, includes which of the following?
  - A. Preparation of a detailed project scope statement
  - B. Creation of the work breakdown structure (WBS)
  - C. Specifications for formal verification and acceptance of completed project deliverables
  - D. All of the above
  
2. You are creating your WBS and find that you keep decomposing tasks into smaller and smaller units. How can you tell when you are done?
  - A. Keep decomposing tasks until you reach an amount of work that is small enough to reliably estimate required resources and duration.
  - B. Keep decomposing tasks until you reach an amount of work that can be accomplished in one hour.
  - C. Keep decomposing work until you reach an amount of work that can be accomplished in your organization's basic work unit.
  - D. Keep decomposing work until you reach a predetermined number of hierarchy levels to keep the WBS balanced.
  
3. Which of the following is a valid input to the collect requirements process?
  - A. Project charter
  - B. Requirements traceability matrix
  - C. Validated deliverables
  - D. Work performance information

**Answers**

1. Answer D is the best response. The project scope management plan includes preparation of a detailed project scope statement, creation of the WBS, and a process specifying how formal verification and acceptance of the completed project deliverables will be obtained.
2. Answer A is correct. A properly sized work package is one that is small enough to allow for reliable estimates for required resources and duration. Answers B, C, and D are incorrect because they assume that you are working toward some artificial target that does not contribute to appropriately sized work packages.
3. Answer A is correct. The project charter is one of two defined inputs for the collect requirements process. (The other input is the stakeholder register.) Answer B is incorrect because the requirements traceability matrix is an output for the collect requirements process. Answers C and D are incorrect because they refer to inputs from other processes.

*Scope management* is the set of processes which ensures that the requirements of the customer are captured in a specification of work that ensures the delivery of the project's deliverables, that all the project work is done, and that only the work required to complete the project is done. In other words, scope management makes sure that the project is completed without expending any unnecessary effort.

## Plan Scope Management

The first process in scope management is a new process, plan scope management. The *PMBOK Guide*, Fifth Edition, adds several processes to separate the initial planning activities from other activities. While all the processes you will learn about in this chapter relate to planning, the new initial processes in scope management and three other process groups bring attention to the importance PMI places on proper planning. The plan scope management process creates the scope management plan. The scope management plan describes the project scope and documents how it will be further defined, validated, and controlled. This process results in a plan that gives the project team guidance on how to manage the scope throughout the project life cycle. Table 4.2 shows the inputs, tools and techniques, and outputs for the plan scope management process.

**TABLE 4.2 Plan Scope Management Inputs, Tools and Techniques, and Outputs**

Inputs	Tools and Techniques	Outputs
Project management plan	Expert judgment	Scope management plan
Project charter	Meetings	Requirements management plan
Enterprise environmental factors		
Organizational process assets		

## Collect Requirements

The second process in the scope management process group is the collect requirements process. This process seeks to use multiple tools and techniques to collect all the project requirements from all the stakeholders. This process attempts to leave no stone unturned and results in a complete list of project requirements. When properly performed, the collect requirements process dramatically reduces surprises as the project moves toward completion. Table 4.3 shows the inputs, tools and techniques, and outputs for the collect requirements process. Pay particular attention to the various creative methods you can employ to develop a list of project requirements.

**TABLE 4.3 Collect Requirements Inputs, Tools and Techniques, and Outputs**

Inputs	Tools and Techniques	Outputs
Scope management plan	Interviews	Requirements documentation
Requirements management plan	Focus groups	Requirements traceability matrix
Stakeholder management plan	Facilitated workshops	
Project charter	Group creativity techniques	
Stakeholder register	Group decision-making techniques	
	Questionnaires and surveys	
	Observations	
	Prototypes	
	Benchmarking	
	Context diagrams	
	Document analysis	

## Define Scope

The next process, *define scope*, is a process that clearly states what the project will and will not accomplish. The supporting documents are reviewed to ensure that the project will satisfy the stated goals, and the resulting scope should state the stakeholders' needs and clearly communicate the expectations for the performance of the project. Table 4.4 shows the inputs, tools and techniques, and outputs for the define scope process.

TABLE 4.4 **Define Scope Inputs, Tools and Techniques, and Outputs**

Inputs	Tools and Techniques	Outputs
Scope management plan	Expert judgment	Project scope statement
Project charter	Product analysis	Project document updates
Requirements documentation	Alternatives identification	
Organizational process assets	Facilitated workshops	

## Work Breakdown Structure: A Common and Dangerous Omission

Many inexperienced project managers move too quickly from the scope statement to the activity sequencing processes. This practice is a mistake and often leads to activity omissions and inaccurate plans. PMI stresses the importance of creating a *work breakdown structure (WBS)* before moving to activity management processes.

A WBS provides the project manager and project team with the opportunity to decompose the high-level scope statement into much smaller, more manageable units of work, called *work packages*. The resulting WBS should provide a complete list of all work packages required to complete the project (and nothing more). Table 4.5 shows the inputs, tools and techniques, and outputs for the create WBS process.

TABLE 4.5 **Create WBS Inputs, Tools and Techniques, and Outputs**

Inputs	Tools and Techniques	Outputs
Scope management plan	Decomposition	Scope baseline (project scope statement, WBS, and WBS dictionary)
Project scope statement	Expert judgment	Project document updates
Requirements documentation		



Inputs	Tools and Techniques	Outputs
Enterprise environmental factors		
Organizational process assets		

### ExamAlert

The *PMI Practice Standard for Work Breakdown Structures* is the guide you need to use for the PMP exam. This is an example of information on the exam that goes beyond the PMBOK. You can find this document in the publications section of the PMI website (<http://www.pmi.org/en/PMBOK-Guide-and-Standards/Standards-Library-of-PMI-Global-Standards.aspx>).

In creating the WBS, the project team repeatedly decomposes the work of the project into smaller and smaller units of work, and the result is a collection of small work packages. The process continues until the resulting work packages are simple enough to reliably estimate duration and required resources. Don't go overboard, though. When you have work packages that are manageable and each represent a single work effort, stop the process. Each project is different, so this process results in different levels of detail for each project.

### ExamAlert

The term *work package* refers to an individual project activity. The work package is the lowest-level WBS component. According to the PMBOK, "A work package can be scheduled, cost estimated, monitored, and controlled."

The last main feature of the WBS is that it is organized in a hierarchical fashion. The highest level is the project. The children that represent project phases, divisions, or main deliverables are listed under the project. Each child process or task is divided into further levels of detail until the lowest level, the work package, is reached. Figure 4.2 depicts a sample WBS with multiple levels.

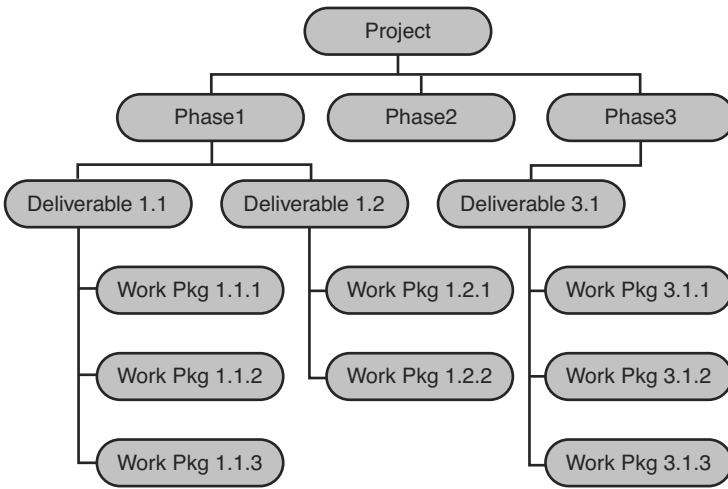


FIGURE 4.2 Sample work breakdown structure.

In addition to the WBS itself, another output of the create WBS process is the WBS dictionary. The *WBS dictionary* is a document that supports the WBS by providing detailed information for each work package. The WBS dictionary can contain many types of information, including

- ▶ Work package name or identifier
- ▶ Accounting code identifier
- ▶ Description of work
- ▶ Technical specifications
- ▶ Quality requirements
- ▶ Owner or responsible party assignment
- ▶ Required resources
- ▶ List of schedule milestones
- ▶ Associated schedule activities
- ▶ Cost estimates
- ▶ Acceptance criteria
- ▶ Contract information

## Cram Quiz

Answer these questions. The answers follow the last question. If you cannot answer these questions correctly, consider reading this section again until you can.

1. As project manager, you are about to start the define scope process. You have the project charter and the organizational process assets list. Because there are no change requests in your project at this point, what must you have before you begin?
  - A. Product analysis
  - B. Requirements documentation
  - C. Updates to project documents
  - D. WBS
2. What does a project scope statement document?
  - A. What work is to be completed during the project
  - B. What deliverables need to be produced by the project
  - C. Both A and B
  - D. Neither A nor B
3. The work breakdown structure (WBS) does all of the following except
  - A. Organizes and defines the entire scope of the project
  - B. Divides the project into smaller, more manageable tasks
  - C. Serves as a high-level planning tool for work planned but not yet approved
  - D. Both A and B
4. Which of the following is an output of the collect requirements process?
  - A. Scope management plan
  - B. Requirements management plan
  - C. Requirements risk breakdown
  - D. Requirements traceability matrix

## Cram Quiz Answers

1. Answer B is correct. The requirements documentation is an input you need before starting the define scope process. Answer A is incorrect because product analysis is a tool and technique of define scope, not an input. Answer C is incorrect because project document updates are an output, not an input. Answer D is incorrect because the WBS is created in a subsequent process and is not available at this point. Know your inputs, tools and techniques, and outputs of all processes.
  2. Answer C is the best response. A project scope statement documents what work is to be accomplished and which deliverables need to be produced. Answers A and B are both individually correct, but Answer C is the better response. Answer D is incorrect.
  3. Answer C is the correct response. The WBS provides a detailed definition of work specified in the current, approved project scope statement. Both Answers A and B describe the WBS and are therefore incorrect responses to the question.
  4. Answer D is the correct response. Answers A and B are incorrect because these are outputs of the plan scope management process. Answer C is incorrect because there is no such defined output as a requirements risk breakdown.
-

# Activity Planning—From WBS to Project Schedule

- ▶ **Plan Schedule Management—6.1**
- ▶ **Define Activities—6.2**
- ▶ **Sequence Activities—6.3**
- ▶ **Estimate Activity Resources—6.4**
- ▶ **Estimate Activity Durations—6.5**
- ▶ **Develop Schedule—6.6**

## CramSaver

If you can correctly answer these questions before going through this section, save time by skimming the Exam Alerts in this section and then completing the Cram Quiz at the end of the section.

1. Which type of network diagram method allows you to depict four types of dependencies?
  - A. Precedence diagramming method (PDM)
  - B. Arrow diagramming method (ADM)
  - C. Dependency diagramming method (DDM)
  - D. Gantt chart diagram (GCD)
  
2. What term is defined as the practice of planning activities based on how soon the tasks are scheduled to start, such that activities that are close to their start date are planned at a more detailed level than those farther in the future? This term also implies that more detailed plans are required as activities approach their start date.
  - A. Progressive elaboration
  - B. Rolling wave planning
  - C. Planning component elaboration
  - D. Milestone detail planning
  
3. Which of the following statements best describes the estimate activity resources process?
  - A. Identifying and documenting relationships among the project activities
  - B. Identifying the specific actions to be performed to produce the project deliverables
  - C. Estimating the number of work periods needed to complete individual activities
  - D. Estimating the type and quantities of material, people, equipment, or supplies to perform each activity

4. Which estimating technique is best to use if you know the standard usage rate for a resource (such as an installer can pull 40 feet of cable per hour) to estimate the duration of an activity?
- A. Analogous estimating
  - B. Parametric estimating
  - C. Three-point estimates
  - D. Reserve analysis
5. Which of the following is NOT a tool and technique for the develop schedule process?
- A. Critical path method
  - B. Alternatives analysis
  - C. Schedule network analysis
  - D. Leads and lags

## Answers

1. Answer A is correct. The precedence diagramming method (PDM), also called activity-on-node (AON) diagramming, supports finish-to-start, finish-to-finish, start-to-start, and start-to-finish dependencies. PDM is often used in critical path methodology (CPM). Answer B is incorrect because the arrow diagramming method (ADM) only allows for finish-to-start dependencies. Answers C and D are incorrect because they are not real diagramming methods.
2. Answer B is the best answer. Rolling wave planning is providing detailed plans for tasks that are starting in the near future by using the most current information and revisiting future activities as their starting dates approach. Although rolling wave planning is a type of progressive elaboration, it is mainly concerned with near-term activities. Answer A is not the best answer because progressive elaboration is the process of continuously improving a project plan as more is learned about the project. Answers C and D are incorrect because they are not valid project planning terms.
3. Answer D is correct. Estimate activity resources is the process of estimating the type and quantities of material, people, equipment, or supplies to perform each activity. Answer A is incorrect because it describes the sequence activities process. Answer B is incorrect because it describes the define activities process. Answer C is incorrect because it describes the estimate activity durations process.
4. Answer B is correct. Parametric estimating uses known historical data, such as production rates, to estimate duration. Answer A is incorrect because analogous estimating uses comparison with other, similar project work. Answer C is incorrect because three-point estimates use best, worst, and most likely estimates to calculate duration. Answer D is incorrect because it refers to the process of including contingency reserves into estimates, not actually calculating estimate durations.

5. Answer B is correct. Alternative analysis is a tool and technique for the estimate activity resources process. Estimate activity resources is the process of estimating the type and quantities of material, people, equipment, or supplies to perform each activity. Answers A, C, and D are all tools and techniques for the develop schedule process.

The next section of the planning processes address the steps required to develop the project schedule. This is the part of the project plan that might be most familiar to new project managers. Many automated project management tools help create schedules by keeping track of activities, resources, durations, sequencing, and constraints. Although the schedule is an integral part of the project plan, it is only one part. Don't start working on the schedule until you have a proper WBS. Starting to work before completing the WBS nearly always results in doing more work than is necessary. A good WBS reduces task redundancy and helps ensure that all work performed is in the scope of the project.

## Plan Schedule Management

The first process in the time management knowledge area is *plan schedule management*. This process defines the policies and procedures for planning, managing, and controlling the project schedule. This process provides guidance on how the schedule will be managed throughout the project. All the subsequent processes in the time management knowledge area depend on the plan developed in this process. Table 4.6 shows the inputs, tools and techniques, and outputs for the plan schedule management process.

**TABLE 4.6 Plan Schedule Management Inputs, Tools and Techniques, and Outputs**

Inputs	Tools and Techniques	Outputs
Project management plan	Expert judgment	Schedule management plan
Project charter	Analytical techniques	
Enterprise environmental factors	Meetings	
Organizational process assets		

## Define Activities

The first process in the activity planning section is *define activities*. This process starts with the WBS and identifies the activities required to produce the various project deliverables. Activities are viewed from the perspective of the work packages. You ask the question, “What activities are required to satisfy this work package requirement?” Next, the resulting information from this process is used to organize the activities into a specific sequence. Table 4.7 shows the inputs, tools and techniques, and outputs for the define activities process.

TABLE 4.7 **Define Activities Inputs, Tools and Techniques, and Outputs**

Inputs	Tools and Techniques	Outputs
Schedule management plan	Decomposition	Activity list
Scope baseline	Rolling wave planning	Activity attributes
Enterprise environmental factors	Expert judgment	Milestone list
Organizational process assets		

Sometimes it is difficult to know everything about a project during the planning stage. It is common to learn more about the project as you work through the project life cycle. This is called *progressive elaboration* and affects the planning process. If you don’t know everything about a project, you can’t plan the whole project to the necessary level of detail.

For a large project, it is common to plan the entire project at a high level. The project starts with detailed plans in place for the work packages that are near the beginning of the project. As the time draws near to begin additional work, the more detailed, low-level plans for those work packages are added to the project plan. The planning process is revisited multiple times to ensure that the detailed plans contain the latest information known about the project. This practice is called *rolling wave planning* because the planning wave always moves to stay ahead of the work execution wave.

## Sequence Activities

The next process is arranging the activities list from activity definition into a discrete sequence. Some activities can be accomplished at any time throughout the project. Other activities depend on input from another activity or are constrained by time or resources. Any requirement that restricts the start or end time of an activity is a *dependency*. This process identifies all relationships between activities and notes restrictions imposed by these relationships.



For example, when building a car, you cannot install the engine until the engine has been built and delivered to the main assembly line. This is just one example of how activities can be dependent on one another. The sequence activities process is one that can benefit from the use of computer software to assist in noting and keeping track of inter-activity dependencies. Table 4.8 shows the inputs, tools and techniques, and outputs for the sequence activities process.

**TABLE 4.8 Sequence Activities Inputs, Tools and Techniques, and Outputs**

Inputs	Tools and Techniques	Outputs
Schedule management plan	Precedence diagramming method (PDM)	Project schedule
Activity list	Dependency determination	Project documents updates
Activity attributes	Leads and lags	
Milestone list		
Project scope statement		
Enterprise environmental factors		
Organizational process assets		

## Network Diagrams

One of the most important topics to understand when planning project activities is how to create network diagrams. A *network diagram* provides a graphical view of activities and how they are related to one another. The PMP exam tests your ability to recognize and understand the most common type of network diagramming method: the *precedence diagramming method (PDM)*. Make sure you can read a PDM diagram and use the information it presents.

Figure 4.3 shows an example of a PDM diagram.

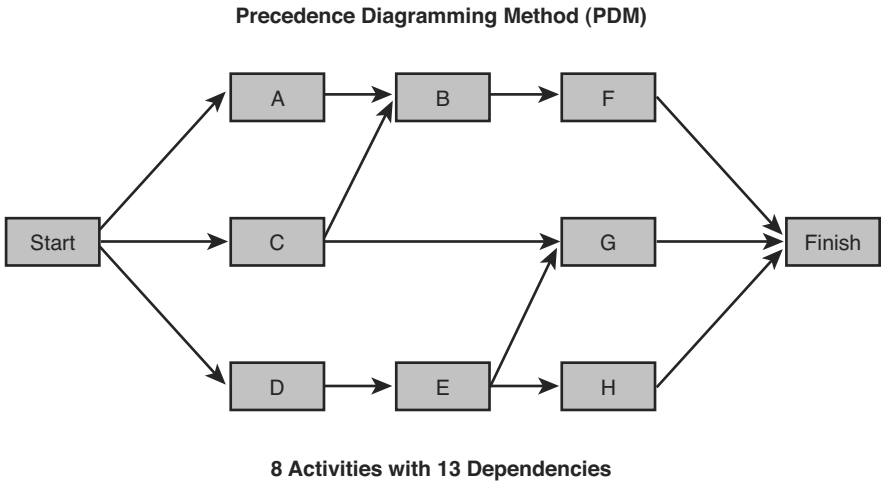


FIGURE 4.3 The precedence diagramming method.

## Precedence Diagramming Method

A PDM diagram shows nodes—representing activities—connected by arrows that represent dependencies. To represent that activity B is dependent on activity A (in other words, activity A must be complete before activity B starts), simply draw an arrow from A to B. PDM diagrams are also referred to as activity-on-node (AON) diagrams because the nodes contain the activity duration information. (We don't have enough information to complete all the information presented here yet. We'll fill in the duration information during activity duration estimating.) In fact, nodes generally contain several pieces of information, including

- ▶ **Early start**—The earliest date the activity can start
- ▶ **Duration**—The duration of the activity
- ▶ **Early finish**—The earliest date the activity can finish
- ▶ **Late start**—The latest date the activity can start
- ▶ **Late finish**—The latest date the activity can finish
- ▶ **Slack**—Difference between the early start and the late start dates

Figure 4.4 shows an example of a PDM node template.

Early Start	Duration	Early Finish
Task Name		
Late Start	Slack	Late Finish

FIGURE 4.4 The sample PDM node template.

The PDM diagram in Figure 4.3 shows eight activities, labeled A through H, with 13 dependencies. The arrows show how some activities are dependent on other activities. For example, activity B cannot start until activities A and C are complete. To show this dual dependency, we draw an arrow from A to B and another arrow from C to B.

You can represent four types of dependencies with a PDM diagram:

- ▶ **Finish-to-start (the most common dependency type)**—The successor activity’s start depends on the completion of the predecessor activity.
- ▶ **Finish-to-finish**—The completion of the successor activity depends on the completion of the predecessor activity.
- ▶ **Start-to-start**—The start of the successor activity depends on the start of the predecessor activity.
- ▶ **Start-to-finish**—The completion of the successor activity depends on the start of the predecessor activity.

### ExamAlert

Carefully consider the different types of dependencies. Some—especially start-to-finish—can be confusing. On the exam, you are asked to evaluate the scheduling effect of changes in start or end dates. The overall effect on the project depends on the type of relationship between activities. Don’t skip over the dependencies too quickly. Take the time to really read the question before you construct diagrams.

## Project Task Information

When you are comfortable with the main types of network diagrams, you need to understand how to use them. Let’s talk about a few basic scheduling concepts and look at how network diagrams help you understand project schedules, starting with a few project tasks. Table 4.9 lists the tasks for a project, along with the predecessors, duration, and earliest start date.

TABLE 4.9 Project Task Information

Activity	Predecessor	Duration	Earliest Start Date
A	None	5	9/5/14
B	A	2	9/10/14
C	A	3	9/10/14
D	B	7	9/12/14
E	C	4	9/13/14
F	D	1	9/19/14
G	E, F	2	9/20/14

Now use the sample PDM node template shown in Figure 4.4 to create a PDM diagram for the project.

Your completed network diagram should look like the one shown in Figure 4.5.

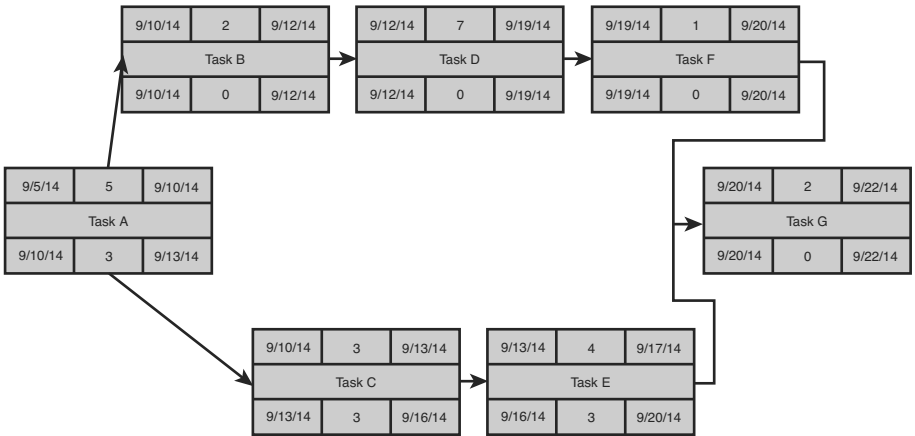


FIGURE 4.5 A completed sample PDM diagram.

## Estimate Activity Resources

Now you have a list of activities and their relative dependencies. The next process is to associate activities with the resources required to accomplish the work. This process involves listing each type and amount, or quantity, of each required resource. Every activity requires resources of some sort. Activity resources can include

- ▶ People
- ▶ Materials and supplies
- ▶ Equipment
- ▶ Money

Table 4.10 shows the inputs, tools and techniques, and outputs for the estimate activity resources process.

**TABLE 4.10 Estimate Activity Resources Inputs, Tools and Techniques, and Outputs**

Inputs	Tools and Techniques	Outputs
Schedule management plan	Expert judgment	Activity resource requirements
Activity list	Alternative analysis	Resource breakdown structure
Activity attributes	Published estimating data	Project documents updates
Resource calendars	Bottom-up estimating	
Risk register	Project management software	
Activity cost estimates		
Enterprise environmental factors		
Organizational process assets		

Two of the tools and techniques warrant further discussion. One of the techniques you use when estimating activity resources is *alternative analysis*. Analyzing the various alternatives provides an opportunity to consider other sources or ways to achieve the desired result for an activity. Alternatives might be more desirable than the initial expected approach due to cost savings, higher quality, or earlier completion. Another important outcome of alternative analysis is that in case the primary source becomes unavailable, you might have already identified a replacement method to complete the work. Suppose your main supplier of industrial fittings suffers a catastrophic fire. If your alternative analysis identified another source, you might be able to continue the project with minimal disruption.

The second item is bottom-up estimating. Recall that one of the purposes of creating the WBS is to decompose project work into work packages that are small enough to reliably estimate for duration and resource requirements. Using the WBS, you can provide estimates for mid- and high-level work by aggregating the estimates for the work packages that make up the desired work. Because this process starts at the lowest level of work (the work package) to create the estimate, it is called *bottom-up estimating*. This type of estimating tends to be fairly accurate because the estimates come from the people doing the actual work. The alternative is *top-down estimating*. Top-down estimates generally come from management or a source that is higher up than the

people actually doing the work. The estimates are really educated guesses on the amount of resources required for a collection of work packages and tend to be less reliable than bottom-up estimates.

## Estimate Activity Durations

After the resource estimates are established for each of the activities, it's time to assign duration estimates. The *estimate activity durations process* approximates the number of work periods that are needed to complete scheduled activities. Each estimate assumes that the necessary resources are available to be applied to the work package when needed. Table 4.11 shows the inputs, tools and techniques, and outputs for the activity duration estimating process.

**TABLE 4.11 Estimate Activity Duration Inputs, Tools and Techniques, and Outputs**

Inputs	Tools and Techniques	Outputs
Schedule management plan	Expert judgment	Activity duration estimates
Activity list	Analogous estimating	Project documents updates
Activity attributes	Parametric estimating	
Activity resource requirements	Three-point estimating	
Resource calendars	Group decision-making techniques	
Project scope statement	Reserve analysis	
Risk register		
Resource breakdown structure		
Enterprise environmental factors		
Organizational process assets		

In addition to expert judgment and reserve analysis, four main techniques are used for project activity duration estimation. In many cases, using multiple techniques provides more accurate estimates. The four estimation techniques are

- ▶ **Analogous estimating**—This uses actual duration figures from similar activities. These activities can be from the same project or another project but share similarities in budget, size, weight, complexity, or other parameters.
- ▶ **Parametric estimating**—This calculates duration estimates by multiplying the quantity of work by the productivity rate. This type of estimate works best for standardized, and often repetitive, activities.

- ▶ **Three-point estimates**—This uses three estimate values for each activity:
  - ▶ **Most likely ( $t_M$ )**—The duration most likely to occur.
  - ▶ **Optimistic ( $t_o$ )**—The duration of the activity based on the best-case scenario.
  - ▶ **Pessimistic ( $t_p$ )**—The duration of the activity based on the worst-case scenario.

This approach originated with the Program Evaluation and Review Technique (PERT). PERT analysis calculates the expected ( $t_E$ ) activity from the three-point estimates by using the following formula:

$$t_E = (t_o + 4 * t_M + t_p) / 6$$

- ▶ **Triangular distribution**—This simple estimating method takes an average of the most likely, optimistic, and pessimistic values. Unlike a three-point estimate, each value receives the same weight. This estimating method assumes that risks are just as likely to be realized as the most likely estimate. You can calculate a triangular distribution by using the following formula:

$$\text{Average} = (t_o + t_M + t_p) / 3$$

## Develop Schedule

The next step is to develop the actual project schedule. The *develop schedule process* pulls all the activity information together and results in the project's initial (baseline) schedule. As work is iteratively planned and accomplished and the project moves through its life cycle, changes to the schedule are likely to occur. The schedule is a dynamic document and requires constant attention on the part of the project manager to ensure that the project stays on track. Table 4.12 shows the inputs, tools and techniques, and outputs for the develop schedule process.

TABLE 4.12 **Develop Schedule Inputs, Tools and Techniques, and Outputs**

Inputs	Tools and Techniques	Outputs
Schedule management plan	Schedule network analysis	Schedule baseline
Activity list	Critical path method	Project schedule
Activity attributes	Critical chain method	Schedule data

Inputs	Tools and Techniques	Outputs
Project schedule network diagrams	Resource optimization techniques	Project calendars
Activity resource requirements	Modeling techniques	Project management plan updates
Resource calendars	Leads and lags	Project documents updates
Activity duration estimates	Schedule compression	
Project scope statement	Scheduling tool	
Risk register		
Project staff assignments		
Resource breakdown structure		
Enterprise environmental factors		
Organizational process assets		

An important topic to understand with respect to project schedules is the critical path. In the AON diagram in Figure 4.3, the critical path is the longest path from start to finish. It is calculated by adding all the durations along each path from start to finish. The reason it is called the *critical path* is that any delay (or increase in duration) of any activity on the critical path causes a delay in the project. It is critical that all activities on this path be completed on schedule.

## Critical Path

Using the network diagram in Figure 4.5, you can calculate the project critical path. The *critical path* is the route with the longest total duration. The *critical path method* performs a forward and backward pass through the schedule network, calculating the early start and finish dates and the late start and finish dates for all activities, based on durations and relationships. The critical path method does not take into account resource limitations. The *critical chain method* does consider resource limitations. In short, the critical chain method uses the critical path method output and modifies the schedule network to account for limited resources. In this example, there are two routes from Task A to Task G:

- ▶ Path A–B–D–F–G will take 17 days to complete. (Just add up all the durations:  $5 + 2 + 7 + 1 + 2 = 17$ )
- ▶ Path A–C–E–G will take 14 days to complete.

From this diagram, you can see that the longest path is A–B–D–F–G, and that is the critical path. Any delays in any of these tasks delay the project.



## Float

The PDM diagram in Figure 4.5 has several pieces of information filled in for each node that we have not discussed. The task name and duration are self-explanatory. What about the rest of the information? The main task of developing the project schedule is to relate each of the tasks and combine duration, resource requirements, and dependencies. You need to make several passes through the network diagram to calculate the values necessary to create a project schedule.

In general, you make two main passes through each path in your network diagram. The first pass starts with the initial project task (the project start task). A task's early start date is the earliest you can start working on that task. The late start date is the latest you can start working on the task. The difference between the early and late start dates is called *float*. The float is the schedule flexibility of a task. In Figure 4.5, the early start date for Task A is 9/5/14. To get the early finish date, just add the duration to the early start date. The duration for Task A is 5 days, so the earliest Task A can finish is 9/10/14. Now, the early finish date for Task A becomes the early start date for any tasks that are dependent on Task A (namely, Task B and Task C). Then, continue to follow each path until you reach the final task, calculating the new early end dates by adding the duration to the early start dates.

### Note

Make sure you follow every path from the starting task to the ending task, calculating duration of each path. There are likely several paths that will get you there. Sometimes the shortest-duration path might not be immediately evident.

Now it is time for the second pass through your project to calculate the late start and late ending dates. This pass starts at the end and moves backward through the same paths you just followed in the forward pass. The first step in the backward pass is to record the late ending date. It is the same as the early ending date for the last task in the project. Then, subtract the duration to get the late start date. In Figure 4.5, the late ending date for Task G is 9/22/14, and the late start date is 9/20/14. Next, move backward to each task on which your current task depends (that is each task that has an arrow pointing to your current task). The late ending date for this predecessor task is the same as the late start date of the dependent task. In other words, the late ending date for Task F and Task E would be 9/20/14 (the late start date for Task G). Continue backward through the project, subtracting the duration to calculate a new late start date.

After completing both the forward and backward passes, you should have all of the early start times (EST), early finish times (EFT), late start times (LST), and late finish times (LFT) filled in. To complete the network diagram entries, calculate the float for each task by subtracting the early start date from the late start date. The float is the amount of time each task can be delayed without delaying the project.

Finally, add the durations for each path from the start task to the finish task. The largest total represents the critical path of your project. There could be more than one critical path. Remember that tasks on the critical path all have a float of 0, and any delay of a task on the critical path results in an overall project delay.

## Allocating Resources

In addition to calculating the critical path and critical chain, it might be necessary to address resource limitations. The process of reallocating resources that have been overallocated is called *resource leveling*. This technique seeks to avoid work stoppage due to limited resources being required by multiple activities. Remember that resource leveling can often change the critical path. Because resource allocation can change the critical path it is often useful to implement another technique: *what-if scenarios*. A what-if scenario allows the project planners to explore the effect to the critical path of resource availability changes. For example, if you depend on a particular person to complete work on the critical path, what happens if that person becomes ill? Such a question would be part of a what-if scenario.

---

## Cram Quiz

Answer these questions. The answers follow the last question. If you cannot answer these questions correctly, consider reading this section again until you can.

Use Figure 4.6 for Questions 1, 2, and 3.

1. What is the critical path for this project, and what is the duration of the critical path?
  - A. A–B–D–F–G, 13 days
  - B. A–C–E–G, 14 days
  - C. A–B–D–F–G, 14 days
  - D. A–C–E–G, 13 days

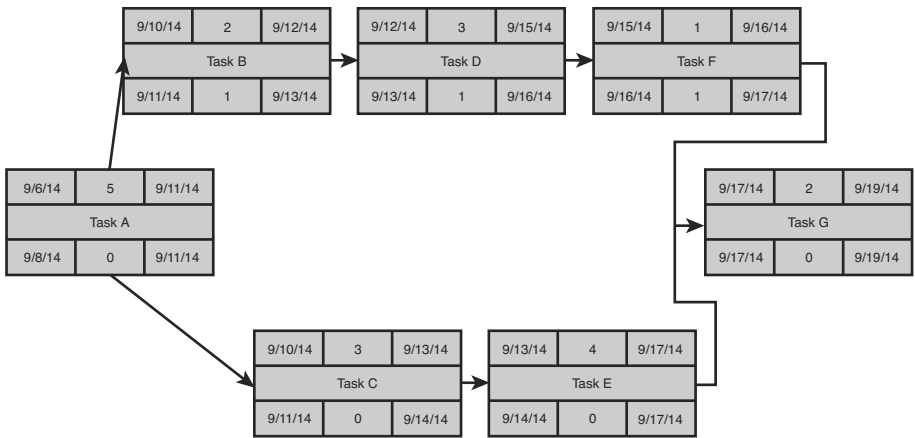


FIGURE 4.6 A sample PDM diagram.

- How many days late can Task D start without affecting the project completion date?
  - A. One day
  - B. Two days
  - C. Zero days
  - D. Three days
- If Task C starts two days late, what is the effect on the project end date?
  - A. The project ends one day late because there is slack of one day.
  - B. The project is still two days early because Tasks B, D, and F each have one day of slack.
  - C. The project is one day late because Task C is on the critical path.
  - D. There is no effect on the project end date.
- When developing the estimates for project phases, you choose to add the individual estimates for the activities comprising each phase. What type of estimation method are you using?
  - A. Parametric estimating
  - B. Bottom-up estimating
  - C. Top-down estimating
  - D. Analogous estimating
- What is the primary purpose of the define activities process?
  - A. Identify the specific actions to be performed that result in the stated project deliverables
  - B. Identify and document relationships among project activities
  - C. Analyze activity sequences, durations, resource requirements, and schedule constraints
  - D. Monitor the status of the project schedule and manage schedule changes

6. Which estimating technique is the best choice if you know the durations of similar activities from other projects?
- A. Analogous estimating
  - B. Parametric estimating
  - C. Three-point estimating
  - D. Historical analysis estimating
7. Which of the following is NOT an output of the develop schedule process?
- A. Project schedule
  - B. Schedule baseline
  - C. Schedule data
  - D. Resource breakdown structure

## Cram Quiz Answers

1. Answer B is correct. The path A–C–E–G is the longest direct path from start to finish. All other answers are incorrect because they state either the incorrect path or project duration.
  2. Answer A is correct. Because Task D is not on the critical path and has a slack of one day, it can start one day late (at most) without affecting the project end date.
  3. Answer C is correct. Because Task C is on the critical path, any delay of the task delays the project.
  4. Answer B is correct. Bottom-up estimating is the process of calculating estimates by aggregating the individual estimates of activities that make up the desired activity group. Answer A is incorrect because parametric estimating uses a process of multiplying quantity of work by the productivity rate. Answer C is incorrect because top-down estimating starts with an estimate and decomposes the estimate into smaller units to apply to the individual work packages. Answer D is incorrect because analogous estimating uses similar work packages, not estimate aggregation.
  5. Answer A is correct. The stated answer is the main purpose of the define activities process. Answer B is incorrect because it states the purpose of the sequence activities process. Answer C is incorrect because it states the purpose of the develop schedule process. Answer D is incorrect because it states the purpose of the control schedule process.
  6. Answer A is correct. Analogous estimating uses parameters from other similar activities to estimate durations. Answers B and C are incorrect because they refer to estimating techniques that do not consider similar activities. Answer D is incorrect because it refers to an estimating technique that doesn't exist.
  7. Answer D is correct. The resource breakdown structure is an output of the estimate activity resources process. Answers A, B, and C are incorrect because they are all valid outputs of the develop schedule process.
-

# Project Cost Estimating Factors

- ▶ **Plan Cost Management—7.1**
- ▶ **Estimate Costs—7.2**
- ▶ **Determine Budget—7.3**

## CramSaver

If you can correctly answer these questions before going through this section, save time by skimming the Exam Alerts in this section and then completing the Cram Quiz at the end of the section.

1. Which type of cost estimation would you use to estimate the cost to finish a floor if you knew the standard cost per square foot?
  - A. Analogous estimating
  - B. Parametric estimating
  - C. Three-point estimating
  - D. Bottom-up estimating
  
2. Which of the following is NOT an input for the determine budget process?
  - A. Basis of estimates
  - B. Project schedule
  - C. Risk register
  - D. Agreements

## Answers

1. Answer B is the best response. Parametric estimating calculates cost estimates by multiplying the quantity of work or result of work by a known rate. Answers A, C, and D are all valid estimating techniques, but they do not arrive at values based on known rates.
2. Answer C is correct. The risk register is an input to the estimate costs process, not the determine budget process. Answers A, B, and D are all valid inputs for the determine budget process.

## Plan Cost Management

The first process in the cost management knowledge area is *plan cost management*. This process defines the policies and procedures for planning, managing, and controlling project costs. This process provides guidance on how costs will be managed throughout the project, taking into account

stakeholder requirements for managing costs. All of the subsequent processes in the cost management knowledge area depend on the plan developed in this process. Table 4.13 shows the inputs, tools and techniques, and outputs for the plan cost management process.

**TABLE 4.13 Plan Cost Management Inputs, Tools and Techniques, and Outputs**

Inputs	Tools and Techniques	Outputs
Project management plan	Expert judgment	Cost management plan
Project charter	Analytical techniques	
Enterprise environmental factors	Meetings	
Organizational process assets		

## Estimate Costs

The *estimate cost process* associates an expected cost of performing work to each activity. Cost estimates can include labor, materials, equipment, and any other direct costs for project activities. Based on the activity resource and duration estimates, the cost estimates express the cost, normally in monetary amounts, of completing the work of the project. As with all other project documents, the cost estimates can change through the project as conditions change. Different events can cause the cost for any activity to go up or down and may require the cost estimates for the project to change. Table 4.14 shows the inputs, tools and techniques, and outputs for the estimate cost process.

**TABLE 4.14 Estimate Cost Inputs, Tools and Techniques, and Outputs**

Inputs	Tools and Techniques	Outputs
Cost management plan	Expert judgment	Activity cost estimates
Human resource management plan	Analogous estimating	Basis of estimates
Scope baseline	Parametric estimating	Project documents updates
Project schedule	Bottom-up estimating	
Risk register	Three-point estimating	
Enterprise environmental factors	Reserve analysis	
Organizational process assets	Cost of quality	

Inputs	Tools and Techniques	Outputs
	Project management software	
	Vendor bid analysis	
	Group decision-making techniques	

Cost estimates are compiled into the project budget. You probably recognize several estimating techniques from other processes. Three of the techniques used in the estimate costs process are the same basic techniques used in the estimate activity durations process. The other technique, bottom-up estimating, is also used in the estimate activity resources process. Although they are the same techniques, they are applied to different criteria and bear revisiting.

- ▶ **Analogous estimating**—This uses actual cost values from similar activities. These activities can be from the same project or another project.
- ▶ **Parametric estimating**—This calculates cost estimates by multiplying the quantity of work or result of work, such as square feet or hours, by a known rate, such as \$30 per square foot or \$45 per hour. This type of estimate works best for standardized, and often repeated, activities.
- ▶ **Three-point estimating**—This uses three estimate values for each activity:
  - ▶ **Most likely**—The cost most likely to occur
  - ▶ **Optimistic**—The cost of the activity if everything goes as planned, or better
  - ▶ **Pessimistic**—The cost of the activity in a worst-case scenario
- ▶ **Bottom-up estimating**—This technique calculates cost estimates by adding the costs of each individual work package. The technique starts at the most detailed level and rolls up the costs until a total cost for the project is obtained.

## Determine Budget

After you know the costs to accomplish the work of the project, you can create the project budget. The *determine budget process* aggregates the activity cost estimates into a single document for the project. The resulting project budget expands on the preliminary budget from the project charter and provides far more detail. Table 4.15 shows the inputs, tools and techniques, and outputs for the determine budget process.

TABLE 4.15 **Determine Budget Inputs, Tools and Techniques, and Outputs**

Inputs	Tools and Techniques	Outputs
Cost management plan	Cost aggregation	Cost baseline
Scope baseline	Reserve analysis	Project funding requirements
Activity cost estimates	Expert judgment	Project documents updates
Basis of estimates	Historical relationships	
Project schedule	Funding limit reconciliation	
Resource calendars		
Risk register		
Agreements		
Organizational process assets		

### ExamAlert

Don't confuse the estimate costs process with the determine budget process. The determine budget process aggregates all of the activity cost estimates to result in a budget baseline against which your project costs will be measured.

## Cram Quiz

Answer these questions. The answers follow the last question. If you cannot answer these questions correctly, consider reading this section again until you can.

- The project cost and schedule for deliverables can be reasonably estimated at what level of the WBS?
  - A. The highest level
  - B. The middle level
  - C. The work package level
  - D. Both A and C



2. When the cost of an activity cannot be estimated with an adequate degree of certainty, the work within the activity can be decomposed. The resource requirements for each lower, more detailed work package can be estimated and aggregated to form a basis for estimating the cost for overarching scheduled activity. What is this type of estimating called?
  - A. Bottom-up estimating
  - B. Decomposed estimating
  - C. Should-cost estimating
  - D. Three-point estimating
  
3. Which process results in the project funding requirements document as one of its outputs?
  - A. Estimate activity resources
  - B. Estimate activity durations
  - C. Estimate costs
  - D. Determine budget

## Cram Quiz Answers

1. Answer D is the correct response. The project cost and project schedule for work can be reliably estimated at the work package, or lowest, level of the WBS using bottom-up estimating, or at the highest level using top-down estimating.
  2. Answer A is the correct response. Bottom-up estimating is a technique for estimating cost through decomposition. A bottom-up estimate is based on the cost requirements for each lower work package and then is combined to estimate cost of the entire component of work. Answer B is incorrect because there is no technique called decomposed estimating. Answer C is incorrect because should-cost estimating is an activity duration estimating technique. Answer D is incorrect because three-point estimating does not incorporate decomposition.
  3. Answer D is the correct response. The determine budget process produces the project funding requirements as one of its outputs, along with the cost performance baseline and project document updates. Answers A, B, and C are incorrect because these processes do not produce the project funding requirements document as an output. Make sure you know the inputs, tools and techniques, and outputs of all the project processes.
- 

## What Next?

If you want more practice on this chapter's exam topics before you move on, remember that you can access all of the Cram Quiz questions on the CD. You can also create a custom exam by topic with the practice exam software. Note any topic you struggle with and go to that topic's material in this chapter.

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