
PMP Examination Preparation

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Course Introduction

Student Guide Overview

This student guide is designed to be the primary resource for your PMI Project Management Professional or PMP® Certification Exam Prep course. The course itself is an online course which includes video lecture, exercises, and practice quizzes. It is specifically designed for the PMP® Exam released in March, 2018. However, if you have not purchased the online course you will still find this book extremely useful in preparing for the exam. Regardless of whether you have purchased the online course or not, it is highly recommended that you obtain a copy of the PMBOK® Guide from the PMI® online bookstore.

Throughout the guide major points are called out in the sidebar to improve learning. These comments appear with one of several indicators to highlight the type of information provided. These indicators include:

-  **TIPS** — Key tips to help ensure that you pass your test.
-  **WARNINGS** — Major pitfalls that often cause people to fail the test.
-  **FORMULAS** — Major formulas or calculations used in the exam.
-  **PRACTICE EXAMS** — Practice exams to help you prepare for the exam.
-  **INFORMATION** — Quick points of general information about the PMP® exam.
-  **ONLINE COURSE REFERENCE** — Shows which slide the content is referring to.

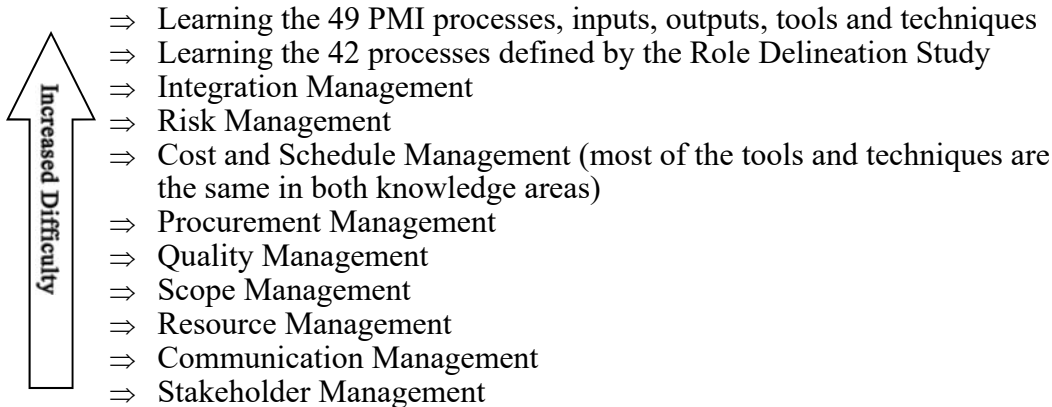
The course is divided into 14 chapters that can be covered in three days when administered in the live, instructor-led format. The chapters are designed to take participants through the entire PMP® Certification Exam. The 14 chapters include the following:

- ⇒ **Chapter 1** — Application and the PMP® Exam
- ⇒ **Chapter 2** — Types of Exam Questions
- ⇒ **Chapter 3** — The Basics of Project Management
- ⇒ **Chapter 4** — Project Integration Management
- ⇒ **Chapter 5** — Project Scope Management
- ⇒ **Chapter 6** — Project Schedule Management
- ⇒ **Chapter 7** — Project Cost Management
- ⇒ **Chapter 8** — Project Quality Management
- ⇒ **Chapter 9** — Project Resource Management
- ⇒ **Chapter 10** — Project Communications Management
- ⇒ **Chapter 11** — Project Risk Management
- ⇒ **Chapter 12** — Project Procurement Management
- ⇒ **Chapter 13** — Project Stakeholder Management
- ⇒ **Chapter 14** — Professional Responsibility



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Not all chapters have the same level of difficulty. When studying, you should therefore allot your time based upon the suggested level of difficulty. Most candidates find the information/knowledge areas fall on a spectrum from most difficult to least difficult that looks like this:



This manual provides some additional resources to assist your learning. The first is a copy of the PowerPoint material used to develop the online course. Additionally, there are three documents that will help you prepare for the exam. These include the PMP Handbook, the Current PMP Exam Content Outline, and the PMP Sample Questions. Each of these items are PDFs that you may download and print and are found at:

<https://www.pmi.org/certifications/types/project-management-pmp/exam-prep>

Course Expectations

Welcome to the world of PMI® and PMP® Certification! Today, project management is one of the fastest growing, most in-demand professions in the world. This course is designed to help you navigate the mountain of information surrounding certification and help you successfully prepare to pass the PMP® certification examination. Unlike other certifications, it is totally unrealistic to expect that you can take **ANY** exam prep course and immediately pass the exam. You must invest your own time to pass. As part of completing this course, you should plan on spending 30-40 hours studying for the test. This largely means taking practice exams and reviewing content based on the practice results. This book is the primary resource for your review. Where necessary, your manual also recommends additional resources for added information.

This course assumes you are already familiar with the 2017 6th edition of the PMBOK® Guide. If you have never read the PMBOK® Guide, stop now and visit the PMI marketplace at <http://marketplace.pmi.org/Pages/default.aspx?Category=PMBOKGuide> to obtain a copy of it immediately. Although the exam is NOT based on the Guide, it is the most important resource. We strongly recommend that you read the PMBOK® Guide using the three read technique used by many of the top graduate schools in the United States. In this technique:



Focus your studies based on the level of difficulty



Download the PMP® Credential Handbook



You must plan to spend 30 to 40 hours studying to pass the exam.

- ⇒ First skim the entire work taking not more than 90 minutes to two hours for the entire book focusing on the headings, graphics and captions. Don't worry that you can't remember anything. You are just getting the big ideas at this point.
- ⇒ Secondly, read for understanding and highlight important information. However, be careful. The PMBOK® Guide is incredibly information dense and there is a tendency to highlight too much.
- ⇒ Finally, review your highlighted content to ensure your learning.

At first blush it might not seem like the three read technique is a time saver, however using this technique will save significant time and dramatically increase your understanding and retention—both of which will increase your likelihood of passing the exam on the first try.

Despite the fact that the PMBOK® Guide is very important for the exam, it is a misconception to think that the PMI-PMP® Exam is based on the PMBOK® Guide. This is not the case. The exam is actually based on a document called the Role Delineation Study, or RDS, which is conducted every three to five years as part of PMI's standards development process. The RDS is available on Amazon or PMI's bookstore. However, be forewarned it is not your typical read. The RDS is a social science survey report showing what skills, tools, and techniques real-world project managers are using to deliver business results. Unfortunately, the information is not presented in a way that provides much help. Outside of the PMBOK® Guide there are twelve books considered foundational for the exam. The PMBOK® Guide is merely one of the 12 although it provides the framework for project management. The other books used as a foundation for the exam include:

- ⇒ *Project and Program Risk Management*, R. Max Wideman, Editor
- ⇒ *Quality Management for Projects and Programs*, Lewis R. Ireland
- ⇒ *Doing Business Internationally*, Walker, Walker and Shmitz
- ⇒ *The Cultural Dimensions of International Business*, Gary P. Ferraro
- ⇒ *Global Literacies*, Robert Rosen
- ⇒ *How to Lead Work Teams*, Fran Rees
- ⇒ *Principles of Project Management*, PMI®
- ⇒ *Project Management A Systems Approach*, Harold Kerzner
- ⇒ *Human Resource Skills for the Project Manager*, Vijay K. Verma
- ⇒ *Earned Value Practice Standard*, PMI®
- ⇒ *The Scrum Guide*™, Jeff Sutherland and Ken Schwaber

These books provide significant information used by the people who write the exam questions. However, it is **NOT** recommended that you read all of these books to prepare for the test unless you are really struggling with a topic and wish to have all the source information.

PMI's Assumptions

As you prepare for the PMP® exam, it is important that you understand some basic assumptions made by the exam item writers. These tidbits can be thought of as free points of wisdom for the exam. They provide much needed context for



Use the three read technique to quickly learn the PMBOK® Guide.



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specific questions. One of the basic assumptions PMI® makes with the exam is that you have real-world experience managing projects. You prove this assumption through the answers you provide on your application concerning your past positions.

The next assumption PMI® makes concerns the type of project you are leading. In the real-world, we are all leading very different sized projects across a wide range of industries. Unfortunately, it is impossible to test across that range. Therefore, PMI® standardizes the basic project used as the baseline for the exam. This is typically a large project in a matrixed organization. Examples of large projects include:

- ⇒ Deploying a new accounting, ERP, or CRM system for any organization of more than 500 people.
- ⇒ Building a new building, road, light-rail system, or other large traditional engineering endeavor.
- ⇒ Developing a new commercial product.
- ⇒ Creating a new manufacturing process for medium to heavy industry or hardware for a high technology firm.
- ⇒ Developing a new support operation for an organization of more than 500 people, such as a new accounting operation, call center, or help desk.

The best way to succeed on the exam is to keep one point of focus. Unless the question provides a different scenario, the following circumstances apply as you go through the exam. You work as a project manager for a large multinational called the Acme Widget Factory. You are leading a project to develop a new product that is critical to the organization's success. You are managing 100 resources located in five different time zones on two different continents. You work in a matrixed organization and none of the resources are dedicated to only your project or report directly to you. It is not enough to simply have worked on projects like these. To be successful with the exam, it is also important that you assume nothing goes perfectly. You are expected to have confronted the following challenges:

- ⇒ Significant issues with scope change.
- ⇒ Significant schedule and cost overruns.
- ⇒ Problems managing resource constraints.
- ⇒ Problems managing product quality.
- ⇒ Significant resource burnout.
- ⇒ A sense of fighting your processes to complete the real work.

The first “free” question is about what the acronym PMP® represents. PMP® stands for Project Management Professional® when formally spelled out. The second “free” question is “When was PMI® founded?” PMI® was founded in 1969. The third set of “free” questions deals with understanding why PMI® believes it is important that project managers become certified. PMI® offers three main reasons for certification from the project manager's perspective:

- ⇒ It gives you higher income potential
- ⇒ It proves you know international standards
- ⇒ It's required by a growing number of employers



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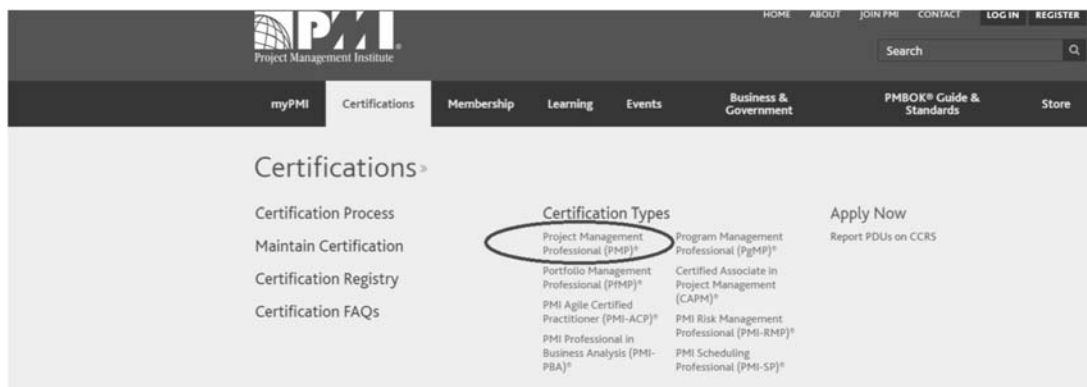


Image 1: PMI's Website Navigation

The Certification Process

Part of being successful in obtaining the PMP® is understanding the process that one must be undertaken to qualify and sit for the exam. This process begins by visiting PMI's website at <http://www.pmi.org> and selecting Certifications / Project Management Professional (PMP) as shown in the *Image 1* on this page. If you are ready to apply now select the *Apply Now* link found on the certification navigation. Once on the PMP® Certification page you can select the link for the Handbook to obtain a copy of the PMP® Certification Handbook. This publication provides all the information you need to know about the actual certification process, and is an excellent resource to have on hand as you complete the application itself. The handbook downloads as a PDF file. It is recommended that you save a copy. Next to the Handbook is a link for the exam content outline, and another link that will take you to a page dedicated to exam guidance. The Exam content outline and the exam guidance are less helpful than you would think, so we will skip them for now.

Once you have downloaded the handbook the real work begins. Select the *Apply Now* button. This will allow you to begin the application process. If this is the first time you have visited the site you are required to create a personal login. This login is valid for 90-days and allows you to complete the application over several sittings rather than all at once. The web application is very similar to a job application and requires you to prove you have the requisite amount of professional experience to sit for the PMP® exam. The form asks for your experience **LEADING** projects, but does **NOT** require that you actually held the title of project manager. As you complete the application, you are required to categorize your hours of experience based upon the five process groups found in the PMBOK® Guide. It is not required that you have hours reported in all the process groups on every project, but it is required that in total you have spent time in all the process groups. Most importantly, it is critical that you complete the application using the terminology found in the PMBOK® Guide and not the terminology from your organization. This is important because most of the application reviewers do not have experience within your organization and have been trained based upon PMI's standards. You do not want to do anything that would confuse your reviewer and thereby slow down the application process.



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Do not be tempted to exaggerate your experience in any way. PMI® is very good at weeding out embellished applications and you will likely be caught. Additionally, such efforts are clear violations of the PMI® Code of Conduct.

PMI® targets an audit rate between 12% and 18% of all applications received. Therefore, it is also possible to be selected for an audit without having a problem on your application. Should you be selected for an audit, PMI® will contact each of your former employers to confirm the information provided, and you will be asked to provide formal proof of your degree and educational status. PMI® commits to completing their portion of the audit process in five to seven days but you are allowed up to 90-days to collect all the information. Should you be audited you can reasonably expect the process to add 30-days to your timeline.

Once you have completed the Experience Verification Form you must submit it to PMI®. You are not required to submit payment at the time of application but you must pay the test fees prior to being able to schedule your exam. PMI® provides a significant enough discount to PMI® members that it actually costs less to join PMI® and pay for the test than to pay for the exam as a non-member. The fees for the exam are:

- ⇒ PMI® members pay \$405 (retaking the test costs \$275)
- ⇒ Non-members pay \$555 (retaking the test costs \$375)

Once you have received your acceptance notification from PMI® and have paid your exam fee you can schedule the test. With limited exceptions, the test is delivered as a computer-based exam and is not based on a set schedule. The exam is administered by Prometric Testing Centers. In most locations it can be taken Monday through Friday during normal business hours as well as on Saturday. This does not necessarily mean, however, that you can take the exam whenever you like. Prometric provides support for most standardized exams so there is often significant competition to get a seat. Therefore, you should schedule your exam at least two weeks prior to your target date and have a little flexibility around your date and time. To schedule your exam or to find the nearest testing center visit Prometric's website at:

<http://prometric.com/PMI>

PMP® Candidate Requirements

Many candidates are confused by PMI's requirements for entry to the exam. There are two major components of the requirements: your professional experience and your education that is specific to project management.

PMI® breaks a candidate's experience into two categories, referred to as Category I and Category II. The defining criteria for which category you are placed in is whether or not you hold a four year bachelor's degree or global equivalent. Candidates do not receive additional consideration for advanced degrees. Those holding a four year degree are considered Category I candidates and those without a four year degree or equivalent are considered Category II candidates. The category determines the number of hours of professional experience required to qualify for the exam.

-
- ⇒ **Category I Experience** — This indicates a minimum of three years/36 months unique non-overlapping professional project management experience during which at least 4,500 hours were spent leading and directing project tasks.
 - ⇒ **Category II Experience** — This indicates a minimum five years/60 months unique non-overlapping professional project management experience during which at least 7,500 hours were spent leading and directing project tasks.

Regardless of the category claimed, applicants are also required to complete 35 hours of formal education in project management. These are formally referred to as “*Contact Hours*.” This is one of the greatest areas of confusion for PMP® candidates so please read this carefully.

A **contact hour** is an hour of formal education with an instructor—or it’s equivalent. The actual course may be delivered using almost any method including online or virtual courses so long as there is a way to test the learning such as a post-course exam and/or survey. Self-directed learning will usually **NOT** qualify.

Contact hours do not expire and college or university courses may be included. When counting the hours of college or university courses, use the rule of thumb that one hour of face-time in the classroom with an instructor counts as one contact hour. Therefore, if your university was on a typical trimester system (fall, spring and summer) with 15 week semesters, and if your course met three times a week, you would claim 45 contact hours for a three credit hour course.

Finally, contact hours are the same as professional development units or PDUs. PDUs represent the continuing education credits that a PMI® certificate holder must obtain in order to keep their certification current. The PMP® requires an individual to obtain 60 PDUs over a three year period. However, any credits toward PDUs received prior to the certification date may not be counted. More information about PMI’s continuing education requirement can be found in the certification handbook. Make sure to consult with your instructor should you have any concerns about the courses you have taken.

PMI® periodically makes changes to the exam and its processes including, but not limited to: changes to the application, processing targets, qualification requirements, the passing score, the breakdown of questions on the test, and/or test administration. For the latest information contact PMI® directly. If there is a difference between information in this book and information given by PMI®, always follow PMI®.

Should you have questions about certification or any other PMI® specific information you should contact PMI® Customer Care at:

Project Management Institute
Certification Dept.
14 Campus Boulevard
Newtown Square, PA 19073-3299 USA
Tel: +1-610-356-4600
Fax: +1-610-356-4647
E-mail: customercare@pmi.org

If you do not have access to the internet, it is possible to complete the application using the application found in the PMP® Certification Handbook. Once you have completed the application simply mail it in to the address listed above. Using the paper application will significantly slow down the review process, however. PMI® says they will review paper applications within 10-days of receipt for an individual and within 20-days for a group. The standard for online applications is five days. You should not hold these as guarantees as it has been known to take longer based on the volume of applications PMI® has at any point in time.

The PMP® Exam

The standard format for the exam is a four hour, 200 question, computer-based test (CBT) administered in English. PMI® does allow for paper-based testing in limited circumstances. Those circumstances include:

- ⇒ Candidates who live at least 186.5 miles/300 km from a Prometric CBT site.
- ⇒ Employers (Corporate Sponsors) who wish to administer a PMI® examination to their employees. In this case, there is no restriction on distance. Only employees of that one organization may test at the event. PMI® also reserves the right to cancel a corporate session if less than 10 participants are scheduled to take the exam.
- ⇒ PMI® maintains additional restrictions for paper-based testing. To learn more about paper-based testing contact PMI® directly at pbtextams@pmi.org.

Although the test is only provided in English, PMI® does provide additional language support in several additional languages. In such situations the exam question is given in English on one half of the screen and the question and possible answers are on the other half of the screen translated into a second language. The available languages are shown in the *Image 2*.

Arabic	Hebrew
Brazilian Portuguese	Italian
Chinese (Simplified)	Japanese
Chinese (Traditional)	Korean
French	Russian
German	Spanish

Image 2: Additional Languages Supported

Upon entering the testing center you must provide two forms of identification. One of these must be a government issued photo ID.

Many of the testing centers provide storage for personal items. However, it is strongly recommended that you do not take anything other than your two forms of



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ID, keys, and a non-scientific calculator with you.

Should you get any math questions, the calculator can come in handy and often prevents simple errors. Fewer and fewer candidates every year get questions requiring significant math, but they are still possible and it is foolish to risk the chance of losing valuable points to simple math errors. Just make sure the calculator you bring is non-scientific. The testing center will provide scratch paper and pencils for your use.

Once you enter the testing center and provide your identification you will be led into the testing room. Depending on the center, there will be somewhere between one and more than a dozen workstations. Each workstation is the same, and provides access to the battery of tests administered by Prometric. The person sitting next to you might be taking the PMP® exam, or they might be taking any number of other exams. Even if the person sitting next to you is taking the PMP® exam they will not have the same test as you. So any effort to copy them will provide no benefit. When you sit to take the exam it is automatically generated from a test bank of more than 2,500 potential questions.

Although no examination preparation organization has access to this test bank, PMI® does disclose some important information about the test. To learn more about the test makeup, review the *Project Management Professional Examination Specification* available at the PMI® marketplace on PMI's website.

Exam questions are broken into six basic groupings and the number of questions per group is weighted based upon the table shown in *Image 3* to the right.

When you sit at your workstation you will be allowed up to 15-minutes to complete a tutorial that helps candidates become familiar with the computer interface and the

format in which the exam is presented. This time is not considered part of the four hours allowed for the actual test. There is also a 15-minute post-exam survey that asks you about your experience and preparation. Both of these 15-minute sections are optional.

Each of the 200 questions is accompanied by four potential answers of varying lengths. The four hour time limit is more than enough time to complete the exam. The average time to complete the test is between 2.5 hours and three hours. Of the 200 questions, 25 questions are pretest, or validation questions. These questions do not count in either the numerator or denominator of your exam score. However, it is impossible for the candidate to know which questions are real and which questions are part of the evaluation bank. Therefore, it is critical that you consider every question real. The pretest questions are used by PMI® to constantly develop and test new potential questions for the test bank.

Domain	Percentage of Questions
Initiation	13%
Planning	24%
Executing	31%
Monitoring and Controlling	25%
Closing	7%

Image 3: PMP® Examination Blueprint



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Domain Tasks

An issue that many PMP students struggle with is understanding the difference between the processes found in the PMBOK® Guide and those defined by PMI's Role Delineation Study. The two are actually very close but they are not in a one-to-one relationship. There are 49 processes defined in the PMBOK® Guide and 42 tasks found in the Role Delineation Study. It is important that you understand both sets of processes. For the purposes of this manual we will refer to the items found in the PMBOK® Guide as "*Processes*" and the items found in the Role Delineation Study as "*Tasks*." Both are grouped into the five process groups shown in Image 3 (Initiating, Planning, Executing, Monitoring and Controlling, and Closing). Much of this course focuses on the Processes found in the PMBOK® Guide. We will start however, with the Tasks and then relate them to the Processes as we go.

The Tasks are often an easier place to start because they are designed to represent a specific task done by the project manager and/or the team in the execution of a project. There is absolutely nothing that says that you must do all of the tasks or processes on any given project. Remember, these simply represent the most common or generally accepted practices PMI® has seen based on their Role Delineation Study (RDS). These tasks did NOT change with the release of the 6th edition of the PMBOK Guide, and will only change when the RDS is updated. It is fully expected, and even encouraged, that every project manager and their team must define the "*right*" processes and tasks on each specific project. This includes the selection of the specific methodology the team wishes to use.

The June, 2015 version of the Exam Content Outline defines the following tasks:

⇒ Initiating Domain — 13% of the Exam

1. Perform a project assessment based on the available information, the lessons learned from previous projects, and the meetings held with relevant stakeholders. This provides the information necessary to evaluate the feasibility of new products or services within the given assumptions and/or constraints. This task is a mouthful, but it simply means that someone must look at what the organization and others have done in the past to determine if the project can really be done in the current situation. This task is all about determining whether or not the project will provide the desired business value given the specific conditions that currently exist.
2. Identify the key deliverables based on the business requirements in order to manage customer expectations and direct the achievement of project goals. This task was new for the 2016 exam, and brought an agile perspective to the PMP®. It pushes project leaders to prioritize the project's requirements from most important to least. It also demands that a project focuses on business needs rather than simply project deliverables.



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3. Perform stakeholder analysis using the appropriate tools and techniques in order to align expectations and gain support for the project. This Knowledge Area was first added to the PMBOK® Guide with the 5th edition. The most recent Role Delineation Study found that most successful project leaders are investing more and more time in understanding who their stakeholders are, how much influence they have on the project, and what they really want to ensure those stakeholders are ready and willing to provide the support that the team needs to deliver business results.
4. Identify high level risks, assumptions, and constraints based on the current environment, organizational factors, historical data, and expert judgment, in order to propose an implementation strategy. It is critical the team selects the appropriate strategy to deliver the expected business value. The team must understand the potential bumps their project might encounter and select an appropriate strategy.
5. Participate in the development of the project charter by compiling and analyzing gathered information in order to ensure project stakeholders are in agreement on its elements. In previous editions of the PMBOK® Guide it was either not discussed at all or it was assumed that this was completed before the project manager was assigned. The 5th edition of the Guide changed that and adopted the approach that many project managers experience in the real world. Most project managers find that the charter is rarely completed before they are assigned to it. More often than not, they are required to work with the sponsor and other stakeholders to create a charter.
6. Obtain project charter approval from the sponsor in order to formalize the authority assigned to the project manager and gain commitment and acceptance for the project. Once the charter is completed it is approved by the sponsor. This step is important because it informs the team about the sponsor's expectations and the limits of their authority. The level of authority given to the project manager and team often provides critical information to everyone else about how important the project truly is to the sponsor and organization.
7. Conduct a benefit analysis with the relevant stakeholders to validate project alignment with organizational strategy and expected business value. This was a new task for the 2016 exam. It focuses attention on the need to align the project with the organizational strategy. That's right! Project managers are supposed to be part of the strategic leadership team, and every project is supposed to be aligned with the organizations strategy.
8. Inform stakeholders of the approved project charter to ensure common understanding of the key deliverables, milestones, and their roles and responsibilities. This task was also new for 2016. It results from the fact that all project managers face a constant requirement to carefully manage expectations, and constantly must work to ensure a common understanding with the stakeholder community.

⇒ **Planning Domain — 24% of the exam**



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1. Review and assess detailed project requirements, constraints, and assumptions with stakeholders based on the project charter, the lessons learned, and by using requirement gathering techniques in order to establish detailed project deliverables. Once the PM and team have a charter they have a starting point to begin project work. But before they begin they must determine what set of deliverables will meet the defined requirements.
2. Develop a scope management plan, based on the approved project scope and using scope management techniques, in order to define, maintain, and manage the scope of the project. We haven't started the course yet and already terms like requirements, deliverables, and scope are being used with ease—assuming that everyone understands exactly what these mean. Unfortunately, many students think of these terms as synonyms. They are not. According to PMI®, a **REQUIREMENT** is a condition or capability that is required to be present in a product, service or result to satisfy a business need. (PMBOK® Guide 2017 p.719). **SCOPE** is the sum of the products, services, and results to be provided as a project. It has two forms: **PROJECT** and **PRODUCT SCOPE** (PMBOK® Guide 2017 p.722). Finally, a **DELIVERABLE** is any unique and verifiable product, result or capability to perform a service that is required to be produced to complete a process, phase or project (PMBOK® Guide 2017 p.704). When we discuss the **SCOPE MANAGEMENT PLAN** we are talking about a component of the project or program management plan that describes how the scope will defined, developed, monitored, controlled, and validated (PMBOK® Guide 2017 p.722). That's a lot to remember. To simplify things, think of requirements as being tests against which the output of the project are measured: it must do this, or have that. **DELIVERABLES** are any unique and verifiable product, result or capability to perform a service that is required to be produced to complete a process, phase, or project (PMBOK® Guide 2017 p.7214). The deliverables must meet the stated requirements. Scope comes in two forms: project and product. **PRODUCT SCOPE** is the features and functions that characterize a product, service, or result (PMBOK® Guide 2017 p.715). **PROJECT SCOPE** is all the work performed to deliver a product, service, or result with the specified features and functions (PMBOK® Guide 2017 p.717).
3. Develop a Cost Management Plan based on the project scope, schedule, resources, approved project charter and other information, using estimating techniques, in order to manage project costs. This is arrived at using estimating techniques. The Cost Management Plan is the second “Management Plan” encountered. Both it and the Scope Management Plan are combined with several other planning documents to make up the Project Management Plan. The Cost Management Plan sets the rules that the PM and team will use to define, manage, and change the project budget and actual costs.

4. Develop the project schedule based on the approved project deliverables and milestones, scope and resource management plans in order to manage timely completion of the project. The project schedule helps to ensure that the team can deliver when they promise. In addition to creating a schedule, the team also must define a schedule management plan which defines how the team will define and manage the project schedule.
5. Develop the human resource management plan by defining the roles and responsibilities of the project team members in order to create a project organizational structure and provide guidance regarding how resources will be assigned and managed. The most important part of any project is the people. To ensure the organization has the right people doing the right things, the PM uses a Human Resource Management Plan.
6. Develop the communications management plan based on the project organizational structure and stakeholder requirements, in order to define and manage the flow of project information. Like all the management plans found in this course, the communications management plan defines how the team intends to manage all aspects of the area in question. This means basic practices as well as changes. The notion is that before the team defines the specifics for the area, they must first agree with key stakeholders to a basic set of rules they will follow.
7. Develop the procurement management plan based on the project scope, budget, and schedule, in order to ensure that the required project resources will be available. Sometimes the project requires the team to purchase things from outside the organization. This can include paying for outside consultants or components of some kind, and means the team must have a plan established.
8. Develop the quality management plan and define the quality standards for the project and its products, based on the project scope, risks and requirements, in order to prevent the occurrence of defects and control the cost of quality. This course will spend a significant amount of time talking about what quality really means. For now, it is enough that you recognize the need to have a plan in place to define it and the processes necessary to manage it.
9. Develop the change management plan by defining how changes will be addressed and controlled in order to track and manage change. This plan defines how changes will be addressed and controlled. When most project professionals hear about change management they immediately think scope change, but change can occur in any area of the project. The change management plan simply sets the ground rules for making a change.
10. Plan for risk management by developing a risk management plan; identifying, analyzing, and prioritizing project risk; creating the risk register; and defining risk response strategies in order to manage uncertainty and opportunity throughout the project life cycle.

Successful management of risks is critical to project success. It requires establishing rules for defining, analyzing and executing responses to risk.

11. Present the project management plan to the relevant stakeholders according to the applicable policies and procedures in order to obtain the approval to proceed with project execution. Once all the various plans are completed, the entire package is presented to the project sponsor and other key stakeholders.
12. Conduct kick-off meeting, communicating the start of the project, key milestones, and other relevant information in order to inform and engage stakeholders and gain commitment. This meeting announces the start of the project and covers the key milestones and other relevant information. It is essential for managing stakeholder's expectations and instilling good communications. This is part of the initiating process and occurs before the team has planned out the project because it provides critical information needed for planning.
13. Develop the stakeholder management plan by analyzing needs, interests, and potential impact in order to effectively manage stakeholders' expectations and engage them in project decisions. This was a new task for the 2016 exam and highlights the importance of having a plan for managing stakeholders. They are the reason that teams do projects and far too many projects fail because the PM or team members see the stakeholders as a hurdle to overcome rather than as a critical part of the team to incorporate in decisions in order to achieve overall success.

⇒ Executing Domain — 31% of the Exam

1. Acquire and manage project resources by following the human resource and procurement management plans in order to meet project requirements. Thus far we have been focused in the planning process which has dealt with creating the various management plans that define the rules that the organization is supposed to follow to execute the project. This task is the first of many tasks which simply follows those guidelines.
2. Manage task execution based on the project management plan by leading and developing the project team in order to achieve project deliverables. PMI® does not assume the team has all the skills necessary to deliver the desired project results. Instead, it is assumed the project manager must work with the rest of the organization to provide training and leadership to develop the required skills.
3. Implement the quality management plan using the appropriate tools and techniques in order to ensure that work is performed in accordance with required quality standards. The PMI® framework requires the project manager to first define quality and then work to ensure that the team meets that standard. It is critical that you really understand what PMI® means when they talk about quality.



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4. Implement approved changes and corrective actions by following the change management plan in order to meet project requirements. Every project faces changes. The key to success is dealing with those changes appropriately by ensuring that everyone follows the change management plan.
5. Implement approved actions by following the risk management plan in order to minimize the impact of the risks and take advantage of opportunities on the project. Risks are both good and bad things. They occur on every project regardless of how much the team plans. The key therefore, is following the processes the team defines for managing those risks.
6. Manage the flow of information by following the communications plan in order to keep stakeholders engaged and informed. This is a new task for the 2016 exam. The plan in this task is sometimes called the communications management plan. The task highlights the need for the team to focus on constant communication and information flow with stakeholders.
7. Maintain stakeholder relationships by following the stakeholder management plan in order to receive continued support and management expectations. Stakeholders, stakeholders, stakeholders. They are the key to successful project management. This task was new for the 2016 exam and represents yet again the continued shift towards emphasizing that stakeholder engagement is necessary for good project execution.

⇒ **Monitoring and Controlling Domain — 25% of the Exam**

1. Measure project performance using appropriate tools and techniques in order to identify and quantify any variances and corrective actions. Quantitative measurement is a key aspect of attaining project success. Only by using objective measures can the team determine variances and define appropriate corrective action.
2. Manage changes to the project by following the change management plan in order to ensure that project goals remain aligned with business needs. Throughout the project, the team will face a variety of changes. Therefore, it is critical that they follow the approved change management plan and constantly reconfirm that the project fits with the organizational strategy.
3. Verify that project deliverables conform to the quality standards established in the quality management plan by using the appropriate tools and techniques to meet project requirements and business needs. This task is simply about following through on the practices that were established when quality was defined.



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4. Monitor and assess risk by determining whether exposure has changed and evaluating the effectiveness of the response strategies in order to manage the impact of the risks and opportunities on the project. There are a variety of techniques that may be used to respond to different project risks. The key is alignment, or making sure the team uses the best response strategy to achieve the desired end. This means that the team must constantly judge how well each response is working.
5. Review the issue log, update if necessary, and determine corrective actions by using appropriate tools and techniques in order to minimize the impact on the project. An **ISSUE** is a current condition or situation that may have an impact on the project objective (PMBOK® Guide 2017 p.709). Issues may have positive or negative outcomes and are documented in the issue log.
6. Capture, analyze, and manage the lessons learned, using lessons learned management techniques in order to enable continuous improvement. Successful teams know they cannot keep making the same mistakes over and over again. It is critical that teams review what has happened on projects in the past.
7. Monitor procurement activities according to the procurement plan in order to verify compliance with project objectives. Lessons learned provide an opportunity to focus on continuous improvement. This is a task often foreign to PMP® students. Make sure you understand PMI's perspective on procurement to avoid missing points on questions that are easy otherwise.

⇒ **Closing Domain — 7% of the Exam**

1. Obtain final acceptance of the project deliverables from relevant stakeholders in order to confirm that project scope and deliverables were achieved. To call any project a success it must meet the quantifiable, objective success criteria everyone agreed to at the beginning, and the key stakeholders must sign off that this has happened.
2. Transfer the ownership of deliverables to the assigned stakeholders in accordance with the project plan in order to facilitate project closure. More than just producing the desired results, the product or service of the project must be put in operation for the project to have real value to the organization. This step ensures that the team does not get forced into operations management.
3. Obtain financial, legal, and administrative closure using generally accepted practices and policies in order to communicate formal project closure and ensure transfer of liability. For many students of the exam, this step is foreign. It represents a critical focus of dotting the i's and crossing the t's necessary for true project closure. In the real-world, this is a paperwork step sometimes handled by those outside the project team.



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4. Prepare and share the final project report according to the communications management plan in order to document and convey the project performance and assist in project evaluation. As has already been stated, lessons learned and continuous improvement are key topics for test takers. You must focus on these two ideas and understand the importance that PMI® places on them.
5. Collate lessons learned that were documented throughout the project and conduct a comprehensive project review in order to update the organization's knowledge base. This is yet another task dealing with lessons learned and continuous improvement. Hopefully, you already see the trend.
6. Archive project documents and materials using generally accepted practices in order to comply with statutory requirements and for use in future projects and audits. This was a new task with the 2016 exam and represents a continuation of the efforts seen in the last couple of items. There has always been an idea that project managers should look at what the organization has previously done to understand how to avoid common pitfalls. This task formalizes that process.
7. Obtain feedback from relevant stakeholders using appropriate tools and techniques and based on the stakeholder management plan in order to evaluate their satisfaction. This task was also new for the 2016 exam. It provides the opportunity for the team to check in with the key stakeholders to ensure that their needs have been met. It focuses the attention of the team on meeting the needs of the business. It is the very reason projects are undertaken in the first place.

Required Score

Once you begin the actual exam make sure to answer every question because there is no penalty for incorrect answers, but questions left blank are considered wrong. As you progress through the exam, mark any question you are unsure of for review. At the end of the exam you can check all the questions or only those questions that you have marked for review. Upon completing the exam, and your review, the system will ask if you are ready to have the exam scored. Once you confirm you are ready for the exam to be scored it will take less than ten seconds for the results to be presented. It is important to remember that the PMP® Exam is a pass/fail exam. The passing score is 61% or 106 of the 175 graded questions. Unfortunately, only 68% of the exams taken are actually passed! Stop for a moment and think about those two numbers. What they suggest is that this exam is so difficult that only about two-thirds of those who take the test can answer enough questions correctly to obtain a D– or better. Simply put, the PMP® Exam is likely the most difficult standardized test you will ever take. Do not underestimate how hard it will be!



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What Makes the PMP® Exam So Difficult?

So what makes the PMP® Exam so tough? The standards for the profession are well-known. There are lots of organizations providing exam preparation courses. And PMI® requires every candidate to meet a requisite number of hours of both experience and education. Shouldn't everyone pass? No! If everyone passed the exam it would seriously undermine the value of the certification. The PMP® certification does not prove qualification any more than having a doctor be Board Certified proves they are a good physician. All any certification proves is that a test has been passed and the holder of the certification has a foundational level of knowledge.

Typically, there are nine reasons why the PMP® Exam is so difficult. These reasons include:

- ⇒ Many people assume that the test simply covers the PMBOK® Guide. As has already been discussed, there are 12 books that are considered fair game for the exam. The PMBOK® Guide is just one of these. Memorizing everything in it will not ensure passage of the exam. However, the PMBOK® Guide is the most important of the 12 books for preparation purposes.
- ⇒ The exam requires more than memorization. Many other certifications simply require you to regurgitate information from a textbook, standard, or an exam prep course. In many cases, it's possible to take those exam preparation courses and then immediately take the actual exam. This is not possible with the PMP® because memorizing a bunch of formulas and information is not enough. Passing the PMP® requires memorization, real world experience, and a clear understanding of the PMI® perspective.
- ⇒ A large percentage of the exam questions ask what would you do in a given situation. Unfortunately, the PMBOK® Guide answer is almost never one of the four choices. Just like the real-world, the exam requires to select the best choice from a list of sub-optimal options. If you do not have real-world project management experience you won't be able to do this. And if you have not memorized the processes and framework in the PMBOK® Guide you will not know the PMI® way of thinking about a topic. Miss either one of these two components and you fail the exam.
- ⇒ The exam focuses on the five process groups and ten knowledge areas found in the PMBOK® Guide. The PMBOK® Guide is the standard for the profession of project management. There are well over two million PMBOK® Guides in circulation. However, the Guide does not represent a formal methodology for doing projects. It is a framework. There are more than 30 major methodologies that are fully compliant with the standard. Passing the exam requires you to understand the difference between these.
- ⇒ The exam requires you to answer questions from PMI's perspective and not the perspective of any current or past job. This fact requires a very delicate balancing act. As was previously mentioned, it is impossible to pass the exam without real world experience. However, relying too heavily on personal experience will cause you to fail the exam. Instead, PMI® requires you to



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answer the questions from the perspective of the standard meaning you must assume the “typical” project PMI® uses for test design.

- ⇒ Some questions might be a series. This means the first question in the series asks you to solve a math problem or model and then anywhere from one to four additional questions asks what the resultant value tells you about the situation. If you get the first question wrong you will likely get all the associated questions incorrect as well. Missing a series of questions like this is a quick way to fail the exam.
- ⇒ Some of the questions are based on the inputs, outputs, tools and techniques found in the 49 processes described in the PMBOK® Guide. This creates a list of several hundred items that must be learned correctly. That’s a lot of information and it takes time. It is not required to memorize each input, output, tool and technique, but you do need to have a strong sense about them and when one is called out where it fits in a specific process. Manage your time accordingly!
- ⇒ A number of key formulas will likely be on the exam. These formulas include: Earned Value, Critical Chain or CCPM, PERT, EMV, and CPM. Studying these formulas is a lot like purchasing insurance. The formula you are most likely to see on the exam is the one you have studied the least or with which you are least comfortable. In fact, if you really study hard and master all the formulas, it’s even possible to not get any questions requiring their use. On the other hand, if you don’t study them you will be the one person that seems to get an exam of nothing but math. Which one of these scenarios sounds better to you?
- ⇒ Another 10%-15% of the exam will require the use of other formulas such as the formulas for Didactic communication, standard deviation, depreciation, or net present value (NPV). The same rules apply here as above.

Test-Taking Strategies

The PMP® exam is similar to a lot of other standardized exams, and as such you can apply a number of commonly used test-taking strategies to improve your results. These strategies will not replace knowing the subject matter, but they can provide a significant lift to your score when you are nervous or struggle with specific questions. These strategies include:

- ⇒ **Predict the answer:** If you have studied hard and truly know the material, a great technique is to predict the correct answer to a question before you read the choices. This technique is especially effective on questions that test your factual knowledge or ask you to fill in the blank or complete a sentence. By first predicting the answer you can avoid being distracted by choices that don’t agree with your knowledge. Once you make your prediction make sure to read all of the choices so you can be sure to select the answer that most closely meets your expectations.



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- ⇒ **Your first instinct:** Often, test-takers struggle because they overthink the questions. If you have done your homework, you will know the information and must have confidence in that knowledge. It is critical that you trust your first instinct. That little voice you hear is right more often than not. Research has shown that your intuition often works faster than your reasoned mind. If you have studied, your subconscious will often retrieve information before you have a chance to work out the associations that support it.
 - ⇒ **Read the whole question:** Predicting the right answer and trusting your instincts does **NOT** justify failing to read the entire question. Adding or deleting one word can significantly alter the meaning of a question. Far too often, test takers scan a multiple-choice question and recognize a few familiar words. They then quickly progress to the answers where they find exactly what they believe to be the correct choice. Unfortunately for them, test designers also know about this tendency and regularly design questions taking it into account. The only way you can avoid this pitfall is to read each question carefully and then read it again before continuing to the potential answers. PMI® allows up to four hours for the exam. This is more than enough time to complete the exam. There is absolutely no reason to rush through the exam. Take the time to carefully read each question and all the potential answers before attempting to select the appropriate answer.
 - ⇒ **Look for wrong answers:** Once you have read the question carefully twice it is time to examine the potential answers. One of the best way to simplify a multiple-choice exam is to limit the number of potential choices. Focus on removing the obviously wrong answers from the list before you consider the potential right ones. Sometimes identifying an incorrect answer can help you find the correct one as often the right answer is the exact opposite of one of the wrong answers. This is not always the case, but it is a quick enough tactic to help in many cases.
 - ⇒ **Don't overanalyze:** It is very common for test takers to be nervous. When you are nervous the brain often runs wild with a hundred different thoughts and scenarios for each question. To succeed, you must take a deep breath and **SLOW DOWN!** You have plenty of time to complete the exam. Focus on the actual words in front of you. Do **NOT** create complex interpretations or try to get into the mind of the test designers. Answer the question in front of you and limit your thoughts to the information presented.
 - ⇒ **Key words:** Do you struggle with poor reading comprehension skills? If so, you are like 60% of the people who take the PMP® exam. You can dramatically improve your understanding by using the provided scratch paper to jot down a few key words or phrases. This practice helps you to concentrate on the process of reading by forcing the mind to weight the relative importance of the question parts. This process will help you think more deeply and carefully about the question.
 - ⇒ **Confusing answer choices:** The PMP® exam is full of long winded questions and answers. Many candidates are confused by such wordy content. As a result, they tend to focus on the answers that are shorter and often easier to

understand. Don't make this mistake. The length of an answer or its confusing diction has nothing to do with its validity. When you see a long winded question or answer pay extra attention and try rephrasing it to ensure your understanding.

- ⇒ **True statements:** Often PMI® uses information within the four potential answers that is completely factual. That's right, the information is true, but just because the information provided in the answer is true it does NOT make the answer necessarily correct. It is critical that you learn to tell the difference between a factual answer and a correct one.
- ⇒ **No pattern:** Many students believe they can decipher a pattern in the answers on the test, or that they should always select a specific letter like "C". This is one of the worst ideas you can possibly take into the testing room. Remember, your exam is generated from thousands of potential questions. The criteria for being included in your test is whether or not the question gives us the correct number of questions for a specific area. Additionally, the system randomizes the answers so that two candidates could be sitting next to each other and get the same question, but find the correct answer is a different letter.

Final Comments Before Starting

It is very important that you plan on taking your exam within 45-days of completing this course. Although according to PMI® you have up to one year to complete the exam from the date of your application acceptance, our experience has been that students who do not complete the exam within 45-days have a high probability of never taking the exam at all. It all starts by making the commitment. You **WILL** complete the process within 45-days from the end of this class. The clock is ticking so it's time to get serious.

You must have a plan for studying for the exam. There are a few techniques we recommend. First, become part of a study group. Studying with others can really help. Each time your group meets it is a great practice to have each member of the group present a different PMBOK® Guide knowledge area until each person presents each area. The single best thing you can do to prepare for the exam is teach the material to someone else. Studies have shown you will retain more than 90% of what you teach to others.

Should it be required, you may take the PMP® exam up to three times in one 12-month period. If you fail the exam three times in that period PMI® requires you to wait a full 12-months before you can test again. We have never had a candidate who needed to take the exam three times. In fact, 99% of our candidates pass on the first attempt. Do not become the exception. We know the test and have a proven method to get you ready. This process and the knowledge you need has absolutely nothing to do with the way your organization manages projects. As much as you might want to argue with some of the processes, most—if not all of them—have their basis in common sense, have been designed to work across a wide range of industries, and are on the test. Arguing about questions or answers will not accomplish anything but waste your time and create confusion.

The rest of this course is designed to follow the basic structure of the PMBOK® Guide with practice exams designed to facilitate learning at the end of each section. The first two chapters are the exceptions as they simply introduce information about the test and learning process. Chapter three in the Student Guide represents chapters one through three of the PMBOK® Guide. Chapters four and onward align with the same chapter number found in the PMBOK® Guide.

There are two types of questions in this guide:

- ⇒ Questions designed to facilitate your learning of the processes, formulas, inputs, outputs, tools and techniques. These are memorization questions and do not reflect the questions you will see on the real exam. However, they are a powerful tool to help you learn the information that will allow you to answer the real exam questions.
- ⇒ Questions designed to simulate what you will see on the real test.

It is important that you do not write in the course book when taking your practice exams because you will want to retake the practice tests multiple times. Finally, you will know that you are ready for the real exam when you regularly score 90% or better on the practice tests.

Exercise 1 — PMP® Application and Exam

These questions are not designed to replicate or reflect actual exam questions. They are designed to ensure you clearly understand the topics discussed in this chapter, which will help you study for the PMP® Exam.

1. Which of the following correctly represents the acronym PMP®?
 - A. Project Mentoring Professional
 - B. Project Management Professional
 - C. Program Management Professional
 - D. Portfolio Management Professional
2. Which of the following is a benefit to holding the PMP® credential?
 - A. Higher income potential
 - B. Shows knowledge of a global standard
 - C. It is required by a growing number of companies
 - D. All of the above
3. If you have a four-year baccalaureate degree how many hours of professional experience leading projects do you need?
 - A. 3,600
 - B. 4,500
 - C. 7,500
 - D. None of the above
4. If a candidate is attempting to qualify to sit for the PMP® exam how many contact hours must be completed?
 - A. 35
 - B. None, PDUs are required
 - C. 45
 - D. 21
5. If you do not have a four-year baccalaureate degree how many hours of professional experience leading project do you need?
 - A. 6,000
 - B. 4,500
 - C. 9,000
 - D. 7,500
6. Which of the following best describes a contact hour?
 - A. Contact hours are the same as PDUs
 - B. Contact hours represent hours of formal instruction or education in the field of project management
 - C. Contact hours represent hours spent reading about or training in the field of project management
 - D. None of the above



Exercise 1—The Application & Exam

-
7. How many questions are in the PMP® exam?
 - A. 175
 - B. 250
 - C. 200
 - D. 150

 8. Which of the following PMBOK® Guide knowledge areas represents the largest percentage of test questions:
 - A. Executing
 - B. Monitoring and Controlling
 - C. Planning
 - D. Initiating

 9. What is the required passing score for the PMP® exam?
 - A. 68%
 - B. 80%
 - C. 61%
 - D. 75%

 10. Approximately what percentage of test questions will be a direct quote from the PMBOK® Guide?
 - A. 15%
 - B. 21%
 - C. 5%-10%
 - D. 0%

Exercise 1 — PMP® Application and Exam Answers

1. **Answer B:** The PMP® is the most popular project management certification in the world. It stands for Project Management Professional.
2. **Answer D:** All of the above are true according to PMI®.
3. **Answer B:** Under PMI's Category I qualifications for people who hold a baccalaureate degree, each candidate must possess at least 4,500 hours of professional experience leading projects and 36 months of experience.
4. **Answer A:** For all PMP® candidates 35 contact hours must be obtained. A contact hour is the same as an hour of face time with an instructor.
5. **Answer D:** Under PMI's Category II qualifications for people who do not hold a baccalaureate degree, each candidate must possess at least 7,500 hours of professional experience leading projects and 60 months of experience.
6. **Answer B:** Contact hours represent hours of formal instruction or education in the field of project management. Contact hours are the same as PDU categories 1, 3 and/or 5.
7. **Answer C:** The PMP® exam contains 200 questions of which only 175 are actually graded. 25 questions are being evaluated for future addition to the test bank. The test requires you to get 106 of the 175 graded questions correct.
8. **Answer A:** The executing process group represents 27% of the PMP® exam. The planning process group represents 23%.
9. **Answer C:** 61% or 106 of the 175 scored questions must be answered correctly to pass the PMP® exam. Approximately 68% of all exams receive this score or better.
10. **Answer D:** You should expect none of the correct answers on the exam to be exact quotes from the PMBOK® Guide because of the focus on situational questions.

Types of PMP® Exam Questions

Chapter Overview

The PMP® exam item writers structure the exam in a variety of ways. Understanding the types of questions is important to ensure you don't miss otherwise easy points because of the question structure. Additionally, questions types are used in combination and not in isolation. This can significantly increase question complexity. This chapter discusses a number of “PMIisms” you must learn to dramatically improve your test score. It also reviews the most common reasons people fail the exam. Finally, many students complain about the level of ambiguity in the questions. Don't be surprised if you don't like the way the questions are structured or if you feel like PMI® is trying to “trick” you. Let's be clear. PMI® is **NOT** trying to trick you. PMI® is using a well tested, proven technique for evaluating knowledge.

There are seven different types of questions for which you need to prepare:

- ⇒ Two right answers.
- ⇒ Situational questions.
- ⇒ Math or modeling questions.
- ⇒ Long winded questions and/or questions with extraneous information.
- ⇒ Understanding vs. simple memorization.
- ⇒ Questions with invented terms.
- ⇒ Questions with more than one component in the answer.

Questions With Two Right Answers

The first type of question you might encounter are questions with what appears to be more than one right answer. On the PMP® exam there is **NEVER** more than one right answer. However, test designers are very good at writing questions in a way that it appears two or more answers are correct. Often these questions offer multiple factual statements. However, only one of the facts or statements actually answers the question asked. These questions effectively weed out less experienced project managers. The more real world experience you have, the less difficulty these questions will pose.

The key to correctly answering these questions is remembering three simple rules.

- ⇒ Begin to answering each question by eliminating any answers you know are wrong. In many cases this means you can eliminate two choices, leaving two potential correct answers. You have just gone from a 25% chance of getting the question correct to a 50% chance—doubling your odds!
- ⇒ Always assume you will be dealing with sub-optimal choices, just like the real-world. Simply put, the textbook answer is not going to be one of your choices.
- ⇒ In a situation where you might want to do more than one of the choices it is important to ask yourself, what you would do first? PMI® has a very specific perspective on this. The first thing you must always do is evaluate your



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Focus on what you would do first.

alternatives. Only then should you communicate to stakeholders or do anything else.

Let's look at a sample question:

During your daily standup, a teammate reports that they are struggling with a critical task that is causing the project backlog item to be delayed. What should you do?

- A. Immediately inform the sponsor and key stakeholders.
- B. Evaluate alternatives with the team.
- C. Trust the team to handle it.
- D. Keep pushing ahead as there is nothing you can do.

Most people are able to immediately eliminate D because it means ignoring the problem. The other three options might be a bit tougher. Immediately informing the sponsor and key stakeholders might seem like a good idea if you are a proponent of transparency, but it is a terrible idea. Most senior leaders do not respond well to project managers who come in with problems and no potential solutions. Project leaders are hired to lead. Option B provides a reasonable solution in evaluating alternatives based what was just suggested. Option C also appears reasonable given that this question suggests yours is an agile project. Agile development places a strong emphasis on trusting the team. However, agile development does **NOT** suggest that the scrum master or project leader should just assume the team will handle problems. The correct answer is B — Evaluate alternatives with the team. It is always the first step in the process.

Situational Questions

The most important questions to prepare for on the exam are the situational questions. These questions attempt to place you in a real-world situation and require you to determine the best answer. In most cases the textbook answer is not one of the four choices. As a result, you must pick the best from four sub-optimal answers where you probably don't really like any of the choices. Isn't that often the way things work in the real world?

Let's examine a sample question.

Molly works for a large multi-national organization that manufactures steel as a project coordinator. He organization is matrixed. She is responsible for three different projects, each with teams of ten to 20 team members who are also assigned to multiple projects. Yesterday she received an email from the vice president of stamped products complaining that one of her three projects was failing to meet the customer's expectations, and they had sent notification of their intent to cancel the contract. What is the most likely cause of this problem?

- A. The customers in question were not involved early enough in the process.
- B. Molly failed to get the customer to sign the scope statement.
- C. Scope definition happened after the backlog definition.
- D. The customer did not read their e-mail.



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This question requires two skills. First you needed to eliminate the answer or answers you know to be false. In this case, most students are able to eliminate option D. Rarely is PMI® ever flippant and “the customer did not read their e-mail” definitely qualifies as a flippant answer. The other options all look at least possible. Most experienced project managers have struggled with scope and requirements issues so the question has a ring of truth to it. PMI’s perspective on scope and requirements issues is that they often occur because stakeholders become involved way too late in the process to actually impact the results. The team is then forced to deal with significant changes to meet the true stakeholder needs. The way PMI® phrases this problem is to say that stakeholders are usually not involved earlier enough in the process. When you know this basic PMIism and have real world experience to back it up, this question becomes very easy. Based on the information provided, you cannot tell whether or not Molly failed to get the customer to sign the scope statement. Nor can you tell if scope definition happened after the backlog definition. Both of these answers describe specific scenarios that require additional information to confirm. Option A, “the customers in question were not involved early enough in the process” is the correct answer because it follows the PMI® mindset and matches the information provided.



Stakeholders must be engaged early and often for the project to succeed.

Math or Modeling Questions

Most exam takers fall into one of two camps. Camp one struggles with the situational and ambiguous questions. Camp two struggles with questions requiring a strong working knowledge of the math and modeling in project management. Fortunately—or unfortunately, depending on who you are—the PMP® exam has a lot more of the former than the latter. However, this does not mean you do not need to know the formulas and modeling. There are many different ways PMI® can test your knowledge of these equations beyond just making you solve a math problem. As we’ve said, it’s a lot like insurance. The one time you are not prepared will be the time you need the information. The good news is that these often represent the easiest questions on the exam because they have absolute right and wrong answers. The difficulty with these questions comes from two aspects.

- ⇒ First, you must actually know the equations and models and also know how to use them. This is simple memorization, but it must be done. This course will examine all of these equations.
- ⇒ The second aspect making these questions difficult is that they often are used as part of a series that requires you to build the model first and then answer two or three questions about the results. If you do not build the model or complete the equation correctly in the first question you will not get the rest of the questions correct either. It is almost impossible to pass the exam if you get these series questions wrong.

Let’s look at a sample.

The first question might ask what is the project duration for the following series of tasks (See Image 4)?

- A. 34
- B. 35
- C. 37
- D. 38

Task	Duration	Predecessor
A	5	N/A
B	8	N/A
C	6	A,B
D	7	C
E	3	D
F	4	D
G	9	F
H	4	E,G

Image 4: Model Sample Tasks

The second question would then ask for the critical path of the network. Or you could get several questions about the slack or float of various tasks. You could also be asked situational questions. Such as what would you do if a particular task fell behind a certain number of days. Of course, if you can't build a precedence diagram or calculate the critical path you are going to miss all of these questions. In this case, D is the correct answer to the question.

Long winded questions and/or questions with extraneous information


The most common type of questions encountered on the exam are extremely long winded questions or questions that contain a large amount of extraneous information. These questions present a problem because it's often difficult to determine what information is truly important. There are a several things you can do in order to dramatically increase your likelihood of getting these questions correct.

- ⇒ Read each question and potential answer twice before attempting to answer it.
- ⇒ Jot down any key words or phrases you notice in the question.
- ⇒ Ask yourself what is the question really asking? Then, go through the question and eliminate information that does not help address that issue.
- ⇒ Finally, carefully examine the last sentence. Often this last sentence includes the real question. In many cases, the last sentence will even have everything necessary to answer the question. However, do not assume this to be true. Make sure to carefully read the entire question twice.

Examine the following example:

You are the project coordinator for a textile manufacturing company that is based in Southeast Asia. Your project's original budget was \$648,000 USD, and you have already spent \$462,000 USD. You currently have a CPI of 0.86 and an SPI of 0.62. Your project has an EV of US \$399,000 and an ETC of \$288,316. You are more than halfway through your project, and have a TCPI of 0.86. Your sponsor has just requested a major shift in project scope; what should you do?

- A. Try to convince the sponsor to change their mind.
- B. Agree to implement the changes immediately.
- C. Evaluate the changes for impacts to the cost and schedule.
- D. Stop the project until the issue is resolved.

 **Read every question and answer twice before answering.**

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This question has a lot of information from a discipline called earned value management (EVMS) with which you might or might not yet be familiar. Answering this question correctly requires that you to know about earned value. Knowing earned value allows you to know that it has nothing to do with the question being asked. Only the last sentence is pertinent. The last sentence asks what would you do if the person paying for the project asks for a significant shift in scope. The answer to this question is found in the most important PMIism. The first thing you must always do is analyze the situation and develop alternatives. Simply getting the sponsor to change their mind is rarely a valid option without first doing some analysis. Similarly, you should never agree to implement changes without completing the requisite analysis. You also rarely have time to just stop the project until you can solve the problem. In analyzing alternatives two key areas of examination are cost and schedule. Once you remember those factors the question is easy. Only option C, “evaluate the changes for impacts to the cost and schedule” takes this concept into account.

Understanding Versus Memorization

Many people who attempt the PMP® exam try to pass by memorizing the PMBOK® Guide. More often than not, they fail. The importance of the PMBOK® Guide creates a major point of confusion for the exam. Many exam preparation books and publications suggest you do not need to read the PMBOK® Guide. If you didn't get this point earlier, let's make it again. Although the PMP® exam is based on the Role Delineation Study, and although there are twelve other resources used for the exam, the PMBOK® Guide is the most important resource for the exam. **YOU MUST READ THE PMBOK® GUIDE TO SUCCESSFULLY PASS THE EXAM.** However, you will not pass the exam just by memorizing the 49 different processes and the inputs, tools and techniques, and outputs found in the ten knowledge areas of the PMBOK® Guide. To pass the exam you must be able to take that knowledge and apply it to real situations.

So what kind of questions can PMI® ask that require memorization as a baseline and at the same time require knowledge of practical application? Examine the following sample question:

At lunch you are sitting with a new employee within the organization. They are an experienced scrum master and commenting about how frustrated they are with the organizational requirement to use a Work Breakdown Structures for their projects especially early in the process when requirements are so poorly defined. You comment that a properly done WBS is similar to an FBS and an important tool for project success even early in the project. Which of the following statements best justifies this statement?

- A. The WBS is a great communication tool.
- B. A well formed WBS provides a strong visualization of the product of the project across its phases.
- C. A well formed WBS is similar to a FBS allowing for task assignments.
- D. The WBS allows for progressive elaboration using placeholder work packages.



You MUST read the PMBOK® Guide to pass the exam!



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To answer this question correctly you must know what a WBS really is. A Work Breakdown Structure is a graphical representation of the deliverables of the project that is then further extended to include the tasks and activities needed to produce the desired project results. It has nothing to do with time or resources and is only organized based upon things that belong together. There is a lot of debate within the agile community around the differences and similarities between a feature breakdown structure and a work breakdown structure, but most experts agree that well formed WBSs and FBSs are largely the same. Although PMI® considers the WBS an excellent communication tool, it is vague and not the best answer. A well formed WBS has nothing to do with time so B is not a correct choice. A WBS also has nothing to do with resources so C is excluded. Option D mentions the use of progressive elaboration using placeholder work packages and is a true statement. Therefore, both A and D are true statements, but option D is the best answer because it is both true and specific. For the 2016 exam the WBS was de-emphasized, but it is still worth knowing.

Questions With Invented Terms

Making up terms is a very old test designer's trick to weed out candidates who really don't know the material. A few well placed highly technical sounding terms can quickly throw off the unprepared. PMI® rarely attempts to trick test takers by requiring you to remember complicated acronyms and most terms are completely spelled out. However, the only real solution is to actually know the subject matter. Again, this takes you back to the need to study the PMBOK® Guide and this book. If you truly put in your time you will quickly be able to pick out questions with made up terms like the one shown here:

Your boss wants to know what cost performance measures your team must achieve to complete the project within the original budget. Which of the following do you provide to her?

- A. The Cost Performance Index
- B. The To-Complete Performance Index
- C. The Remaining Budget Ratio
- D. The Estimate For Completion

In this question two of the answers are fabricated terms and two are real. Only one of the real terms is correct. The Remaining Budget Ratio and Estimate For Completion are both fake project management terms that sound like real terms. Although the Cost Performance Index is real, it also is not correct. The correct answer is the To-Complete Performance Index or TCPI.

Answers With More than One Component

Questions with more than one component in the answer require you to carefully examine the component pairings within each option in order to find the correct answer. Many students struggle with these questions and are frustrated because they feel the questions are a gimmick or trick. They are not. In fact, with a little practice these can be some of the easiest questions on the exam. So what is the best way to deal with these questions? The answer is the same as with several other



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sections. First, you need to know the processes of project management. Knowing the basic processes of project management will often allow you to determine the correct answer because the options will often include sets of made up processes. Begin by eliminating the incorrect choices. Second, like all questions, ask yourself what is the test really asking.

Let's examine a potential question:

According to the PMBOK® Guide, how stringently must a project manager ensure that all the defined process interactions occur?

- A. Interactions within the planning process are dependent on the nature of the project, and so there is a great deal of flexibility.
- B. Interactions within the planning process are not dependent on the nature of the project and are only depend on the PMBOK® Guide, so there is not significant flexibility.
- C. Interactions within the planning process group are not dependent on the nature of the project but there is significant flexibility based on the definitions in the PMBOK® Guide.
- D. None of the above is true.

There is a lot of text to get through with these answers. And most of them have more than one piece of information. However, this question is actually very easy. If you have read the PMBOK® Guide you know that PMI® presents a framework and not a formal methodology. Because it's a framework, the only answer that is possibly correct is one that allows for flexibility and not rigid structure. Therefore option A is the correct answer.

These questions are very similar to the longwinded questions. The only difference is that in these questions it's the answers that are long and not the questions. Note that it's also possible to see questions where both the question and the answer are long. Make sure to take your time and read both the questions and answers carefully.

PMIisms

What is a PMIism? A PMIism is a heuristic and represents our interpretation of the PMP® exam authors' perspective on an issues. Because test preparation book authors are not allowed into the test writing sessions, we cannot say for sure if these beliefs are true—and they are not endorsed by PMI®. However, we believe they accurately reflect the exam itself. We have had great success preparing candidates for the exam based on these assumptions and recommend that you take them to heart. Each of these assumptions can be used on almost every question.

- ⇒ There is a basic assumption that you keep historical records for all your projects. These records are important for the organization to continue to make improvements. Remember, continuous improvements and lessons learned are very important to PMI®.
- ⇒ You must understand the process of project management (what to do first, second, third, etc.). This process is found in the PMBOK® Guide. The Guide



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presents 49 processes in ten knowledge areas and five process groups. It is **NOT** assumed you do each process on every project. You are supposed to have the subject matter expertise to determine which processes are appropriate.

- ⇒ You must not only understand the topics, but you must also understand why you should care about them. It is not enough to simply memorize the processes presented in the PMBOK® Guide. You must also understand each process so you can correctly apply it to the various situations presented on the exam. Most of the questions will present you with a situation and the PMBOK® Guide answer will not be one of the four choices.
- ⇒ Everything should be coordinated with the stakeholders of a project and expectations managed. Missed expectations are a common theme for PMI® and a constant issue in the real world. Almost every project manager has some experience with a stakeholder who was dissatisfied with a project because the project manager was not aware of their expectation. According to PMI®, the project begins with stakeholder analysis, and stakeholder analysis continues throughout the project.
- ⇒ All roles and responsibilities must be clearly defined. Roles and responsibilities are a type of expectation. Just like the expectations of all other stakeholders, the roles and responsibilities of the project team must be defined so that everyone knows what they are supposed to do. Failing to clarify roles and responsibilities often causes a team to miss deliverables and disappoint expectations.
- ⇒ A project plan is not a Gantt chart. For many, Microsoft Project® represents everything they know about project management. A large number of people even believe they are the same thing. As any true professional project manager knows, they are absolutely not the same! PMI® provides a very specific definition of a project plan that encompasses significantly more than a simple Gantt chart. Although a Gantt chart can be part of a project plan, it is never one by itself. A real project plan can include a wide range of documents based on the methodology being used. It is critical that you understand this relationship.
- ⇒ A WBS is not an organization chart but it is a key element of successful project management. PMI® is very fond of work breakdown structures. In fact, key elements of the planning process group center on the creation and development of the WBS. PMI® also believes that the WBS is a powerful communication tool that project managers should use.
- ⇒ Project managers are awesome and are very skilled. Hey, it is the Project Management Institute after all! A key component of PMI's strategy is promoting the work done by practitioners. You should not be surprised that PMI® wants to pat you on the back. However, this position occasionally creates a point of separation with your personal experience. In the real-world, many project managers do not get as much authority or respect in their organizations as PMI® assume you project managers get. If that is you, for at least the four hours of the exam imagine that you have that authority.

- ⇒ PMI does not support gold plating. Simply put, gold plating is evil! Gold plating is adding extra functionality or features into a product that have not been agreed to by the sponsor. This is bad because the project manager is held accountable to deliver the triple constraints of a schedule, a budget and a list of agreed upon features, requirements or scope. Adding something without approval often causes one leg of this triangle to change without balancing the others—and that is a major problem.
- ⇒ The preferred estimating techniques are almost always consulting experts and using bottoms up methods. In most of the processes that require that some sort of estimate be developed, there are several choices. Expert judgment and bottoms up estimating are always options on the list. From PMI's perspective, these represent the best choice and using them together gets your most knowledgeable people to provide estimates at a level where they will be the most accurate.
- ⇒ Environmental factors always influence a project. Projects are never done in a vacuum. They are done in the real world. And in the real world our surroundings and our situation have a major impact on every project.

Why People Fail The Exam

A lot of people take the PMP® exam. In fact, the number of people is quickly approaching 150,000 each year. When considering all the ways to design a test most people would agree that one of the easier designs is where every question offers four potential multiple choice answers. However, the numbers tell a different story. Each year only approximately 68% of all exams taken achieve the requisite 61% passing score. That means nearly one-third of all exams are failed on a test where simply guessing provides a one in four chance of a correct answer! Simply put, this exam is hard. To increase your odds of success it is very important that you understand the most common causes of failure. These include:

- ⇒ Many people fail because they believe they can pass the test by relying only on their professional experience. Probably 60% of all failed exams fall into this category. Every exam prep instructor has had at least one student who believed because they were a practicing project manager for a long time they did not need a prep class. These people represent the hardest group to help. If the exam was about how their particular organization managed projects they would be correct. Unfortunately, it is not. The exam covers how PMI® believes projects are to be managed — and that can be a very different thing. Sadly, most of these grizzled old veterans will not believe in the need to study until they have failed a few practice tests. Don't let your ego get in the way of your success!
- ⇒ At the other extreme are those people who fail the exam because they lack real-world project management experience. As has already been stated, it is impossible to pass the PMP® exam by memorizing the PMBOK® Guide or any other book. A significant number of questions on the test are situational in nature. If you have never experienced similar situations, you will lack the appropriate context to answer the question correctly.



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- ⇒ Candidates often miss a large number of questions because they fail to read the questions carefully. The questions can be wordy. PMI® often uses language that is difficult to understand. One reason for this is that some of the questions are designed by people who have English as their second language. Additionally, many questions can be confusing because they include words like **EXCEPT** or **NOT**. Make sure to take your time and read every question twice before you answer it.
 - ⇒ Many people also get questions wrong because they fail to read all of the potential answers. This issue arises when test takers read an early answer and it sounds pretty good. However, if they would have read all the options, they would have found a better answer. Remember that you are always trying to find the **BEST** answer and not the perfect answer. The only way you can do that is if you read every potential answer!
 - ⇒ Another common mistake test takers make is simply not trusting their own knowledge. This often happens when you change an answer. 90% of the time your first instincts are correct. Do not change an answer unless you are absolutely positive about the change. If you have doubts, the odds are you are changing a correct answer to an incorrect response.
 - ⇒ The final thing that causes candidates to fail the PMP® exam is nervousness. No matter how hard you prepare you will be nervous when taking the exam. Depending on who you are, nervousness can have a major impact on your score. Do not be surprised if your actual score is 10%-15% points lower than your average practice score. To allow for this drop we recommend that you study until you score 90% or better on all your practice exams before you attempt the real test.

If you avoid these common pitfalls and follow the instruction laid out in this manual you can successfully navigate the PMP® exam.

Exercise 2 — Types of Questions

These questions are not designed to replicate or reflect actual exam questions. They are designed to ensure that you clearly understand the topics discussed in this chapter, which will help you study for the PMP® Exam.

1. Which of the following is a type of exam question you should expect?
 - A. Two right answers
 - B. Situational questions
 - C. Extraneous information
 - D. All of the above
2. Which of the following is not an assumption made by PMI®?
 - A. There is a basic assumption that you keep historical records for all your projects.
 - B. You must memorize the exact process of project management (what to do first, second, etc.).
 - C. You must not only understand the topics but also why you should care about them.
 - D. Everything should be coordinated with the stakeholders of a project and expectations should be managed.
3. Which of the following is not a basic belief of PMI®?
 - A. All roles and responsibilities must be clearly defined
 - B. A project plan is not a Gantt Chart
 - C. A WBS is not an org chart but is a wonderful and key element of successful project management
 - D. All of the above are PMI® beliefs
4. Which of the following is a basic belief of PMI?
 - A. PMI® does not support gold plating (adding extra functionality)
 - B. Expert judgment and bottoms up is preferred
 - C. Environmental factors are influencing the project
 - D. All of the above
5. Which of the following is a common reason why people fail the PMP® exam?
 - A. Belief that they can pass the test from their experience (not studying)
 - B. A lack of PM experience
 - C. Failure to read the questions
 - D. All of the above



Exercise 2 — Types of Questions

Exercise 2 — Types of Questions Answers

1. **Answer D:** The PMP® Exam is attempting to test both knowledge and understanding of a global standard and generally accepted practice within the profession requiring a number of question types.
2. **Answer B:** PMI® does not want you to simply memorize process. It is much more critical that you understand the processes and know how to apply them.
3. **Answer D:** Each of these are basic assumptions made by PMI®.
4. **Answer D:** Each of these are basic assumptions made by PMI®.
5. **Answer D:** Each of these are common reasons why people fail the PMP® exam.

The Basics of Project Management — Part 1

What is the Perfect Structure?

It's time to get down to business and start learning the concepts of project management that you will need to pass the exam. We will begin with some basic foundational topics. The first of these topics is how to best structure your team and organization.

When considering organizational structure it is important to know that there are two forces that determine how to best group people. These forces are **DIFFERENTIATION** and **INTEGRATION**. According to <http://Merriam-Webster.com>, differentiation is the development from the one to the many, the simple to the complex, or the homogeneous to the heterogeneous. If you are like most readers you are now completely confused. Don't be. Differentiation happens in any organization where a small group of people create a culture that is distinct from the larger group. This can be because of a shared knowledge, products, or geography. Integration is defined as the act or process or an instance of integrating: such as incorporation as equals into society or an organization of individuals of different groups. This definition is likely equally unhelpful. However, it too is a simple concept. Integration represents the force or power of bringing people together. Differentiation is a force that isolates people and groups. Integration is a force that brings them together. Together they create two forces that pull the organization in opposite directions. When discussing project management, these forces create a series of predictable organization types:

- ⇒ Organic or simple
- ⇒ Functional
- ⇒ Multi-divisional
- ⇒ Matrix
- ⇒ Projectized
- ⇒ Virtual
- ⇒ Hybrid
- ⇒ PMO

This list represents a continuum moving from the project leader having no authority and the organization not showing any focus on the profession of project management to the project leader having significant authority and the organization seeing project management a critical business profession.

For the exam, it is important that you can determine the type of organization based upon the clues given in the question. These questions can be very easy if you just look for the key indicators:

- ⇒ The first clue is the title of the person serving the project management function. An expeditor or coordinator is someone with very little power. A project expeditor primarily acts as a communications coordinator and staff assistant. The project



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To determine the organization type look at the title of the PM, who they report to, how much time resources dedicate to the project and how much admin support they receive.

coordinator has limited power to make decisions and usually reports to a higher-level manager. A project manager has more power.

- ⇒ The second clue you should examine is who the project leader reports to. If they report to a functional manager it is likely the PM has little power and is therefore more of a functional organization. If the project leader reports to someone who is the leader of project managers such as in a PMO, the organization is more of a projectized organization.
- ⇒ The third clue to the organizational structure is how much time the various resources dedicate to each individual project. The more their time is split, the more the organization has a functional structure. The more the resources are dedicated to a single project, the higher the likelihood they are part of a projectized organization.

Let's examine these organizational structures in detail.

Organic or Simple Organizations

The linear progression begins with the organic or simple structure. It is best exemplified by small, startup organizations where every member of the team has multiple roles and responsibilities. Typically, no one in the organization has a project management title. The project is often managed by the owner of the organization and there is no administrative support. From a purely project management perspective, this is the weakest organizational structure. It happens often because the organization is in its early formation stages and there is little structure for any department. Each member of the team is scrambling to cover multiple areas and any project management tools or expertise is purely happenstance. This is not necessarily a bad thing. Remember the organization is in its infancy and having a robust project management practice would be unrealistic at this point.

Functional Organizations

The next type of structure is the functional organization. A functional organization is one where the staff is organized by their job or function. Common functional departments include sales, engineering, marketing, accounting, or finance. In functional organizations, expertise — or drive for deep technical knowledge — is the dominant force. In these organizations, resources have one clear supervisor, typically referred to as the manager of the technical area. The manager then reports to the director of the area, who reports to the vice president of the area and so on. The number of layers in this hierarchy is largely driven by the size of the organization.

Another key characteristic of a functional organization is that projects are only handled within the functional area. This is a highly localized approach to dealing with projects. Each resource and/or resource manager only cares about the project in terms of how it impacts their functional area. Little to no consideration is given to the areas of the project outside one's individual silo. This aspect of a functional organization is usually the cause of significant criticism because it means that



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A Functional Organization

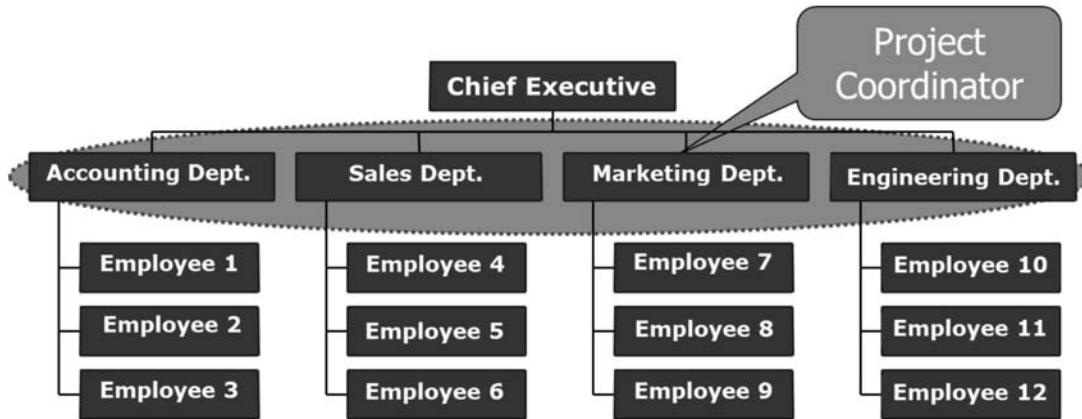


Image 4: A functional organization chart

project stakeholders get passed from one resource to another without anyone taking general responsibility for the overall project. To better understand a functional organization, examine the functional organization chart shown in *Image 4*.

Notice that the project leader is called an **Expeditor** or **Project Coordinator**. Also note that the project leader reports to one of the functional departments. Although it is difficult to tell, these two clues indicate that the project manager has almost no formal authority. They also indicate that the project leader serves more as an administrative assistant than anything else. However, a functional organization produces a number of advantages including:

- ⇒ **Clear reporting relationships** — Within a functional organization each resource knows very clearly who they report to because the organizational structure is based on vertical silos.
- ⇒ **Highly specialized expertise** — The vertical structure of functional organizations allows resources to develop deeper knowledge of the skill set that is targeted or described by the function. This can be contrasted to a non-functional organization, which requires resources to be stronger generalists.
- ⇒ **Easier to manage** — This advantage is very much an opinion. The argument is that it is easier because you only have to manage a single skill set and you manage within the framework of the vertical silo.
- ⇒ **Homogeneous groups** — Functional organizations, by definition, create homogeneous groups, where the members are alike or have similar skill sets. This advantage ties directly to making them easier to manage.
- ⇒ **Drive for technical excellence** — In a functional organization the resources in the individual silos are typically incentivized to achieve superior knowledge and performance in the technical aspects of their work.



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- ⇒ **Clear career path** — When the organization is structured into functional silos the resources are presented with a well understood progression for their career. Often this means the individual starts out as a junior resource, then becomes a senior resource, then a manager or team leader, a senior manager, a director and finally the vice president of the silo.
 - ⇒ **High quality organizational knowledge** — Within each individual silo the functional organizational structure makes it possible to develop deep technical knowledge because you have several resources with the same skill set all focused on being the best in that technical area.

A functional organizational structure is not perfect. According to PMI® there are a number of disadvantages, or issues, with a functional organizational structure. These include the following:

- ⇒ **Conflicting priorities from overlapping projects** — Functional organizations often struggle to provide consistent visibility across all the silos of the organization. This can cause resources to become frustrated because they are asked to complete multiple tasks at the same time without prioritization.
- ⇒ **Project boundaries are limited to one's discipline** — In a functional organization projects are typically only handled within the individual silo. This can create a number of problems including the development of incomplete solutions, incorrect solutions, expensive solutions, or significant post-project repairs.
- ⇒ **Barrier to customer influence and satisfaction** — Functional organizations often struggle to meet the needs of their stakeholders because they do not have a single individual who can act as a stakeholder, who has the authority to address issues, and who the team can approach with concerns. The stakeholders therefore end up having to go to each silo to deal with different issues.
- ⇒ **Employee development opportunities are limited** — In a functional organization the silo leaders are primarily focused on developing the core competencies of the silo. Skills that are perceived to be outside that silo are generally not supported.
- ⇒ **Project Manager is dependent on personal influence** — In a functional organization all (or almost all) of the organizational power is held by the functional managers. Project managers are generally perceived as administrative aids who report to functional managers. Therefore, they must rely on forms of personal influence such as being well-liked.
- ⇒ **Hierarchical decision and communication processes** — In a functional organization resources are organized into silos based upon their technical skills. Communication has to follow the chain of command up one structure and then across to the leader of another silo before filtering down to the technical resources in the other skill area.



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- ⇒ **Overwork technical issues vs. build to a standard** — Because resources in a functional organization are organized according to technical skill, they often focus on building the perfect technical solution rather than simply the right solution.
- ⇒ **Fosters part-time roles** — In a functional organization resources are usually asked to serve as operational resources and work on multiple projects. As a general rule, resources only handle a project within their functional area. This often leads to resources that are less than 20% dedicated to a single project.

If a functional organization is less than perfect, moving towards the opposite organizational structure might prove advantageous.

Projectized Organizations

The opposite extreme from the functional organization is the projectized organization. In a projectized organization the resources are organized based upon the projects to which they are assigned. Each resource is assigned to only one project and each team has all the resources the project requires for completion.

Image 5 shows a sample of a projectized organization chart.



Image 5: A projectized organization chart

Projectized organizations present a number of key advantages. These advantages include:

- ⇒ **Strong project manager role** — It is important to remember you are studying for a certification managed by the world's largest organization dedicated to the advancement of project management. As a general rule, things that make



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project managers stronger are perceived by PMI® to be good.

- ⇒ **Full-time administrative staff with clear accountability** — A key indication of a projectized organization is that the project manager is supported by a full-time administrative staff that reports directly to the project manager. This is an advantage for the project manager since it helps them achieve the desired project results.
- ⇒ **Fosters collocation** — Collocation means resources are physically located in the same facility. This is an advantage because it makes it easier to communicate with other resources and stakeholders on the project.
- ⇒ **Improves focus** — Improved focus on what? The overall project—as opposed to individual components of the project. This is a more holistic view.
- ⇒ **Cost and performance tracking of projects** — Many organizations struggle with tracking the real performance of their projects. Projectized organizations have an advantage in this area. Because the organization is structured around the various projects, it's easier to determine the results of each team. In an organization where everyone is working on multiple projects simultaneously this is much more difficult.
- ⇒ **Decision-making based on overall project view** — The core premise of a projectized organization is that performance improves when each team member is focused on only one project. This concept extends to decision-making as well. When the entire team is focused on only a single project they are more likely to make good decisions.
- ⇒ **Customer relationships tied to various projects** — In a projectized organization the end customer is able to communicate with a single point of contact—the project manager—for all needs. This reduces the likelihood of miscommunication.

However, projectized organizations are not perfect either. They suffers from a number of potential issues. These issues include the following:

- ⇒ **Reduction of employees' professional identity** — Employees often associate themselves more with their level (such as senior engineer, director, or manager) rather than with the project to which they are assigned. In a functional organization this is perfectly aligned. However, in a projectized organization the focus is on the project, not one's level, and therefore individuals can struggle to find their place.
- ⇒ **Reduced focus on technical competence** — This issue is similar to the reduction of professional identity. However, instead of the issue concerning one's level within the organization, the primary issue is technical skill or role. This issue occurs when people view themselves according to their core skills or their roles, rather than according to the project to which they are assigned.



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- ⇒ **Leadership by the non-technically skilled** — Often project managers do not come from a technical background. When the organization is projectized the position of project manager is seen as a technical expertise unto itself. Although the project manager is highly skilled in the processes, tools and techniques of project management, they do not necessarily know anything about the key fields of expertise that are required to actually execute the project. As a result, the technical resources may not always respect the project manager and therefore might treat them as administrators with little authority.
 - ⇒ **Focus on administrative work vs. technical work** — A focus on the administrative work often stems from the leadership issue cited previously. Because the project leader does not come from a technical background, she might focus on the area where she feels most comfortable, which is often the administrative work of project management.
 - ⇒ **De-valuing of functional managers** — In any organization there is only a limited amount of power. In a functional organization all the power resides with the functional managers at the expense of the project managers. In a projectized organization the exact opposite is true. The project managers hold the vast majority of power at the expense of the functional managers. As you can image, whoever lacks authority will feel devalued and frustrated.
 - ⇒ **Process vs. deliverable emphasis** — A process versus deliverable emphasis is a fancy way of raising some of the same concerns held in the two previous bullet points. A projectized organization can struggle because it becomes too focused on the project management processes rather than the desired output.
 - ⇒ **Creates redundancy of efforts** — In projectized organizations the focus is on the successful completion of the individual project. Each person is assigned to one and only one project. The result is a situation where no one is focused on evaluating the various projects against one another. In the end, the organization can end up with two “*successful*” projects where the only differences are minor and everyone feels the organization could have been better served if only one of the projects had been completed.
 - ⇒ **Project end can be a traumatic event** — In projectized organizations each resource is assigned to a single project. When a project ends the resources assigned to that initiative are potentially out of work. This can be a major concern for the resources and can cause a situation where projects never end, they just enter a new phase.

If both functional and projectized organizations are so significantly flawed we could be in a lot of trouble. Fortunately, most organizations attempt to find some middle ground between the two extremes. We refer to this middle ground as a matrix organization.

Matrix Organizations

Matrix organizations combine the elements of both functional and projectized organizations. The different weighting of functional and projectized characteristics allows matrix organizations to be categorized into three types: Weak, Balanced, and Strong. Often the easiest way to think of matrix structures is to imagine a linear continuum with the functional organization on the far left followed by the weak matrix, the balanced matrix, the strong matrix organization, and finally the projectized organization on the far right.

A Weak Matrix Organization

Often for the PMP® exam candidates are required to differentiate between the various types of organizations. For many, the most difficult two organizational types to tell apart are the functional and the weak matrix organizations. The differences between these two are often miniscule. In the functional organization the project manager has no authority because the functional manager has it all. In a weak matrix organization, the project manager has slightly more power—something incrementally higher than zero. In a weak matrix organization the title of the project manager is likely to be project coordinator. In a weak matrix organization the project manager will not have significant administrative support. The project resources will primarily be focused on their functional duties. The resources will also be assigned to multiple projects. The project manager in a weak matrix organization reports to a functional manager. *Image 6* on the next page shows a weak matrix organization.



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Image 6: A Weak Matrix Organization

A Balanced Matrix Organization

The absolute middle in the linear continuum of structures is the balanced matrix organization. The balanced matrix attempts to take the best of both the functional and projectized organizational structures in equal proportions. The key way to recognize a balanced matrix organization is that the project leader is called a project manager, and everyone reports to this person. In a balanced matrix organization, the project manager reports to a functional head. The balanced matrix organization is the only one where a titled project manager reports to a functional head. Balanced matrix structures pull resources from functional department and they receive a moderate amount of administrative support. However, resources are not fully dedicated to a single project. *Image 7* shows a balanced matrix organization.

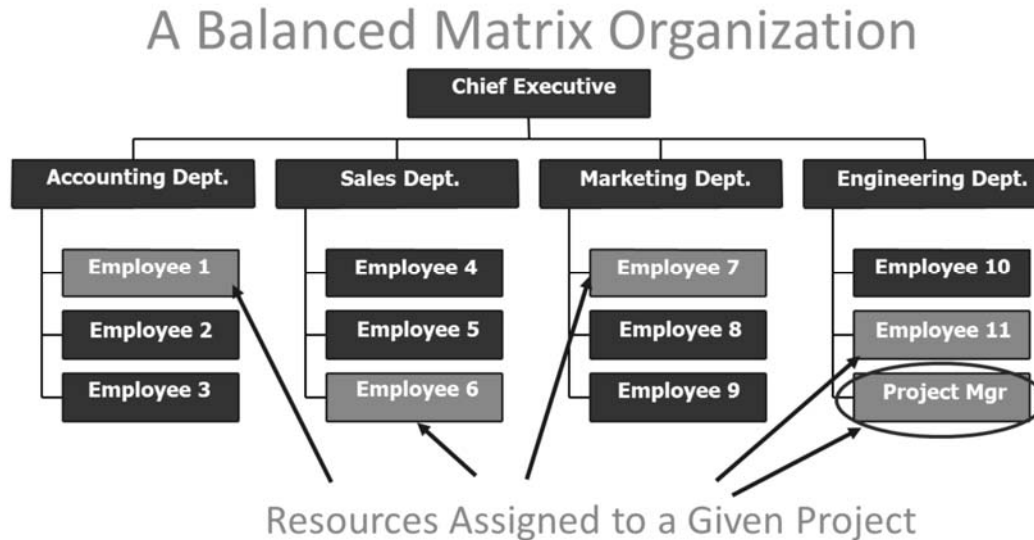


Image 7: A Balanced Matrix Organization

A Strong Matrix Organization

The last type of organization is the strong matrix. The strong matrix structure is most closely aligned to a projectized organization. This means the project manager has more power than in any other matrix structure. In a strong matrix organization the project managers are organized into a department of their own. This department is often referred to as a Project or Program Management Office or PMO. It is headed by a manager just like any of the other functional units. This fact serves to immediately elevate the power of project managers within the organization. In a strong matrix organization project management has at least an equal footing with all other functional departments. In a strong matrix organization the project manager has full time administrative support. However just as in all the other forms of matrix organizations, in a strong matrix structure the project resources are not dedicated to only one project. In many cases resources are assigned to multiple projects and also hold operational



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responsibility. What makes this structure unique is the fact that a single department owns process, methodology definition, and practice maintenance. It also allows for a single executive to own the entire portfolio of new initiatives within the organization. *Image 8* shows a strong matrix organization.

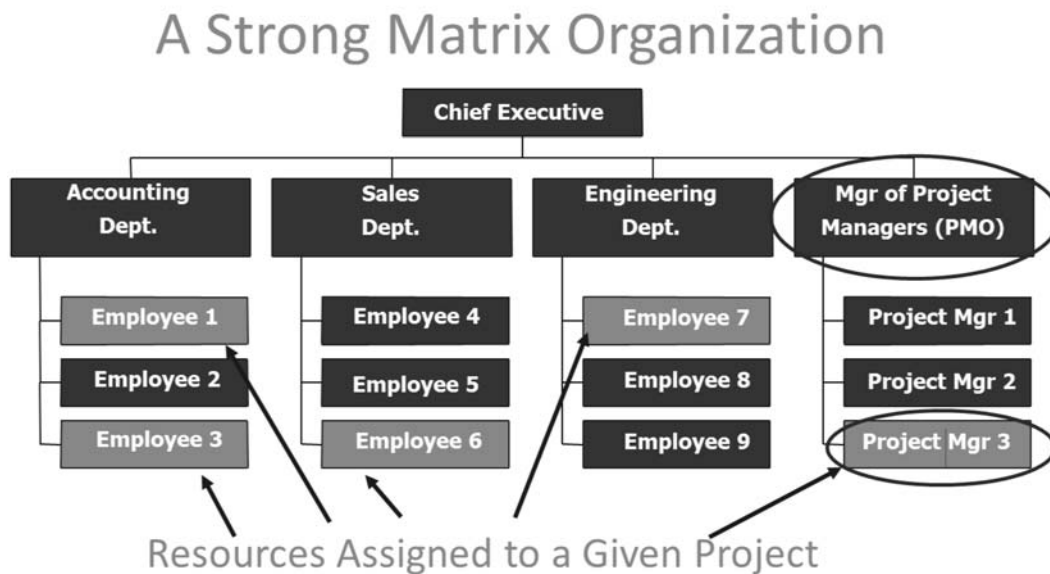


Image 8: A Strong Matrix Organization

Advantages of a Matrix Organization

- ⇒ **Visible project objectives** — Matrix organizations shift power from functional managers to project staff in order to increase the visibility of projects and to improve their performance.
- ⇒ **Improved control of resources by project managers** — Since project managers theoretically have more authority it stands to reason that they also have better control over project resources. This improved control happens at the expense of the authority of functional managers.
- ⇒ **Rapid response to contingencies** — If project managers have greater authority and are focused on the projects they own then they are more likely to see problems earlier in the lifecycle and therefore respond more quickly.
- ⇒ **Greater support from functional managers** — This is often the subject of debate. The theory is that because project managers have greater authority and visibility they receive greater support from the functional managers. The problem comes from the fact that the project managers have gained this authority and visibility often at the expense of those same functional managers.
- ⇒ **Coordination of efforts across organization** — As the organization gives more authority to project managers they become more effective at coordinating the various aspects of the project across the entire organization.

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Remember, project managers provide a single point of focus for the project.

- ⇒ **Project end is not a traumatic event** — This advantage addresses one of the major concerns of a projectized organization. In projectized organizations the staff has no job when the project ends. This does not happen in functional organizations because the resources are part of their functional teams. Matrix organizations gain the advantage found in functional organizations through the hybrid model while also improving on project focus.
- ⇒ **Strong technical base** — This is another advantage shared with functional organizations. Because the functional organizations still exist in matrix structures, projects gain access to the strong technical knowledge provided by the hierarchical, skill-based functional organizations.
- ⇒ **More effective dissemination of information** — This advantage is also the subject of much debate. The theory is that because matrix organizations have both the vertical communication found in functional organizations and the horizontal communication found in projectized organizations the staff should have a lot more accurate information and should have a greater ability to quickly communicate with other project stakeholders. However, there is also a chance that all this communication will cause confusion.

Matrix organizations have a number of challenges as well. These challenges include:

Potential Issues With a Matrix Organization

- ⇒ **Project personnel report to more than one boss** — This issue is often referred to as a “dotted line relationship.” In many cases, resources are forced to choose between conflicting instructions given to them by the project manager and the resource manager. In these situations the resource rarely wins.
- ⇒ **Complex to monitor and control** — As organizations become more complex with bidirectional leadership (both functional and project) the metrics used to monitor real performance become more complicated. As they become more complicated the probability of providing false indications of performance become greater.
- ⇒ **Conflicts with resource allocation and project priorities** — What should the resources be working on at any given moment? Functional managers often have responsibilities for operational efforts as well as project work. Their priorities are often very different from those of each project manager. This can lead to project work not getting done.
- ⇒ **Potential for duplication of effort with “independent” projects** — As the organization moves closer to the projectized structure, the tendency is to examine the team’s efforts based on the totality of the project. While this is good from a project management standpoint, it can create a blind spot by not comparing all projects. The result can be a portfolio with several similar products or services when only one was needed.



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⇒ **Power struggles and competition for scarce resources** — In any organization there is competition for the limited resources available to complete work. However, in matrix organizations, that competition is heightened by the power struggle that can exist between project managers and functional managers.

Virtual / Hybrid / PMOs

At far end of this side of the continuum are the virtual, hybrid, and PMO organizations.

Virtual organizations are a new concept found in the 6th edition of the PMBOK[®] Guide. In a virtual organization, team members work in disparate locations and communicate through the use of advanced technology. In a virtual organization the project leader has low to moderate levels of authority. There is no typical amount of time put in by the project leader. Much of this is because resources work on multiple projects at the same time. Virtual organizations also have a wide range of administrative support structures.

Hybrid organizations represent a catchall group. A hybrid organization can be a mixture of all the other organizational structures. In each of the specific characteristics that describe structures a hybrid is described as mixed.

The final type of organizational structure is the PMO, and we will discuss it later in this course.

Regardless of the organizational structure, a few simple clues can help you answer likely exam questions quickly. Review the table below in *Image 9* to ensure that you have a firm grasp on these keys. On the exam you are likely to experience a number of questions where the organizational type is not defined. When this happens, assume it is a matrix organization.



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Project Characteristics							
Organizational Structure Type	Work Groups Arranged By	Project Manager's Authority	Project Manager's Role	Resource Availability	Who Manages the Project Budget	Project Management Administrative Staff	
Matrix	Organic or Simple	Flexible; people working side by side	Little or none	Part-time; may or may not be a designated job like coordinator	Little or none	Owner or operator	Little or none
	Functional (centralized)	Job being done (e.g. engineering, manufacturing)	Little or none	Part-time; may or may not be a designated job like coordinator	Little or none	Functional manager	Part-time
	Multi-divisional (may replicate functions for each division with little centralization)	One of: product; production processes; portfolio; program; geographic region; customer type	Little or none	Part-time; may or may not be a designated job like coordinator	Little or none	Functional manager	Part-time
	Weak	Job function	Low	Part-time; done as part of another job and NOT a designated job role like coordinator	Low	Functional manager	Part-time
	Balanced	Job function	Low to moderate	Part-time; embedded in the functions as a skill and may not be a designated job role like coordinator	Low to moderate	Mixed	Part-time
	Strong	By job function, with project manager as a function	Moderate to high	Full-time designated job role	Moderate to high	Project manager	Full-time
	Projectized (project-oriented composite or hybrid)	Project	High to almost total	Full-time designated job role	High to almost total	Project manager	Full-time
	Virtual	Network structure with nodes at points of contact with other people	Low to moderate	Full-time or part-time	Low to moderate	Mixed	Could be full-time or part-time
	Hybrid	Mix of other types	Mixed	Mixed	Mixed	Mixed	Mixed
	PMO	Mix of other types	High to almost total	Full-time designated job role	High to almost total	Project manager	Full-time

Image 9: Organization Structures

Exercise 3 — Organizations and Project Management

Some of these questions are not designed to replicate or reflect actual exam questions. They are designed to ensure you clearly understand the topics discussed in this chapter which will help you study for the PMP® Exam.

1. In what type of organization does the project manager have little or no authority?
 - A. Functional
 - B. Weak matrix
 - C. Balanced matrix
 - D. Projectized
2. In what type of organization is the functional manager likely to maintain project budget control?
 - A. Weak matrix
 - B. Balanced matrix
 - C. Strong matrix
 - D. Projectized
3. In that type of organization does each employee have one clear superior and is grouped by specialty such as sales, marketing, engineering, accounting, etc.?
 - A. Projectized
 - B. Balanced matrix
 - C. Weak matrix
 - D. Functional
4. In what type of organization is the project coordinator likely to be a part-time position with almost no administrative support?
 - A. Balanced matrix
 - B. Weak matrix
 - C. Functional
 - D. Projectized
5. In what type of organization is the project manager likely to have a variety of possible budgetary control models?
 - A. Functional
 - B. Balanced matrix
 - C. Projectized
 - D. Any of the above



Exercise 3 — Organizations & PM

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6. Sally is a frustrated project coordinator. All of her resources split their time between operational responsibility and project work. It seems she can only get about 10% to 15% of their time. She also has very limited authority, and has very little administrative support. In what kind of organization does Sally work?
 - A. Functional
 - B. Weak matrix
 - C. Balanced matrix
 - D. Strong matrix
 7. Kevin is a full-time project manager within his organization. He gets some administrative support, but really has to fight to get time from his resources because of his low level of authority. In what type of organization does Kevin work?
 - A. Weak matrix
 - B. Balanced matrix
 - C. Strong matrix
 - D. Projectized
 8. Ann is new to her company, the XYZ Widget Co. She really likes her job because although she has to interface with functional managers, she has a high degree of authority within the company, can quickly get the resources she needs, and gets a lot of administrative support. In what kind of organization does Ann work?
 - A. Functional
 - B. Balanced matrix
 - C. Strong matrix
 - D. Projectized
 9. Jim is a project manager within the ABC Company. Within his organization there are departments but these groups provide support services to the various projects. In what kind of organization does Jim work?
 - A. Functional
 - B. Balanced matrix
 - C. Strong matrix
 - D. Projectized
 10. The project manager's role in a weak matrix organization is most like what?
 - A. A true project manager
 - B. A project sponsor
 - C. A coordinator
 - D. A functional manager

-
11. The term used to describe most modern organizations that use multiple organizational structures is what?
- A. Composite organization
 - B. Balanced Matrix
 - C. Projectized
 - D. Functional
12. In which of the following organization types can a PMO *not* exist?
- A. Functional
 - B. Balanced matrix
 - C. Composite
 - D. A PMO may exist in any organization type
13. A project manager takes a job with a new firm. He has little experience and will be working in a matrix organization. Based upon his situation he should expect communication with his stakeholders to be:
- A. Complex
 - B. Formal and written
 - C. Formal and verbal
 - D. Informal and written
14. A very seasoned project manager leaves a position in an organization that was highly projectized for a job in an organization that is a balanced matrix. His new manager is very senior in the organization. Based on this information, he can expect communication to be:
- A. Complex
 - B. Less structured
 - C. More structured
 - D. Easy
15. A project coordinator takes a new position and she is concerned about the amount of work it will take to communicate with all the stakeholders. The organization employs more than 30,000 people in 12 different locations. Her project team is a strong matrix organization. In her previous job her resources were projectized. As a general rule, what can she expect the communication to be?
- A. Complex
 - B. Simple
 - C. More structured
 - D. Hard to automate

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16. Two project managers in a weak matrix organization argue over which of them is more senior. Eventually they determine that one of them is actually a project manager and the other is a project expeditor. How is the expeditor different from the project manager?
- A. The manager cannot spend money
 - B. The expeditor cannot make decisions
 - C. The manager reports to a higher level authority
 - D. The expeditor can spend money
17. A project manager comments to their spouse about how frustrated they are at work. Everyone is telling their resources what to do. In a functionally organized firm who can formally direct project resources?
- A. The functional manager
 - B. The project sponsor
 - C. The senior manager
 - D. All of the above
18. Two project managers are discussing how frustrated they are with their projects because of the number of people who provide direction to their project resources. In a matrix organization, who can direct project resources?
- A. The project manager
 - B. The functional manager
 - C. The project sponsor
 - D. All of the above
19. Sam is talking to Sally about his new job. As he describes his position he concludes that although he is called a project manager he is actually a project coordinator. Sally comments that he's doing better than her because she's a project expeditor. Which of the following most accurately describes the difference between a project expeditor and a project coordinator?
- A. The project coordinator cannot make more decisions
 - B. The project coordinator can make more decisions
 - C. The project expeditor reports to a higher level manager
 - D. The project expeditor has more authority
20. A project manager is trying to complete a complicated COTS software project but is struggling to get enough attention to complete the required work. Most of the resources needed are focused on completing operational work and the project manager doesn't have authority to shift their focus or assign other resources. In which type of organization must the project manager be working?
- A. A functional organization
 - B. A technical matrix organization
 - C. An operational matrix organization
 - D. A weak matrix organization

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21. Cathy is a new project manager with very little real experience. She's been assigned to lead a project for which her boss feels she's perfectly suited. Her organization is a matrix organization. Based on these characteristics she should expect communications to be:
- A. Simple
 - B. Mostly verbal
 - C. Mostly automated and written
 - D. Complex
22. Ralph is currently leading a project in the planning phase when two key stakeholders come to him and ask for an explanation of the development methodology being used on the project. They are specifically interested in where it came from and how it differs from the methodology being used on most of the projects being done within the organization. As Ralph explains the methodology, the stakeholders become nervous about a number of new terms he uses (which they are unfamiliar with) and how this new methodology will impact the organization. They stakeholders are long-time associates of Ralph's. What should he do?
- A. Ask the stakeholders to trust him as they are long-time associates
 - B. Supply the stakeholders with a glossary of terms for the new methodology
 - C. Notify the PMO of the stakeholders' concerns
 - D. Advise the stakeholders that he will keep them informed regularly on the project
23. A young project manager has just been assigned to his second project even though he has yet to complete his first project. The first project is relatively small and both the project manager and his boss believe the project manager has the capacity to manage both efforts at the same time. However, as time passes the second project begins to grow significantly in scope and the project manager quickly comes to believe he needs help. In talking about the situation with his peers, the project manager learns a similar project was completed 18 months prior. What should the project manager do?
- A. Wait to see if the second project continues to grow in scope
 - B. Make sure the scope is agreed to by all stakeholders
 - C. Obtain the historical records and guidance from the project management office (PMO)
 - D. Contact the project manager from the previous project for guidance
24. A project manager gets assigned to a manufacturing effort for a new product and gathers their team to begin work. Although the team has worked together on previous efforts they struggle to create the project charter. Which of the following best describes the real problem?
- A. Constraints and assumptions have not been defined
 - B. The project deadline has not been set
 - C. They have not identified the project objectives
 - D. They are working on an operation and not a project

-
25. The previous project manager for your project did her work without much formal organization. There is little management control and there are no clearly defined deliverables. Which of the following would be the best choice for getting the project better organized?
- A. Define the project methodology
 - B. Adopt a lifecycle approach to the project
 - C. Develop specific work plans for each work package
 - D. Develop a description of the product of the project
26. The project cycle differs from the product life cycle in that the project life cycle:
- A. Does not incorporate a methodology
 - B. Is different for each industry
 - C. Can spawn many projects.
 - D. Describes project management activities
27. You are a Project Manager leading a large project within a manufacturing organization that is matrixed. One day one of your resources approaches you and states that she does not know which of her several assignments for different projects is most important. Who should determine the priorities between projects in the organization?
- A. The project management office (PMO)
 - B. The project manager
 - C. The project team
 - D. The project management team

Exercise 3 — Organizations & Project Management

Answers

1. **Answer A.** PMBOK® Guide – Although a weak matrix provides a project manager with limited authority, only the functional organization provides the project manager with little or no authority. Remember, according to PMI the project manager is a very powerful position.
2. **Answer A.** PMBOK® Guide – According to PMI, the project manager has a very powerful role. As the organization gets closer to a projectized organization, the PM gains more influence. The organization in which they have the least authority is the weak matrix, and this is where the functional manager has budgetary authority.
3. **Answer D.** PMBOK® Guide – In a functional organization, people are organized based upon the job they perform. These silos provide the basis for power within the organization. Project managers in such organizations have very little authority.
4. **Answer C.** PMBOK® Guide – The key to this question is the fact that the role is called a coordinator, is part-time and has no administrative support. A coordinator who had a little administrative support would have been a weak matrix, but as it is represented in this question, it is a functional organization.
5. **Answer B.** PMBOK® Guide – Only in a balanced matrix organization are there mixed models of budgetary control.
6. **Answer B.** PMBOK® Guide – Sally works in a weak matrix organization. The keys to this question are the facts that she gets some administrative support (even though it is not much) and she does have a little authority. If not for these two differences she would be in a functional organization.
7. **Answer B.** PMBOK® Guide – The fact that Kevin is full time tells you that he does not work in a weak matrix organization. The fact that he has a low level of authority tells you he does not work in a strong matrix or projectized organization. Only the balanced matrix organization meets such criteria.
8. **Answer C.** PMBOK® Guide – The key to this question is the fact that functional managers still exist in Ann’s organization. Without this difference she could be in a projectized organization.
9. **Answer D.** PMBOK® Guide – Only in a projectized organization are there departments that either report directly to the project manager or provide support services to the various projects.
10. **Answer C.** PMBOK® Guide – Weak matrix organizations maintain many of the characteristics of a functional organization. The project manager’s role is more like a coordinator or expeditor than a manager.
11. **Answer A.** PMBOK® Guide – Most modern organizations involve all of the structural types to one degree or another at their various levels. These organizations are called composite organizations.

-
12. **Answer D.** PMBOK® Guide – A PMO can exist in any of the organizational structures—including a functional organization. However, the more the organization moves towards a projectized organization, the more likely a PMO becomes.
 13. **Answer A.** PMBOK® Guide p.28 – This is a tricky question because much of the information is unnecessary to correctly answer it. The only piece of information necessary to answer this question is the fact that the organization is a matrix. In matrix organizations communication is complex because of the importance placed on communicating with the many power structures.
 14. **Answer A.** PMBOK® Guide p.28 – This is a tricky question because much of the information is unnecessary to correctly answer it. The only piece of information necessary to answer this question is the fact that the new organization is a balanced matrix. In matrix organizations communication is complex because of the importance placed on communicating with the many power structures.
 15. **Answer A.** PMBOK® Guide p.28 – This is a tricky question because much of the information is unnecessary to correctly answer it. The only piece of information necessary to answer this question is the fact that the new organization is a strong matrix. In matrix organizations communication is complex because of the importance placed on communicating with the many power structures.
 16. **Answer B.** PMBOK® Guide p.28 – A project expeditor has no authority to make decisions or spend money. Typically a true project manager can make decisions and often reports to a higher-level authority, but this is not guaranteed.
 17. **Answer A.** PMBOK® Guide p.28 – In a functional organization, the functional manager has the power to direct resources. The project manager must use influence to get the functional manager to direct the resources necessary to achieve project tasks.
 18. **Answer D.** PMBOK® Guide p.28 – In a matrix organization, either the functional manager, project manager or a sponsor could have the power to direct resources.
 19. **Answer B.** The project coordinator can typically make more decisions than an expeditor. They also usually have more authority and report to a higher level manager than the expeditor.
 20. **Answer A.** This is an example of a functional organization because the project manager does not have any power to shift resources that are focused on operational activities.
 21. **Answer D.** Matrix organizations increase the complexity of communications. This question has little to do with the amount of experience the project manager has. Additionally, it is not possible to tell if the communication would be written or verbal with the information given.

-
22. **Answer C.** Many students believe this is an unfair or trick question. It is not. It represents a fairly common type of question on the exam. The key to remember here is that although you might do several of the items listed, you would do one of them first. The very first thing to be done is notify the PMO because they are the keepers of the organization’s project management policies, procedures and methodologies.
23. **Answer C.** The concept of continuous improvement is very important to PMI®. A key element to continuous improvement is keeping of historical records for just such a situation as this. Although the project manager might do several of these items, the very first thing they should do is review the historical records from past similar projects.
24. **Answer D.** Read the question carefully. Did you notice the question describes an operation? Operations are not managed the same way as projects. Attempting to do so is what is causing the problem.
25. **Answer B.** Don’t be tempted to select “developing a work plan” for each work package. Although this would help control each phase, it would do nothing for the integration of the phases. Answer B is the only option that both improves the scope of the project and the integration.
26. **Answer B.** The project life cycle does incorporate a methodology—for doing the work. It is the product life cycle that spawns many projects. Project management activities are described in the project management process. The project life cycle is different for each industry, so that is the correct answer.
27. **Answer A.** Because this question deals with multiple projects, the only answer that can be correct is the project management office or PMO. A PMO deals with multiple projects.

The Basics of Project Management — Part 2

Project Management Defined

According to the PMBOK® Guide 6th edition (p.4), project management is the management of a temporary endeavor undertaken to create a unique product, service, or result. Projects are completed by every kind of organization to produce a wide range of results using a large number of different tools, techniques and methodologies. This makes defining project management in a purely black and white context nearly impossible. PMI® focuses on what is called the Body of Knowledge or the BOK. The **BOK** represents everything that has ever been written or recorded about the management of projects. This is a huge amount of information that cannot possibly be consolidated into a single work. Instead, PMI® created the Guide to the Project Management Body of Knowledge or the PMBOK® Guide. Think of the Guide as a map to what is considered generally recognized as good practice for the field of project management. It is critical that we unpack the concept of generally recognized good practice as over the years it represents the root of much misinterpretation.

Generally recognized as good practice is broken into two components. First, generally recognized means there is consensus by the majority of those executing projects around the knowledge and practices being successfully applied to most projects most of the time. Notice this statement doesn't say **ALL** projects. It says **MOST**. This means that by definition, there are always exceptions to the standards. If as you go through the standards you find yourself disagreeing with the standards because that is not the way your organization does things don't panic! It just means you are possibly not doing what most organizations do and there is likely nothing wrong with that so long as the organization has confirmed that the practices are best for you. Also recognize that at least for the exam you **MUST** understand and know the standards.

The second component of this statement is good practice. This phrase simply means that whatever the knowledge, skill, tool, or technique in question is found to enhance the chances of creating the expected business value. According to PMI® the practices described in the PMBOK® Guide are descriptive and not prescriptive. In other words, PMI® does **NOT** say you must do these practices. Instead, PMI® describes practices that are considered best. Unfortunately for many readers of the Guide, a number of these practices conflict with each other. Don't worry or get confused. Just remember that PMI® is **NOT** suggesting you do every practice in any specific order. PMI® also provides the Lexicon of Project Management Terms to ensure your understanding of the terms used in the Guide.

Projects vs. Operations

In simplest terms, everything an organization does can be placed into two categories: operations and projects. There are no exceptions. Everything falls into one of these two categories. They are both critical to an organization's success. Operations manage the existing processes, products, services, or



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results. Projects focus on the new things being created. While operations focus on consistency, stability and repeatability, projects focus on change. Operations focus on removing the waves from processes. Projects, on the other hand, create the next product, service or result — and these naturally create waves. Operations and projects do, however, have several characteristics in common. The obvious thing they have in common is that both operations and projects are accomplished by people. Also, people are a kind of resource that is often limited in both operations and projects. Finally, in both projects and operations there are efforts made to plan and control the people and processes involved.

For the PMP® exam, it is important that you can compare and contrast projects and operations. Here are the common characteristics held by projects:

- ⇒ **Have unique charter and goals** — Projects are created to generate a very specific and defined set of results. To help ensure that this actually happens, projects have charters that define the boundaries, the success criteria and the specified goals.
- ⇒ **Might have unique organization** — The organizational structure defines whether or not the project will have a unique organization assigned to produce it. Projectized organizations will have a unique organization defined, while functional or matrix organizations will not.
- ⇒ **Develops a unique product or service** — Projects produce a unique product or service — in contrast to operations which manufacture the same product, such as a car or a widget. Projects are not used to create repetitive products or services.
- ⇒ **Defined start and end dates** — Projects are not continuous. In addition to having specified scope with defined success criteria projects also have defined start and end dates. These factors create what is commonly referred to as the triple constraints of project management (time, costs, scope and quality).
- ⇒ **Mostly heterogeneous teams** — Projects require teams with varying and often dissimilar skills. This makeup is also determined by the organizational structure. The closer an organization is to being projectized, the more heterogeneous the team will be.

A better understanding of the difference between projects and operations can be had by comparing the common characteristics of each. Here are the common characteristics of operations:

- ⇒ **Usually has semi-permanent charter** — Operations can exist for a significant period of time — often significantly longer than projects. The agreement to do the operation and the rules under which it exists form the basic operational charter.
- ⇒ **Semi-permanent organization** — Operations require teams that are long-term and stable to deal with the repetitive nature of the operation. Therefore, semi-permanent structures often make the most sense.



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- ⇒ **Maintains an existing set of practices** — As has been previously stated, operations are mainly concerned with maintaining the consistency of performance according to an existing set of standards. The key here is stability.
- ⇒ **Provides a standard product or service (e.g. an assembly line)** — A key differentiator for operations is that they produce a manufactured product, process, service or result that can be produced repeatedly.
- ⇒ **Are continuous** — Unlike projects that have defined start and end dates, the other key differentiator for operations is that they are ongoing or continuous.

Remember, the key to differentiating projects and operations is to focus on the constraining factors found in projects that are not found in operations, such as defined scope, schedule and costs.

In addition to differentiating projects and operations, PMP® candidates must be able to differentiate between the levels of effort required for management.

Projects, Programs, and Portfolios

Within the field of project management three *levels* are defined. The lowest level is the project. A project is a temporary endeavor undertaken to create a unique product or service. Above a project is a program. A program is a group of related projects managed in a coordinated way. The projects involved in the program are connected in some way that justifies adding the management expense and effort required to coordinate them. Finally, above a program is a portfolio. A portfolio is a grouping of related and unrelated projects and programs that are grouped for



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Organizational Project Management			
	Projects	Programs	Portfolios
Scope	Projects have defined objectives. Scope is progressively elaborated throughout the project lifecycle.	Programs have a larger scope and provide more significant benefits.	Portfolios have an organizational scope that changes with the strategic objectives or the organization
Change	Project managers expect change & implement processes to keep change managed & controlled.	Program managers expect change from both inside & outside the program & are prepared to manage to it.	Portfolio managers continuously monitor changes in the broader internal & external environment.
Planning	Project managers progressively elaborate high-level information into detailed plans throughout the project lifecycle.	Program managers develop the overall program plan & create high-level plans to guide detailed planning at the component level.	Portfolio managers create & maintain necessary processes & communication relative to the aggregate portfolio.
Management	Project managers manage the project team to meet the project objectives.	Program managers manage the program staff & the project managers; they provide vision & overall leadership.	Portfolio managers may manage or coordinate portfolio management staff, or program and project staff that may have reporting responsibilities into the aggregate portfolio,
Success	Success is measured by product & project quality, timeliness, budget compliance, & degree of customer satisfaction.	Success is measured by the degree to which the program satisfies the needs & benefits for which it was undertaken.	Success is measured in terms of the aggregate investment performance & benefit realization of the portfolio.
Monitoring	Project managers monitor & control the work of producing the products, services, or results that the project was undertaken to produce.	Program managers monitor the progress of program components to ensure the overall goals, schedules, budget, & benefits of the program will be met.	Portfolio managers monitor strategic changes & aggregate resource allocation, performance results, & risk of the portfolio,



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Image 10: Comparing projects, programs and portfolios

visibility and control purposes. Often, portfolios are created based upon budgetary authority, but they can be formed for many reasons. An example of a simple portfolio is everything for which an executive has budgetary responsibility. To better understand the relationship between projects, programs and portfolios examine how each address the issues of scope, change, planning, management success, and monitoring.

Projects

- ⇒ **Scope** — Projects have defined objectives. Scope is progressively elaborated on throughout the project's life cycle.
- ⇒ **Change** — Project managers expect change and therefore implement processes to keep change managed and controlled.
- ⇒ **Planning** — Project managers elaborate on high-level information, turning it into detailed plans throughout the project cycle.
- ⇒ **Management** — Project managers manage the project team in order to meet the project's objectives.
- ⇒ **Success** — Success is measured by the product and project quality, timeliness, budget compliance, and degree of customer satisfaction.
- ⇒ **Monitoring** — Project managers monitor and control the work of producing the products, the services or the results that the project was undertaken to produce.

Programs

- ⇒ **Scope** — Programs have a larger scope and provide more significant benefits.
- ⇒ **Change** — The program manager must expect change from both inside and outside the program and must be prepared to manage it.
- ⇒ **Planning** — Program managers develop the overall program plan and create other high-level plans to guide detailed planning at the component level.
- ⇒ **Management** — Program managers manage the program staff and the project managers. They provide vision and overall leadership.
- ⇒ **Success** — Success is measured by the degree to which the program satisfies the needs and benefits for which it was undertaken.
- ⇒ **Monitoring** — Program managers monitor the progress of program components to ensure the overall goals, schedules, budget, and benefits of the program are met.

Portfolios

- ⇒ **Scope** — Portfolios have a business scope that changes with the strategic goals of the organization.

-
- ⇒ **Change** — Portfolio managers continually monitor changes in the broad environment.
 - ⇒ **Planning** — Portfolio managers create and maintain the necessary processes and communication protocols necessary for the aggregate portfolio.
 - ⇒ **Management** — Portfolio managers may manage or coordinate portfolio management staff.
 - ⇒ **Success** — Success is measured in terms of the aggregate performance and value indicators.
 - ⇒ **Monitoring** — Portfolio managers monitor the aggregate performance and value indicators.

For the PMP® exam it is important you remember that most of the questions focus on projects and not programs or portfolios. However, you should be able to differentiate between the three. Additionally, you need to be thinking about the right size of project. In general, you should imagine that you are leading a project that combines at least 50 to 100 resources from several continents and that lasts more than a year and has a value of greater than U.S. \$1,000,000. Furthermore, you should assume that your project goes through a formal review and prioritization process within your organization.

The PMO

A PMO is a department within the organization that centralizes the management of projects. In most cases, the PMO takes one of three roles:

- ⇒ PMOs provide project management for the various projects within the organization and are responsible for the results of those projects.
- ⇒ PMOs provide tools, techniques, policies, methodologies, and templates for the organization to manage various projects.
- ⇒ PMOs provide guidance and support to the organization on how to manage projects. This includes providing training for the project managers on the processes and tools of project management.

Remember, a PMO is not a person, but an organization or department. Most of this manual is focused on describing the role of the project manager, but the PMO is different. Here are some of the ways the PMO is different:

- ⇒ PMOs often have the power to terminate projects.
- ⇒ PMOs often have the power to provide resources to projects.
- ⇒ PMOs often manage the interdependencies between projects.
- ⇒ PMOs often monitor an individual projects' compliance with organizational policies.
- ⇒ PMOs often gather lessons learned and share the information throughout the organization.

- ⇒ PMOs often provide centralized communication about projects.
- ⇒ PMOs are often more heavily involved early in the project.

PMI® describes three types of PMOs that each have varying degrees of control and influence over the project. These include:

- ⇒ **Supportive** — These PMOs act as a consultative role. Their primary function is to provide things like templates, best practices, training, access to pertinent information, and most importantly lessons learned from previous projects. You should think of this type of PMO as a repository. This type PMO has very little power or control over the projects in the organization.
- ⇒ **Controlling** — Controlling PMOs do **NOT** directly manage projects. However, this type of PMO mandates compliance to varying degrees. The PMO maintains this control by establishing project management frameworks and methodologies that must be adopted. It also requires the use of specific templates, forms, and tools.
- ⇒ **Directive** — Directive PMOs take the most direct and overt control of projects. Directive PMOs include the organization's project managers who are assigned by and report to the PMO. In this form of a PMO a high degree of control is maintained.

When discussing a PMO realize that they can have oversight over the entire organization or a single area.

Other Terms

Management by Objectives (MBO) — MBO is a management technique that requires all processes, initiatives and operations to be tracked against specific, defined objectives. If the project does not support or follow a defined objective it is likely to lose its resources and sponsor support and will therefore fail. MBO only works if management strongly supports it. MBO has three basic steps:

- ⇒ Establish unambiguous and realistic objectives.
- ⇒ Regularly evaluate if the objectives are being met.
- ⇒ Implement corrective action when necessary.

Work Performance Data — These are the raw observations and measurements that are identified during the activities performed in the project work: % of work that has been physically completed, start and finish dates & technical measures.

Work Performance Information — This is the performance data that has been collected from the controlling processes. It includes the status of deliverables, status of change requests, etc.

Work Performance Reports — These are the physical or electronic records of work performance.



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Project Life Cycle — These are a series of phases that a project passes through from its initiation to its closure. They provide the basic framework for managing the project.

Project Phases — These are logically related project activities that culminate in the completion of one or more of the deliverables.

Predictive — These are also known as fully plan driven. They are ones where the scope, time and cost are determined as early as possible. They arise in the Waterfall method of management.

Iterative and Incremental — These are project phases that intentionally repeat one or more project activities as the team's understanding increases.

Adaptive — Change driven, adaptive, or Agile methods of management are intended to respond to high levels of change and stakeholder involvement with fixed time and fixed cost.

Constraints — Constraints are factors that limit the options of the project manager and the project team. Common constraints — such as time, budget, requirements, resources or risks — can dramatically impact the results, like the customer satisfaction. It's the management's responsibility to set the priority of each constraint within a project. It is the project manager's and project team's responsibility to analyze the impacts that any changes will have according to the project constraints.

OPM3™ — OPM3™ stands for Organizational Project Management Maturity Model. It is PMI's model to help organizations determine their level of project management maturity. PMI® publishes a separate standard for OPM3™.

Stakeholders and Stakeholder Management — Stakeholders represent anyone with a vested interest in the project. That interest can be positive or negative. This means stakeholders can like or dislike your project. Stakeholder management is the process by which a project manager deals with stakeholders. As you will see later in this course, stakeholder management is only formally called out once in the processes of project management. However, it is something you must constantly do.

Once you have a firm grasp on the hierarchical relationships between project, programs and portfolios, and are conversant with the structures of project management and the basic terms, it is time to focus on the real drivers of projects and the project's success.

The Key Drivers

The PMI® perspective on project management contends that it really comes down to carefully managing six key drivers:

⇒ **Scope** — The project's scope is its defined objectives. The key for the project manager is to avoid scope creep.



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- ⇒ **Quality** — Quality is the degree to which the product, service or result meets the stated requirements.
- ⇒ **Schedule** — The project schedule is the committed delivery date for the project.
- ⇒ **Budget** — The budget is the forecasted expenditure for the project.
- ⇒ **Resources** — The resources are the people and/or materials needed to complete the desired product, service, or result.
- ⇒ **Risk** — Unknown events happen on every project. Being able to manage the unknowns is perhaps the most important skill of a true professional project manager.

Deming's PDCA Cycle and the PMI® Process Model

One of the key elements to passing the PMP® exam is understanding the process model for project management as defined by PMI®. Like most of the process models widely used in the world today, PMI's model finds its roots in Edward Deming's famous PDCA cycle. The PDCA cycle represents a well formed process where the work is first planned, then the work is executed according to the plan, the results are checked against the expected outcomes, and finally any variances are acted upon. PMI® builds on this basic model to explain the process every well-managed project goes through regardless of size, cost or scale.



Image 11: The PDCA Cycle

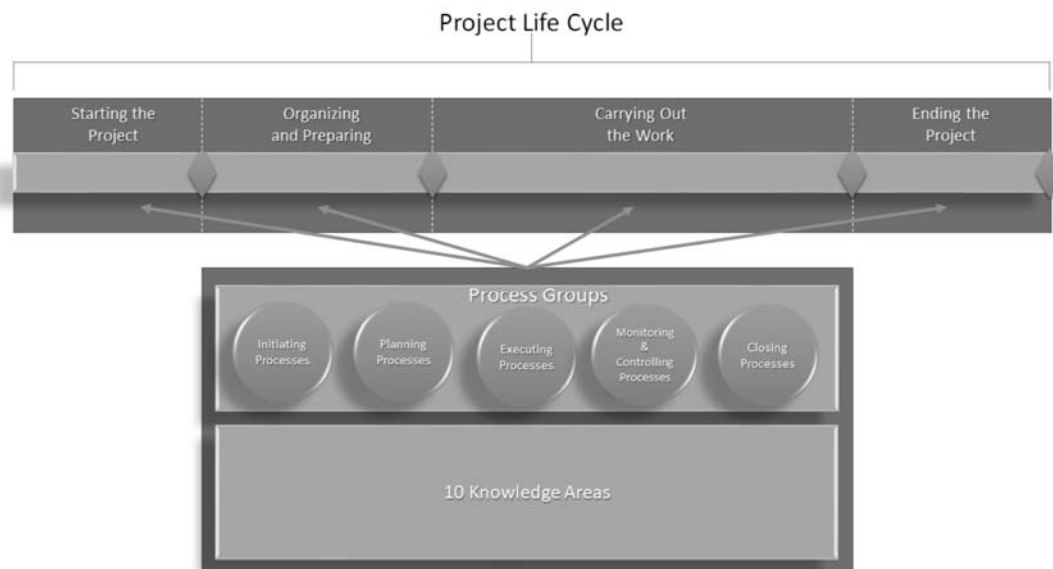
To understand the PMI® model, it is important to know a number of key concepts (PMBOK® Guide 6th Ed. p.18):

- ⇒ **Project life cycle** — The series of phases that a project passes through from its start to its completion.
- ⇒ **Project phase** — A collection of logically related project activities that culminates in the completion of one or more deliverables.
- ⇒ **Phase gate** — A review at the end of a phase in which a decision is made to continue to the next phase, to continue with modification, or to end a program or project.
- ⇒ **Project management processes** — A systematic series of activities directed toward causing an end result where one or more inputs will be acted upon to create one or more outputs.



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- ⇒ **Project management process group** — A logical grouping of project management inputs, tools and techniques, and outputs. The Project Management Process Groups include Initiating, Planning, Executing, Monitoring and Controlling, and Closing. Project Management Process Groups are **NOT** project phases.
- ⇒ **Project management knowledge area** — An identified area of project management defined by its knowledge requirements and described in terms of its component processes, practices, inputs, outputs, tools and techniques.



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Image 12: Interrelationship of PMBOK Guide Key Components in Projects PMBOK Guide 6th Ed. p.18

In the 6th edition of the PMBOK[®] Guide changed how PMI[®] represented this model in hopes of reducing confusion between the defined framework and various methodologies or life cycles (See Image 12). The new representation begins at the top with the project life cycle which represents the actual process used for your specific project. In general terms, each life cycle goes through a similar series of steps where the project is first started. Once the organization recognizes it has a project on its hands and decides to manage it as such, the effort must be organized and preparatory work completed. The team then uses its defined processes to complete the project work, and eventually the project ends.

Beneath the project's specific life cycle sits the five PMI[®] process groups: initiating; planning; executing; monitoring and controlling; and closing. These five containers represent placeholders for the 49 specific processes defined in the ten knowledge areas of the PMBOK[®] Guide. It is at this point that examining PMI's previous model holds value for understanding the project management framework.

The model (Image 13) begins with a project sponsor or initiator defining a business or organizational need. The need is further defined until someone recognizes that it should be a project. At that point the initiating process group begins.

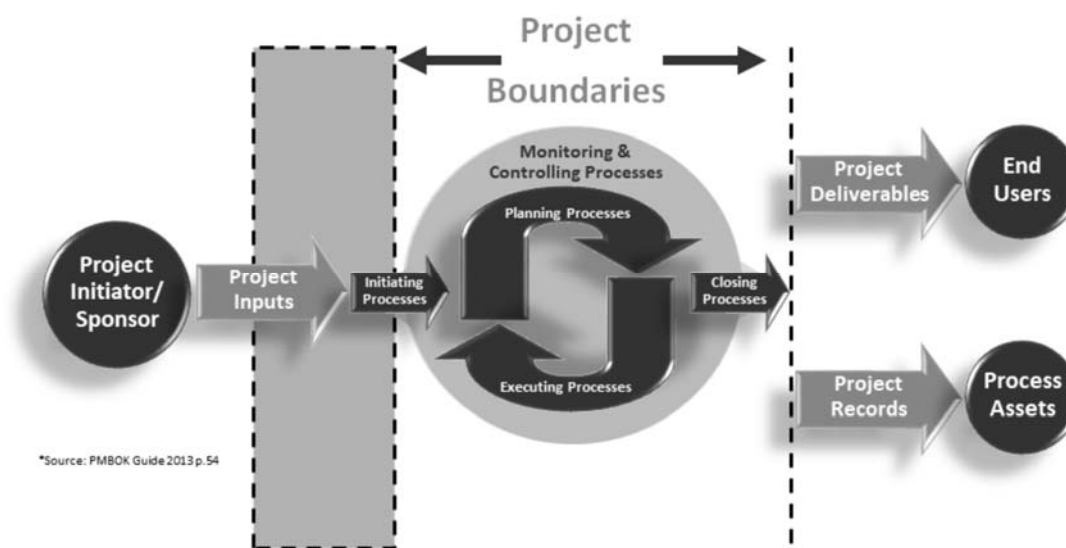


Image 13: The PMI® Process Framework PMBOK® Guide 2013 p.54

The initiating process group has two key goals: to develop a project charter and to identify stakeholders. The charter authorizes the project and is discussed further in the next chapter. Identifying the stakeholders is discussed in the stakeholder management chapter. Once the charter is created and stakeholders have been identified, the project progresses into the planning process group.

The planning process group is the largest of the five project management process groups. It also has the potential for a looping relationship with the executing process group. This relationship is the point of the confusion with students of project management. If both the planning process group and executing process group are done just once it creates a linear life cycle such as in a waterfall or SDLC. But the model also allows for the planning and executing process groups to be completed many, many times in a back-and-forth relationship.

Deciding when planning is complete, and when it is time to execute the project is the monitoring and controlling process group. This process group acts as the project's eyes and ears. The monitoring and controlling process group might also decide that a project requires more planning after execution has begun, or that all the project work is complete.

Lastly, there is the closing process group. Whereas the executing process group produces deliverables, only the closing process group produces the final product, service, or result. Additionally, the closing process group produces project records which then become assets to the organization because they allow it to engage in continuous process improvement, which is very important to PMI®.

Development Methodologies /Life Cycles

Development methodologies and life cycles are critical to project success. However, a development methodology should not be confused with project



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management. This section examines how development methodologies impact projects and provides a basic understanding of the five families of development methodologies. The purpose of this discussion is not to make you an expert at any one of the methodologies presented, but rather to provide enough information to give you a clear understanding of how they work. This understanding will provide the knowledge necessary to properly align the results of the project, the organization, and the team with a methodology most likely to produce success. Above all else remember that almost any project can succeed with almost any methodology. The key is understanding the risks and benefits of each so you can make informed choices.

Development methodologies are easier to understand when they are placed within a construct that allows the comparison of one methodology against another. *Image 14* shows such a construct.

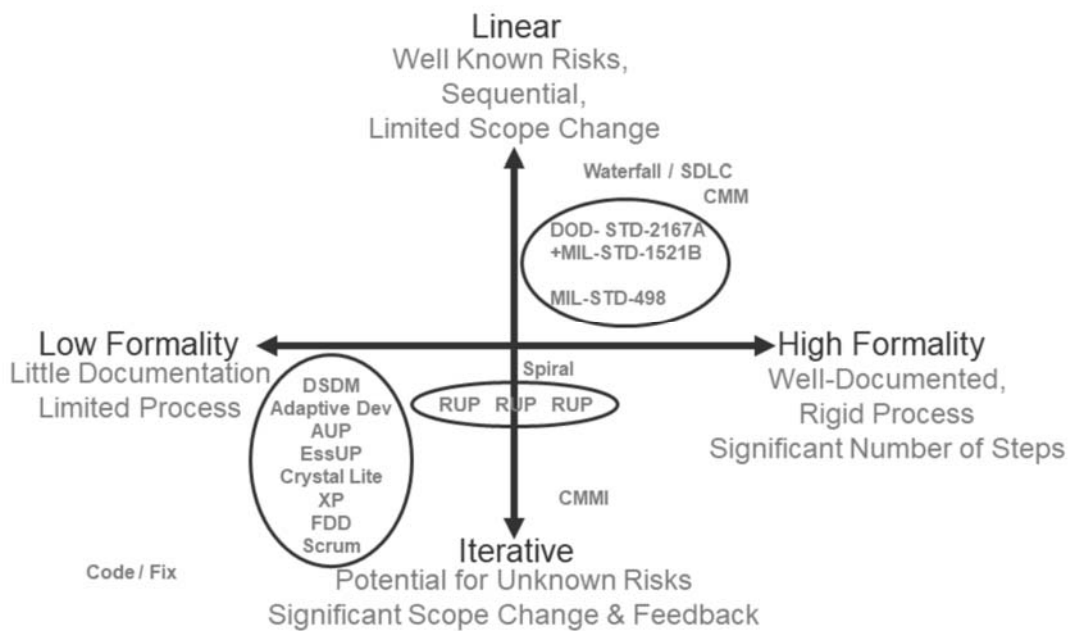


Image 14: Lifecycles or Methodologies

The horizontal axis in the model measures the amount of formality or a structured process the methodology uses. A key representation of this formality is found in the volume of required documentation. Methodologies with low formality typically require little documentation, while methodologies with highly structured processes usually require significantly more documentation. However, do not equate the amount of process and formality with the quality of the management or likelihood of success.

The vertical axis in *Image 14* represents the number of loops or iterations a project goes through. A methodology that only cycles once through its steps is said to be highly linear or sequential. If the methodology is highly linear it often appears to be rigid. Methodologies that are highly linear tend not to loop back on themselves



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or repeat steps. If the methodology is not highly linear then it is iterative. This means that the methodology allows the project to repeat steps as more information is learned about the project. Recognize that it is not required that only pure methodologies be used. Experienced project managers regularly combine methodologies to best meet specific business needs as is represented by a hybrid life cycle. This is a key ability for project success. However, the project leader must understand the basics of the major methodologies to build that custom methodology. *Image 15* shows the “Big 3” types of life cycles together to give you a visual reference.

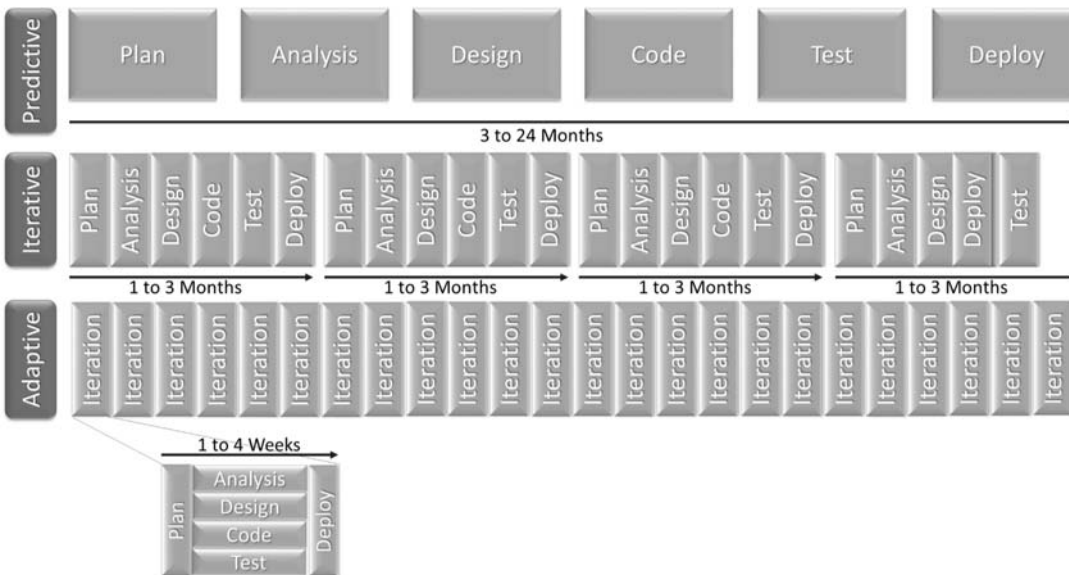


Image 15: The Major Life Cycles / Methodologies

We have already offered a basic definition of the core methodology or life cycle classes, but we have not really dove into them in any detail. That discussion begins with a better understanding of the predictive model.

Understanding the various life cycles that fit into this model is a very important aspect of your studies. PMI® describes life cycles as generally either being adaptive or predictive. In the simplest terms, these two concepts represent constantly evolving planning where the project is broken into small components over a less determined timeline versus project planning that is done in a linear fashion with a specific development plan structured specific scope, schedule and cost estimates. However, all of these life cycles are broken into phases specifically associated with the development of products, services and results. The discussion of lifecycles or methodologies has a variety of options beyond the basic predictive and adaptive. These include:

- ⇒ **Predictive life cycles** — In a predictive life cycle the team spends significant time in the early phases of the project determining project schedule, scope, and cost estimates, often referred to as the project’s triple constraints. Throughout the rest of the project, the team then works to tightly manage any scope changes. A predictive life cycles include the Software Development Life Cycle



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and the Waterfall Methodology. This model works well when it is reasonable to expect that all the requirements are knowable at the beginning of the project and it is critical to maintain stable scope, schedule and cost targets. However, this model does not typically respond well to missed or changing requirements.

- ⇒ **Iterative life cycles** — Iterative development generates a cyclical process that often has a single general roadmap. However, it uses a series of steps where each step learns from the previous ones to produce the overall product, service or result. An iterative process embraces the fact that many projects struggle with knowing at the beginning what the final product should look like and responds by building in as many learning opportunities as possible. An often used tool in iterative development is prototyping.
- ⇒ **Incremental life cycles** — In incremental life cycles the product, service, or result of the project is produced using a series of chunks. The most common implementation of incremental delivery has the team delivering business value in a series of releases rather than one large chunk. The big difference between this model and an iterative cycle is that those using an incremental life cycle will work to maintain the original road map, and few opportunities exist for feedback from the customer until the final product, service or result is released.
- ⇒ **Adaptive life cycles** — Adaptive life cycles may be iterative, incremental, or agile. In an adaptive model, project scope is defined at the beginning of each iteration and only generally at the beginning. These life cycles are also called agile or change-driven. Agile methodologies are all the current rage. Scrum, Extreme Programming, DSDM, Feature Driven Development, and Crystal are all examples. These models typically have smaller collocated teams and offer critical advantages when the team is dealing with poorly defined or changing requirements.
- ⇒ **Hybrid life cycles** — A hybrid life cycle is a combination of the adaptive and predictive life cycles. In this model, the team uses a predictive model for those requirements that are either well known or fixed and uses an adaptive model for requirements that are unknown, incomplete, or evolving. This is not an undefined process where the team is allowed to do whatever it wants. In most cases, the team follows a process defined by the larger organization to ensure consistency of process.

It is up to the team to decide the best life cycle for the particular project in their specific organization. However, the information provided above, which largely aligns with the limited information found in the PMBOK® Guide, is definitely not enough to make a real-world decision on the best methodology to use. It also isn't enough to get you through the exam. To help you better understand methodologies review the following:

The Predictive Model

The use of the term “waterfall model” comes from its linear series of steps that proceed downward like a waterfall. Work is completed in a sequential manner with one deliverable being completed and approved prior to moving to the next

deliverable. These gates are commonly referred to as phase gates, stage gates, milestones or go-no-go decision points. Some common names for these gates include:

- ⇒ Stakeholder Review
- ⇒ Requirements Review
- ⇒ Use Case Review
- ⇒ Critical Design Review

The waterfall model uses an extremely linear process. This process begins with the definition of the business need. This is referred to as conceptualization or analysis. It then continues through all the steps in the waterfall until ending in the deployment of the product or service of the project. The Software Development Lifecycle or SDLC is one of the best known waterfall models. Like many waterfall models it has five steps or phases.

- ⇒ **Analysis** — The business need is defined and the top level scope is defined for the product or service that will best meet the need.
- ⇒ **Design** — The specific requirements that are necessary to complete the product or service are defined.
- ⇒ **Development** — The product or service is built in accordance with the previously defined requirements.
- ⇒ **Testing** — The product is tested to ensure that all the features and functionality are working in accordance with the requirement. In addition, integration testing is completed to ensure the product or service will function correctly within the global environment.
- ⇒ **Deployment** — The product or service is completed and moves into the operations phase.

Waterfall Advantages

- ⇒ A waterfall model offers the easiest departmentalization and managerial control.
- ⇒ A waterfall model forces the team to completely define all requirements before proceeding to the next phase. This is also its biggest disadvantage.
- ⇒ The waterfall model has strong emphasis on documentation and the development of source code.
- ⇒ The waterfall model provides a very structured and disciplined approach to development. This high degree of structure may also be seen as a disadvantage by many.

Waterfall Challenges

- ⇒ Real world projects rarely follow a purely sequential process. In practice steps are often repeated multiple times or the project must go backwards to continue progressing.



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- ⇒ The waterfall model requires the project team to know and define all the requirements at the beginning of the project. This can be extremely unrealistic.
 - ⇒ Waterfall models often cause a large time gap between requirements definition and when stakeholders actually see the product or service of the project. This gap can cause the stakeholders to become uncomfortable with the progress or to change requirements. There is also a risk the product or service may no longer meet stakeholder needs.

Selecting a waterfall methodology is often warranted if any of the following are true:

- ⇒ The project has requirements that are extremely well known and unlikely to change.
- ⇒ The project involves a high volume, transactional system where errors or incomplete requirements could damage existing capabilities.
- ⇒ The project team is made up of new and inexperienced resources or resources that have never worked together before.
- ⇒ The project would benefit the organization was not allowed to alter requirements.

To better understand how these decisions should be made, examine the following situations:

Imagine a credit card processing system. Several million times a day merchants send credit card transactions into your system. If your team was to deploy inaccurate or incomplete components the entire system might fail. This would both significantly and negatively impact the business. This situation would provide a timely opportunity to use a waterfall methodology.

Now imagine a new website. What would be the impact on the site if one or two of the pages were not completed when the site is deployed? You would not be able to see those pages, but all the other pages would work correctly. This may lead the project manager to select a different methodology, such as one where the project manager could deliver some type of actual product so the stakeholders could determine what they really want prior to the end of the project.

Iterative Life Cycles

The most common form of an iterative life cycle is the Spiral methodology. A spiral methodology is one of the only formal methodologies that uses prototyping to prove capabilities or investigate requirements and functionality. This methodology is often referred to as “*chunking*” because it makes use of discrete phases to produce parts of the overall product, service, or result of the project. These chunks are not considered “production ready until they are combined with the other components at the end of the timeline.

Iterative development is a rework scheduling strategy in which time is set aside to revise and improve parts of the system. The concepts of iterative development



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creates loops in the process of executing a project that allow the team to change their process to improve execution and delivery. In a single looped linear process, the team is stuck with the process with which they start the project. This is a key advantage to seasoned, experienced teams. Those teams have completed multiple projects together and hopefully those experiences provide insights on the current effort. Agile projects get lots and lots of chances to deliver because they use lots of short iterations. Each one requires a short cycle of reflection to determine the best way to improve the process and deliver better results.

Iterative development allows for segregated teams based on their functional areas. For example, a project might have a group of stakeholders and team members solely focused on the definition of requirements. These individuals would begin immediately on the project defining the requirements by chunk. They would begin by defining the first chunk, then the second, the third, and so on.

As soon as the first chunk is defined a second team or individual begins defining the design specifications for the first chunk before moving on to the second, third, and so on. There would also be sub-teams assigned to development and testing that each would begin work as soon as the first iteration was ready.

Within each of these chunks, the team often produces one or more prototype to prove technology, designs, methods or other key aspects. In each chunk the project goes through four stages:

- ⇒ Determine objectives, alternatives and constraints.
- ⇒ Evaluate alternatives, identify and resolve risks (prototype).
- ⇒ Develop and verify the next level of the product.
- ⇒ Plan the next phase of the project.

The spiral model also demands the project manager make a strong effort to determine how many phases or chunks the project will take before beginning the looping process since a failure to effectively make this determination will often lead to a significant problem with schedule and cost control. Remember, iterative development still tries to fix the schedule and budget in the broad sense.

In the spiral model, a prototype is built during the “evaluate alternatives” phase. After gathering feedback about the prototype, the project team determines the next level of the project. The next level of effort and deliverables are planned and then a new phase begins. This process continues in a looping fashion with more and more iterations until the final product is ready for evaluation and testing.

Spiral Advantages

- ⇒ The spiral model is evolutionary in nature allowing the features and functions to evolve over time thereby creating a better final product.
- ⇒ The spiral model provides a strong focus on the project risks. The iterative process mitigates risk by using prototypes to ensure the team can actually deliver the desired results before too much time or money is invested.
- ⇒ Prototypes allow for rapid evaluation of the solution provided by the project



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team. It allows the team to make adjustments to the solution based on the changing business environment.

- ⇒ Other models can be incorporated into the spiral model to assist the developers or to address special needs of the project team.
- ⇒ The project team and sponsor can more quickly see the results of the project and alter requirements as needed.

Spiral Challenges

- ⇒ The project teams must have strong risk assessment expertise. The primary advantage of the spiral methodology is that it provides for better risk management. If the project team lacks skills in this area the advantage doesn't exist.
- ⇒ The model has a greater potential to overrun costs and schedules because a spiral methodology uses looping iterations. Even though the project manager is supposed to define the number of these loops, often additional loops are added to allow for new requirements or new information. This can cause the schedule and/or costs to slip.

Prototyping

When prototyping, the project team builds a smaller version of the product or a core piece of the product's functionality. This process allows the project team to test theories, evaluate alternative solutions, or prove they are capable of delivering specific features. The prototyping process also allows the team to make refinements to the product requirements as new information is learned. Prototyping assumes that it is difficult to know all the project requirements at the inception of the project. To be able to discover and refine the requirements, the developer must build a simplified version of the system and present it to the customer for evaluation and feedback.

The most important thing to remember about prototyping is that it is only used to solicit feedback, prove capabilities, and gather and refine requirements. It should never be released as a finished product. Deploying prototypes is a common error. Preventing this from happening requires the project manager to consistently and carefully manage stakeholder expectations. There are three issues that must be carefully managed with your stakeholders when prototyping:

- ⇒ The prototype should never be deployed as a product. This often happens and causes significant frustration as the prototype is rarely designed to handle the load of real world use.
- ⇒ Creation of the prototype will cost additional money without providing an immediate product. However, it is expected that this will save money in the long run.
- ⇒ The use of prototypes can dramatically increase the likelihood of a problem called architectural compression. This problem occurs when organizations build one system either on top of or beside another repeatedly without



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consideration for the overall architecture. Eventually, the entire foundation collapses under the weight of all of the independent components. The use of prototypes can often make this problem worse because they rarely have any consideration for the overall architecture.

To be successful with the spiral methodology the project manager must keep a careful eye on the needs of the overall structure of the project and work to constantly manage expectations.

Incremental Life Cycles

Incremental life cycles get us closer to true agile development, but **NOT** all the way there. In incremental development the team breaks the project into smaller components or chunks that each have value to the customer, and at the completion of each chunk the customer receives a working product, service or result. This product might only have one or two capabilities, but those capabilities work in the production environment per the project requirements. Each subsequent release add new, complete functionality to product with only very limited rework occurring on previously completed features. It is different from iterative development because it does not focus on a single release of the product, service or result and it typically makes use a complete team instead of one broken by functional areas.

Incremental delivery is also different from iterative development because of its focus of having a complete process in each cycle. This means that each project chunk goes through a similar evolution of requirements, design, testing, release to production and operation with the entire team participating in each part.

Incremental development is a staging and scheduling strategy in which the various parts of the system are developed at different times or rated and integrated as they are completed. This means that the features or requirements do not have to be completed as part of a single release. When a team uses incremental delivery they are able to deliver features or requirement in a wide range of orders defined by the team. This fundamentally changes how projects are executed. Suddenly, it what is delivered at any point in the project. This notion is somewhat similar to the ideas surrounding Object Oriented Programming where features and requirements are delivered as discrete objects independent of others.

The incremental life cycle is especially advantageous when working with new or unfamiliar technology and has the advantage of producing production ready product, service, or result early in the project timeline. It also has the advantage of experiencing lower costs to change requirements as compared to other models. Team often experience less difficulty developing and testing the project product because of the focus on small pieces of functionality, and the iterative model allows the customer to more quickly provide feedback.

Iterative development is not perfect however, and does have some disadvantages. The most important of which is the fact that the team may experience significant struggles with the overall system architecture because no time is ever spent building an overall architecture. It also requires a seasoned and skilled project manager to lead the effort because there is often less formalization of the process and documentation.

Adaptive Life Cycles

Adaptive development is most commonly known as agile development. It is typically both iterative and incremental in nature. In addition to incremental and iterative development, agile processes change the way work is completed by team members. Agile development makes extensive use of WIP or work in progress. Although there is no rule or requirement to do so, most traditionally managed projects use a concept called best resourcing. In best resourcing whichever resource possesses the highest skill level is assigned to execute the task. WIP represents a very different way to task project work. To better understand WIP let's exam a simple example.

Imagine that you are part of a project team that has three deliverables to complete and three resources on the team. Each resource is the perfect resource to complete one of the three tasks. Additionally, the team is constrained by only being allowed six time/cost units to complete its work. How do you decide who does what? One option would be to use best resourcing. Option 1 represents this choice. In this option, the person who is the most skilled at the work does each task. As a result, Deliverable X is worked on by Resource A, Deliverable Y is worked on by Resource B, Deliverable Z is worked on by Resource C. Notice that the statement says each deliverable is “worked on” by the specified resource and NOT “completed by”. That is because, like many real-world projects, our example struggles with schedule and budget limitations. At the end of six time/cost units the team runs out of time and/or money. Unfortunately, the team is only 2/3rds complete with each deliverable. This puts the project sponsor in an incredible bind. They have spent all the time and money the planned for the project, but have nothing of tangible value to show for it. The only logical choice is to spend 50% more than planned to complete the deliverables as the alternative is to walk away from the initiative with nothing to show for the effort.

Now let's look at Option 2. In this option, we do not assign the best, most skilled resource to complete the task. Instead we assign a capable resource to the first two deliverables. For Deliverables X and Y nothing changes between the two models. However, with Deliverable Z we see a change. Instead of assigning Resource C to begin working on Deliverable Z where they are the most capable resource we instead ask them to help Resource A with Deliverable X. We do this because of the principles of managing WIP. This principle argues that we want to limit the amount of Work In Progress occurring at any single point. The principle can be thought of like a water main. The objective of the Water Department is to ensure

Deliverable X			
Option 1	A	A	
Option 2	A	C	A
Deliverable Y			
Option 1	B	B	
Option 2	B	B	C
Deliverable Z			
Option 1	C	C	
Option 2			

Image 16: WIP



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the maximum amount of water is constantly available to the end users when they turn on their faucets. Contrary to what you might think, the best way to ensure high water pressure is to ensure the mains are less than 100% full. Remember, the mission is to get each drop to the customer as quickly as possible. If you ask your friendly neighborhood civil engineer, they will confirm that the water will travel the fastest when the pipe is less than 100% full. We do the same thing with our project tasks when using WIP. We need to have all hands focus on getting one deliverable through the process, then another, and another, and so on until the project is complete. The team's focus is on throughput and not just starting as many things as possible.

Now let's go back to our time/cost limitation. Remember, we still only have six time/cost units to spend on our project. In Option 2, both Resources A and C start out working on Deliverable X. At the same time Resource B begins working on Deliverable Y. Once Deliverable X is complete Resource C shifts over and helps Resource B complete Deliverable Y. At the end of the same six time/cost units both Deliverables X and Y are complete. Immediately you might have just thought, "Yeah, but you have nothing done with Deliverable Z." And, you would be correct. However, advocates of WIP would argue this is a positive not a negative. In addition to maximizing throughput (remember we now have two deliverables completed), the team has eliminated all waste. Waste in this case is defined as any partially completed work product when the team runs out of time or money. In this case, we are talking about Deliverable Z. Nothing was done on it so there is no waste. This puts our Project Sponsor in a powerful position because now they truly have a choice. Should they spend the extra 50% time/cost to complete Deliverable Z or not? If the team has correctly applied another common Agile principle of completing the most important work first than Deliverables X and Y were the two most important and Z is less important. The key question for our Sponsor centers on whether or not Z is worth the added 50%. If she walks away now, she has gotten her two most important deliverables and stayed within budget. WIP gives the power back to business and removes the common complaint that they were forced to complete a project because they had already invested so much. Good money no longer needs to follow bad.

Agile Methodologies

Today there are more than 16 different methodologies that are considered part of the agile family. Some of these like to refer to themselves as "frameworks", but the PMBOK® Guide refers to them as methodologies or life cycles because they each have specific rules and processes that must be followed. The most common of these methodologies include Scrum, Extreme Programming (XP), Feature-Driven Development (FDD), Dynamic Systems Development Method (DSDM), and the many forms of Crystal. Two less common, but no less important closely related methodologies include Lean Software Development and Kanban. For the purposes of the PMP® we will focus on Scrum only.

Scrum

Scrum is far and away the most popular agile methodology globally. It was first defined as “a flexible, holistic product development strategy where a development team works as a unit to reach a common goal” as opposed to a “traditional approach” (read a linear approach such as Waterfall) in January, 1986 by Hitotaka Takeuchi and Ikujiro Nonaka in the New Product Development Game published in the Harvard Business Review. This article described a new approach to commercial product development that they argued would increase both speed and flexibility based upon their examination of numerous case studies in manufacturing, photocopier, and printer industries. They called this the holistic or rugby approach. The idea was to create a single, small cross functional team that possessed all, or at least most, of the skills required to complete the project and this team would work singularly on the project across multiple overlapping phases constantly passing work back and forth until complete.

In the early 1990s Ken Schwaber used a version of this approach at Advanced Development Methods while Jeff Sutherland with others developed a similar approach at Easel Corporation. Sutherland is believed to be the first to refer this approach as, “Scrum.” In 1995, Sutherland and Schwaber jointly presented a paper describing the “Scrum Methodology” at the Business Object Design and Implementation Workshop held as part of the Object-Oriented Programming, Systems, Languages, and applications 1995 in Austin, Texas. The two continued to work together for several years bringing together their ideas on Scrum until in 2001, Schwaber published Agile Software Development with Scrum coauthored by Mike Beedle.

Scrum is based on two aspects of industrial process theory: self-organization; and emergence.

- ⇒ **Self-organization** is the idea that the development team will decide what work needs to be accomplished and who will do the work to deliver the desired business results.
- ⇒ **Emergence** is the idea that information, requirements and facts will emerge as the project progresses. The key is that the team uses processes, tools, and techniques capable of harnessing this new information for the betterment of the organization.

The creators of Scrum argue that traditional linear approaches for projects such as Waterfall are based on the concepts of defined processes. Defined processes are repeatable processes such as in manufacturing. Imagine working at the Acme Widget factory. In order to produce widgets of a consistent level of quality it is imperative that our machines stamp and assemble each widget the same way. The more consistently we can stamp the widgets the less variance we see in the finished product. As we move forward we also try to increase the rate of production. With smaller and smaller variances and greater and greater production we are able to take our widget production to a point where we commoditize the production of widgets. Commoditization is defined as the process in which goods that have economic value and are indistinguishable in terms of attributes (uniqueness or



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brand) end up becoming simple commodities in the eyes of the market or consumers. This means widgets become easy to obtain for the consumer because many different organizations make them uniform, plentiful, and affordable. Our widgets are like laundry detergent. If you go to most major grocery stores you find an entire row of detergent. All of it priced similarly and largely indistinguishable from each other. In manufacturing this is largely a good thing. However, such processes in project management are not good.

To understand why we first must understand how projects relate to the overall operation of the organization. In any organization, regardless of its purpose, there are only two types of things occurring: operations and projects or new initiatives. The purpose of operations is to keep the organization moving forward. Operations are all about repetition or doing the same thing over and over again, constantly seeking to become more efficient and squeeze just a little more cost out of the process. This is possible because we are producing the exact same thing day after day. A **defined process** is perfectly tailored to operational management because we want people to follow the exact same steps day after day. Projects or new initiatives are a very different animal. They are all about creating something we haven't had before. They are about creating something new and in some way different. By this definition, the processes we used to execute the last project won't necessarily work with next. Success relies on flexibility, and flexibility requires a different way of doing things. Projects have the greatest chance of success when empirical processes are used.

Empirical processes are used in situations where it is difficult to have consistent likelihood of success processes. Therefore, empirical processes focus on creating a situation with the highest using three primary drivers.

- ⇒ **Visibility** – The aspects of the process that affect the outcome must be visible to those controlling the process and what is seen must be true. The team cannot successfully manage or optimize that which they cannot see. Therefore, the first key is to ensure the team can see all pertinent information.
- ⇒ **Inspection** – The various aspects of the process must be examined frequently enough that unacceptable variances in the process can be detected. It is not enough to say you can see what is going on in a process. The team must also regularly examine all aspects of that process so they can determine when variances are occurring that are beyond what the team has determined is allowable.
- ⇒ **Adaptation** – If one or more of the processes are determined out of control, the processes change. Once you can see the drivers in a process and have taken the time to examine those variables to ensure you know which variables are in control and which ones are not, the only thing left is to fix those processes that are not performing as expected. This step is called adaptation.

Scrum Roles

Scrum is both infinitely simple and incredibly powerful. Learning Scrum requires you to know its three roles, four artifacts or documents, and five meetings. That's it! We begin by describing the three roles of Scrum.



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The first role is the **product owner** or PO. The PO is the individual responsible for representing the interests of all stakeholders, obtaining funding, defining the initial requirements, defining the return on investment or ROI, and the project objectives. They are the primary owner of the product backlog, a document where the user stories, features or requirements of the project are listed in rank order from most important to least important from the perspective of the business. The closest term in the PMBOK Guide® to the product owner is the project sponsor, but there are some differences. Theoretically, a sponsor exists as the all powerful leader. They give the project manager and their team the authority they need to execute the project. The rule when discussing a project sponsor is that you want the most powerful one you can find because the project manager is only as powerful as their Sponsor. This concept creates a hierarchical structure and a direct reporting relationship from the sponsor to the project manager, and then to the team. In Scrum, it is not assumed that the PO is this all powerful entity. Instead, we simply say that the product owner is responsible for certain areas. This means that the PO either has the direct authority to provide the funding and other items or the must go into the greater organization and obtain those things. Scrum doesn't care which. When the development team needs more information about a user story, they rely on the product owner to either know that information or ensure that the correct people are in the room to provide that information.

The second role is the **development team**. In earlier Scrum writings, this role was referred to as simply the team. This is the small group of people who actually do the work to deliver the product, service, or result of the project. The development team is self-managing, self-organizing, and cross functional. The team does not have a project manager or functional leader who directs the team's efforts. The development team is also small. According to the rules of Scrum, the team size is six plus or minus three. This puts the optimal team size somewhere between three and nine individuals. This is an important aspect of agile development. Research has repeatedly shown that smaller teams are much more successful than larger ones. Scrum also defines the development team as being multi-functional meaning it contains all the skills the team needs to complete the work of the project. Furthermore, the team is 100% dedicated to one and only one project. This notion of a team is often difficult for people new to agile development, especially the idea of a team being dedicated to one and only one project. "How is that even possible in the real world?" They ask. It works because the typical Agile team is much smaller than teams in traditional projects. It is still the same total number of total people in the organization, but by breaking the whole into smaller independent teams the organization is able to divide and conquer.

The third and final role is the **scrum master**. The scrum master is responsible for the scrum process, teaching scrum to everyone, implementing scrum so it fits with culture, and ensuring that everyone follows scrum's rules and practices. The closest approximation to in a linear project is the project manager, but there are some key differences, at least from the perspective of the Agilist. Most Agilists believe that traditional project managers are only part of hierarchical organizations with the project manager at the top. All the resources report to the PM. Additionally, this person serves as an administrator directing the team, but having

no technical skills or knowledge of the project. This is a huge oversimplification of the role, but makes for a nice comparison. A scrum master serves as a facilitator. Remember, a scrum development team is self-managing. The expectation is that the scrum master role is to only help the team, to ask probative questions, to ensure the team knows the scrum process and follows it. Development team members report to each other and not the scrum master so the scrum master has no formal authority to make anyone do anything.

Throughout much of the literature and in this book a fourth role is added to the list that is not officially part of scrum, but often unwittingly included. It is the team. The team is different from the development team because it includes all three scrum roles. It is defined as everyone involved in delivering the project. It is the product owner, the scrum master and the development team together. As we go through the rest of this discussion it is important that you can differentiate the team from the development team.

Everyone involved in the project fits into one of these three roles. For many, this is a bit disconcerting. What do you do if you are a business analyst or quality assurance person how do you fit in when there are only three roles and you aren't one of them? In most situations, these additional roles are included as part of the development team. They represent other resources needed to complete the work of the project. However, occasionally they also might fit in to the organization as resources used by the product owner to define the requirements of the project.

We have now covered the three roles found in scrum so it is time to move on to the four documents necessary required to implement scrum. The first of these documents is called the product or project **vision**. Most people are familiar with this document by another name, the project charter. Many Agilists would contend that the two documents are not the same thing, but this has more to do with many project managers failing to create proper charters than the comparison. The vision sets the direction of the project and guides the scrum team. In 2004, Schwaber described the vision this way, "The minimum plan necessary to start a scrum project consists of a vision and a product backlog. The vision describes why the project is being undertaken and what the desired end state is.: (Schwaber 2004, p.68) A well formed vision is a single page document that answers a number of questions. These questions cover five major areas.

The Business Need — This question is sometimes referred to as the problem statement. What is the problem the business needs solved? This can be a very broad topic that includes questions such as who is going to buy the product or who is the target customer? Successful projects solve a point of pain for the business. Someone has to need the thing produced by the team for it to have value. These questions and others such as how does the product of the project compare to existing products, both from competitors and our organization, or what are the product's unique selling features must be answered by the business.

Project Justification — It is not enough to simply solve a business need. That need has to be significant enough that it warrants spending time and money to



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solve it. Projects exist in a competitive landscape. The business must be able to explain why doing this project is the best expenditure of the available resources.

Success Criteria — This is where the rubber hits the road. It answers the question, how will we know when we are successful? It is where the business defines the attributes that are critical to satisfying their needs, and the overall success of the product. The measures must be quantifiable and objective to prevent different people from interpreting the project's results differently.

Prioritization — This area is all about determining how the project fits into the landscape of all the other projects going on within the organization. This is critical information for the Team to know. Understanding where a project rates versus all the other work the organization is trying to accomplish informs the team about the likely level of support they are likely to receive. It is also a good idea to understand how the product owner values three legs of the triple constraints. This will also provide guidance about how much support the project is likely to receive.

Constraints and Assumptions — This last area provides critical information for the development team because it allows the business to define limitation with which the team must live. This includes issues like budget limitations, time constraints, technology or resource limitations.

A common way to validate your vision is to answer the elevator test. Can you explain the product, service or result of the project in the time it takes to ride up in an elevator? (Moore 2006 p. 152). No project can begin without a vision. It is how the organization recognizes a potential project exists. Regardless of methodology every project should have a vision.

The second document in the list of four is a **ranked product backlog**. More often than not the literature talks about just the product backlog. A product backlog is a listing of the user stories, features or requirements. These items are often referred to as product backlog items or PBIs. The key is the “ranked” portion. It is a key aspect of using the product backlog. Ranking the backlog requires the business to prioritize the items in the backlog from most important to the business to the least important. Sometimes the backlog is further defined into groups of user stories that belong together. The development team uses the backlog to define which features to deliver when. Each of the items on the backlog items relatively independent of each other. Additionally, the items on the backlog may be reprioritized at any time.

Before moving to Scrum process, there are a few additional terms pertinent terms which must be introduced.

User Stories — A story is a self-contained unit of work agreed upon by the developers and the stakeholders. Stories are the heart of Scrum, and the building blocks of the sprint. Each user story must be producible in a single sprint. Often, this requires the development team to break stories down until they fit into a single sprint. Additionally, each story must provide functionality that has real value to the business. A user story is different from a feature however as a feature represents a distinct element of functionality that provides capability to the business while a user story is a small aspect of a feature that is used to get feedback from



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stakeholders and find out if you are doing anything wrong. In the real world of implementing agile the two terms are often used synonymously.

Themes — Themes may be thought of as groups of related stories. Often the stories all contribute to a common goal or are related in some obvious way, such as focusing on a single customer. Sometimes stories within a theme may be dependent on each other, and then do not necessarily encapsulate a specific work flow or be delivered together.

Epics — Epics resemble themes in the sense that they are made up of multiple stories. Sometimes they also resemble stories in the sense that may appear as a big story. Unlike themes, epics often comprise a complete workflow for a user and they typically cut across all or some of the three business dimensions (time, scope and organizations). Another important difference is while the stories that comprise an epic may be completed independently, their business value isn't realized until the entire epic is complete. This means that it rarely makes sense to deliver an epic until all of the underlying stories are complete. In contrast, while stories comprising a theme are related, each is independent enough to be delivered separately and still provide some measurable sense of business value. A related rule of thumb is to automatically further break down any story that is estimated above a certain threshold. A good starting point for this threshold may be where your team has historically tended to become inaccurate with their estimates. Epics are most often seen when teams are implementing SAFe as they are often used to enhance business value of the **FULL** solution set or bring a range of technologies together. They are often key economic drivers for the portfolio,

Rocks — Rocks are pieces of functionality used as placeholders when there is an absence of information. The rock acts as a signpost signifying the team does have information about a feature or requirement.

Sprint — A short iteration of fixed time where features are produced that have tangible value to the customer. The original Rules of Scrum stated that each sprint was 30 days in length. However, over the years Scrum has adopted the practices from other agile methodologies and the common practice is to see sprints of between two and six weeks in length. The key is that each sprint must be the exact same fixed length, and each **MUST** produce fully tested functionality that has real value to the customer.

Release — A release is a group of related sprints. Releases become necessary for a variety of reasons. The Rules of Scrum require every sprint to provide fully tested, production ready features. However, there are many situations where it is either impractical or ill advised to put the features completed from a single sprint into production. Imagine an organization that has set release windows where new code can be put into the production system. In these situations, the Development Team simply places the results from sprints “on the shelf” until all the releases that are part of the release are complete and then the entire group of features is place into production together.

The next artifact included in the set of four is the team or scrum board. The team board is the primary tool used by a Scrum team to manage the sprint. The team

board is an **information radiator**, or a large graphical representation of project information that is maintained within easy visual range of all participants in the team's shared workspace. The team board is broken into columns with each column representing the status of the items listed in it.

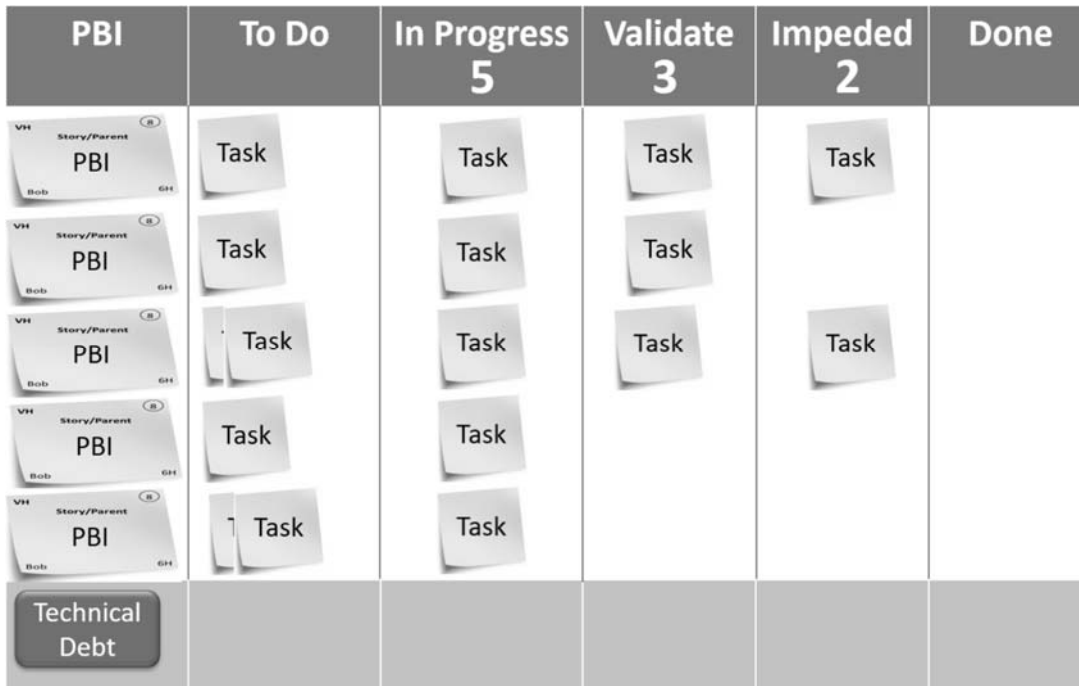


Image 17: A Sample Team or Scrum Board

The far left most column contains the product backlog items or user stories assigned to the current sprint. Each of the other columns represents the tasks required to deliver that story. The next column moving from left to right is To Do. This column is for the tasks that have not started and still need to be completed. The In Progress column represents tasks on which the team is currently working. The number beneath the column represents the maximum number of tasks that are allowed within the column. These numbers are part of using Kanban to managing work in progress or WIP. The values for each column are defined by the team at the beginning of the project. For the In Progress column, this number is 5 meaning there can be up to five tasks in progress at the same time. The next column is validate. This column contains the tasks that are complete and ready for testing. In this example, only three tasks can be present at a time. The next column is Impeded. This column is for tasks that are currently blocked. The team needs to focus on these items to resolve whatever the issue is. Only two items are allowed to be impeded at a time. The final column is Done. This column is where the team places it complete, fully tested tasks. At the end of the sprint all the tasks which begin in the To Do column end in the Done column.

At the bottom of the team board is a single row dedicated to something called technical debt. Ward Cunningham, one of the authors of the Agile Manifesto, said that “so problems with code are like financial debt. It’s OK to borrow against the



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future, as long as you pay it off.” The notion here, is that sometimes teams push products and services into production quickly to get some experience. In many cases this is both a necessary evil and/or a good idea. Eventually, however the team has to go back to that completed item and incorporate that learning into the product. This process is called refactoring. Therefore, technical debt represents is the process of taking short cuts and delivering product, service or result that is not quite right for the task currently being done. Doing so reduces the team’s productivity, and eventually the team must go back a correct these imperfections.

The fourth artifact used in Scrum is a burndown chart. A burndown chart is another information radiator used by the team to show stakeholders how the team is doing on the current sprint. Each day of the sprint is represented by a vertical bar showing the number of story points remaining in the sprint. A story point is an arbitrary estimate of the work required to complete the task. The rate at which the team produces story points is called its **velocity**. The team begins the sprint with a forecasted rate of productivity with the end of the sprint fixed. As the sprint progresses, the team constantly must evaluate how it is doing against that forecast. If it finds the velocity is falling beneath the forecast they must adjust the number of stories being produced because the team is not allowed to change the end date of the sprint.

A fifth artifact that is occasionally included, but does not nicely fit into the memory jogger is the sprint backlog. Let’s now take a look at the basic Scrum process. This process is relatively simple, but it is critical that it be exactly followed for one to gain the benefits of Scrum. The most commonly cited source for what specifically these rules or guidelines are is the Scrum Guide available from the Scrum Alliance or Scrum.org.



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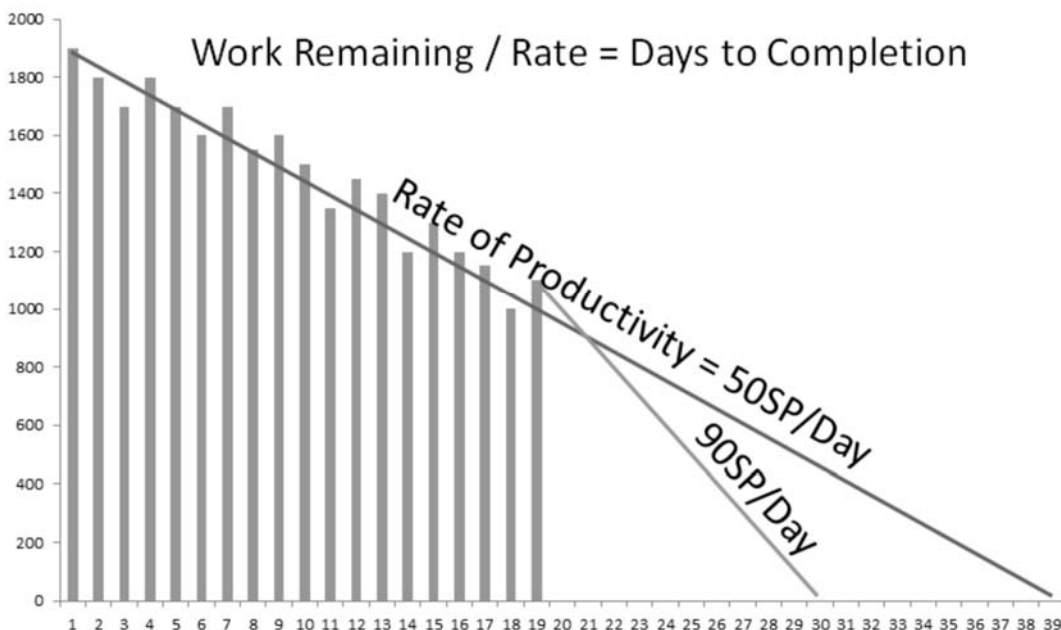


Image 18: A Burndown Chart

Every project begins the same way. Someone creates a vision and a ranked product backlog and the team enters a release planning meeting. The release planning meeting serves several purposes. The development team first uses the meeting to examine the backlog items to determine how they need to be grouped together to produce releases. Additionally, the team must determine how long each sprint needs to be. Remember, each user story must fit into a single sprint. So the team is tasked with getting a sprint length that is as short as possible, but long enough to deliver fully tested, production ready results that have real value to the business. To do this, the team must somehow determine estimates for each PBI. There are a number of techniques commonly used for this purpose that are discussed later in this book. The estimates are used by the development team to ensure each sprint is approximately the same size. Once the development team has determined how long the sprints will be and how the sprints will be grouped into releases, then team is done with the release planning meeting. Approximately once a quarter the team must revisit the release planning meeting.

The next step in the process is the sprint planning meeting represents the first step of the process that gets repeated with each sprint. The purpose of the sprint planning meeting is to plan the work of the current sprint, and it officially kicks off the sprint. The meeting is broken into two parts.

To begin the meeting the team sits and examines the ranked product backlog. The goal of the development Team is to produce the most important features to the business first. That means they take the maximum number of items they can produce in a single sprint starting at the top of the list and work down until they have all they can reasonably complete. There are a number of factors that can limit this production, but let's keep it simple for now. Sometimes, as the team examines the backlog they discover there are User Stories that appear lower down the backlog, but that it makes sense to pull those items up into the current sprint because they relate to the current work in some way, make it easier to produce future items, or are just easier to produce right then. It is perfectly acceptable to occasionally pull those items up so long as it is an exception and not the rule. In addition to selecting the user stories to be produced in the current sprint, the team must also get a lot more detail about those items.

The process of gaining more detail about a feature or backlog item is called **backlog grooming**. This is process where the product backlog items are defined in enough detail that the development team can build the feature. This is a requirements definition process, and is expected to take half the meeting. The second half of the meeting is used to break apart those now well defined PBIs into the tasks needed to complete the user stories, defining the task order, any dependencies, and any specific resource requirements. Earlier we established the rule that no user story could be larger than a single sprint. Now we establish a similar rule concerning the size of the tasks used to deliver the PBIs. The rule is that not task can be larger than a single day. Some sources say no task can be larger than two days. The problem I have with this two-day alternative is that it fails to align with Scrum's measurement system, the daily scrum. In addition, each task must either be a whole day or half day. No other options are allowed. This means exacting estimates of "X" number of hours are completely unnecessary.



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The first half of the meeting requires heavy involvement by the PO. However, the second half does not. Remember, the development team is self-governing so there is no need for a project manager or product owner to tell the team members what tasks they should do. Each sprint then becomes a small project with a fixed duration. The development team's plan must include all the resource requirements, dependencies, task order, and any other necessary information to complete the work. This plan is documented using a visual posted in a war room called a team or scrum board. The scrum board is recreated for each sprint. In the original rules of scrum the sprint planning meeting was expected to take a full work day. However, in the real world where sprints average between two and three weeks the sprint planning meeting rarely takes longer than four hours. Once the development team has created their scrum board they end the sprint planning meeting and begin executing what they just planned.

The goal of the execution phase in Scrum is to produce the just defined User Stories or features by the end of the sprint. These features must be fully tested and truly ready for production. Remember, part of the release planning meeting process was to determine how long the sprints needed to be so the development team had enough time to produce working product, service or project result that was fully tested and ready for production. This means we test and test in every sprint. This process often limits the number of features we can produce in each sprint, but it also tends to produce a better finished product.

To reach the goal, the team uses a standard process every single day to complete the desired work. This is where Scrum really adds value to organizational performance. The early leaders of Scrum learned an obvious lesson often missed by their linear project management cousins. In more linear projects, the team often struggles to determine they are in trouble and react. This happens because of the basic mechanisms use to report progress. In most project, reporting is done on a weekly or alternating week basis. The team comes together either via a conference all or physically and is asked report where they are with their tasks. The most common answer is, "right on track." If a numeric value is required, the most common value is 90%. Yet, somehow it always takes twice as long to do the last 10% as it did the first 90%. Furthermore, no one reports they are behind until it is the last possible second when they suddenly discover they can't meet the deadline. This all happens because of the reporting model. It is not because of bad people. It is a problem with the project measuring increments. If the team is working on a project expected to take several years to complete it is likely OK to have every other week or weekly reporting. However, when the project is a year or less that is likely not frequent enough. Scrum long ago figured out a lesson most of us consider common sense. Smaller things are much easier to manage than larger ones. One of the reasons Scrum works is that it aligns its measurement with reporting frequency.

Every day in a Scrum project the team uses the same process. This is part of what creates its cadence. Each day begins the same way with a meeting called the Daily Scrum. This is a ten to fifteen minute meeting that provides the Team with basic project status and communication. Each day the Development Team stands around the Scrum or Team Board and answers three questions:

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- ⇒ What did they accomplish yesterday?
- ⇒ What are they going to accomplish today?
- ⇒ What impediments do they have?

The focus is supposed to be on the second and third questions as the first is historical and there is no chance to impact it. Each member of the Development Team reports their results to the other members of the Development Team and NOT to the Scrum Master or Product Owner who are also present. The Scrum Master is tasked to act as a facilitator and the PO is only an observer. As each Team member reports their answers to the three questions at the same time they move physical representations of the tasks on the Team Board. The team is allowed to spend a quick moment or two solving simple problems, but cannot get sidetracked as the meeting is only allowed to take 10 to 15 minutes. Once each member of the Development Team has answered the three questions the meeting disbands and everyone begins working on the tasks for that day. While the Development Team works to produce the days results, the Product Owner works on grooming yet undefined User Stories for future sprints while also working with the Scrum Master to remove impediments. No one from the business may add a feature to a sprint once work has commenced, but may add, delete or change items on the Product Backlog at their discretion. The Development Team occasionally has to take User Stories out of the current sprint as new information is learned and may at their discretion pull up a new item if the situation warrants.

On the last day of each sprint two meetings are conducted. First, the Team conducts a Sprint Review. This one hour to 90 minute meeting allows the Product Owner to present the results of the sprint to the customers. This is all about showing working product to the people who will really use it. The Development Team wants the product owner to take this responsibility because it both provides a connection from them to the users and helps to ensure their engagement throughout the sprint. The Team is allowed a few hours to prepare for this meeting.

Once the Sprint Review is complete, the Development Team conducts a Sprint Retrospective. If the Sprint Review is all about the product of the project, the Sprint Retrospective is all about the process. The Product Owner is not allowed to attend the Retrospective and the Scrum Master is only present as a facilitator. This meeting provides the Development Team the opportunity to review the process and find the best way to improve the process. The team uses a wide range of games and tools to answer the question, “If tomorrow we were 1,000% more efficient what we do to get there?” It is singularly focused on the process the Development Team is using to achieve their results.

The next day the process begins again with a new sprint and the Sprint Planning Meeting until either the Development Team delivers all the promised functionality or is out of time and money at which point the Product Owner must decide to close the project or obtain more. That is all there is to the basic Scrum process. However, before we completely leave Scrum I want to spend a minute and add a few connected ideas that are often added to Scrum as a team becomes more advanced.

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The first of these ideas is a revisit of a previous topic. If you remember back several pages we discussed Work In Progress or WIP. Managing WIP requires the Team to limit the number of tasks being worked a single moment based on priority. However, none of the Scrum tools we have so far discussed force this to occur. One tool that is often added to Scrum to achieve this desired result is Kanban. We are not going to introduce Kanban here, just describe its implementation with Scrum.

Within the Team's Scrum Board, there are a series of columns that each represent a separate state in the work's progress. When using Kanban, the only alteration the Team makes to the Board is adding numeric values for each column. These values represent the maximum number of items that can be present in that column. The effect of these limiters is to force the Team to focus on getting tasks all the way through the process rather than allowing them to stagnate in one particular state (usually the Impeded State).

Another practice sometimes used by Scrum teams is Iteration 0. This is NOT part of Scrum found in the Scrum Guide. Remember the basic rule we established for Scrum that said every single sprint would be the same length of time and must produce functionality that has real value to the business? Iteration 0 violates both those rules. The goal of Iteration 0 is to produce two items that do not initially have value to the business. These are the core architecture and feature list. It is not unusual for this work to take significantly longer than a single sprint, and as such it violates the Rules of Scrum requiring and out. If a team has decided to use Iteration 0 because they believe the project needs a more formal architectural plan and/or work on its feature list it is important that the team also provides an iteration or milestone plan to ensure the team quickly moves into more standard Scrum sprints.

Hybrid Life Cycles

A hybrid life cycle is one that combines one or more of the other life cycles. It offers the highest degree of variability and complexity. For the exam, it is unlikely you will see many if any questions on it as it is almost impossible to establish any standards for them.

Agile Development and the PMBOK® Guide

Over the last decade an unnecessary battle has waged between proponents of agile development and the world of professional project management. According to many Agilists, the practices expressed in the PMBOK® Guide are old, and dated representing a linear way of executing projects using only predictive life cycles. PMPs often argued that agile development was costly, unpredictable, and a dangerous way to manage business critical initiatives. Sadly, neither of these views is true. While there are many projects led by PMPs using predictive life cycles, there has never been anything in the PMBOK® Guide that mandated it be done that way. The Guide also has never suggested agile development offered any less chance of success than any other methodology. In fact, PMI® has funded a significant amount of research looking at methodologies and success. That

research has consistently found there are great advantages to applying agile concepts. Yet, the battle raged. With the 6th edition of the PMBOK® Guide finally addressed this disagreement head-on by making a significant effort to specifically call out applications of agile development throughout the Guide. Simply put, as a professional project manager and a PMP candidate you have an obligation to know and understand the basics of agile development. The PMP® exam for which you are preparing will give you ample opportunity to prove that knowledge.

The Ten Knowledge Areas

PMI® takes these six elements and adds four more factors that are elaborated on in chapters four through 13 of the PMBOK® Guide. These chapters are referred to as the ten knowledge areas of the PMBOK® Guide. Appearing in order, these knowledge areas are:

- ⇒ Integration Management
- ⇒ Scope Management
- ⇒ Schedule Management
- ⇒ Cost Management
- ⇒ Quality Management
- ⇒ Resource Management
- ⇒ Communications Management
- ⇒ Risk Management
- ⇒ Procurement Management
- ⇒ Stakeholder Management

Within these knowledge areas, the 49 defined processes of project management are found. It is necessary for you to memorize each of the individual processes to pass the exam. However, simply memorizing the processes, their makeup, and how they relate to one and other is not enough. To successfully pass the PMP® exam, you must clearly understand why each process is important and how it relates to successfully completing a project. Remember, you cannot read into this requirement an attempt by PMI® to suggest that on every project you must complete every one of the processes.

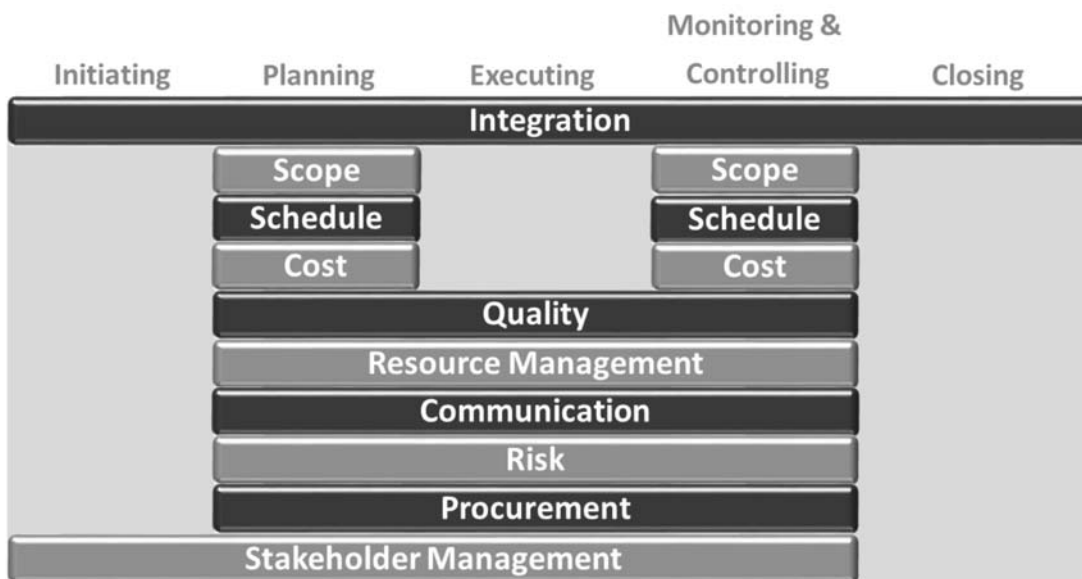


Image 19: Where the processes live



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Conclusions

The process groups are highly interconnected and often flow in non-sequential patterns to produce successful projects. The simplest way of saying this is that you do not know for sure what is going to happen on any given project so you must be prepared to deal with change. Change might require you to enter or make use of another process group. This happens when you run into problems that require additional planning, when you start a new project because the scope warrants a second effort, or when you are simply unable to complete the project so it is cancelled.

Exercise 4 — The Basics of Project Management



Exercise 4 — The Basics

Some of these questions are not designed to replicate or reflect actual exam questions. They are designed to ensure you clearly understand the topics discussed in this chapter, which will help you study for the PMP® Exam.

1. Which of the following is not an output of a project?
 - A. A product or artifact that is quantifiable
 - B. A capability to perform a service
 - C. A manufactured product
 - D. All of the above
2. Which of the following is not a characteristic shared by both projects and operations?
 - A. Performed by people
 - B. Generates repetitive outputs
 - C. Are constrained by limited resources
 - D. Are planned, executed, and controlled
3. Which of the following is an example of an operation?
 - A. The development of a new product
 - B. Constructing a building
 - C. Producing a new car
 - D. Developing a new marketing campaign
4. Which of the following is a key element of defining an operation?
 - A. Operations maintain an existing set of practices
 - B. Operations have unique charters and goals
 - C. Operations have defined start and end dates
 - D. None of the above
5. Which of the following is an that is organization likely to be project-based?
 - A. Organizations who derive most of their revenue from performing projects
 - B. Organizations that have adopted management by projects
 - C. Both A & B
 - D. None of the above
6. Which of the following is not a factor in the development of organizational culture and style?
 - A. Shared values, norms or beliefs
 - B. Technical certifications
 - C. Policies and procedures
 - D. View of authority relationships

-
7. Who is responsible for determining what the “appropriate practice” for the project is?
 - A. The project sponsor
 - B. The project manager
 - C. The key stakeholders
 - D. The project management team
 8. Which of the following is the best description of the primary purpose of the PMBOK® Guide?
 - A. To define the proper methodology for managing project
 - B. To identify the PM knowledge considered good practice
 - C. To establish the international PM standards
 - D. To define proper PM practices
 9. Which of the following is not a common characteristic of a project?
 - A. A project is temporary
 - B. A project produces a unique product or service
 - C. A project has repetitive tasks
 - D. A project uses progressive elaboration
 10. Which of the following is part of the temporary nature of projects?
 - A. The project team seldom outlives the project
 - B. The project team existed prior to the project being created
 - C. The market window is not usually temporary
 - D. The project team is always broken up at the end of the project
 11. Which of the following represents the best definition for progressive elaboration?
 - A. Developed in steps and continuing in increments
 - B. Developed with a continuous process
 - C. Developed with explicit steps
 - D. Developed in accordance with the defined project phases
 12. Which of the following is a reason to authorize a project?
 - A. A market demand
 - B. A specified organizational need
 - C. A regulatory requirement
 - D. All of the above
 13. Which of the following correctly identifies the project management process groups?
 - A. Initiating, planning, developing, testing, and deployment
 - B. Initiating, planning, executing, monitoring and controlling, and closing
 - C. Envisioning, planning, developing, deployment, and closing
 - D. Envisioning, planning, executing, monitoring and controlling, and closing.

-
14. Which of the following is not one of project management's triple constraints?
- A. Time
 - B. Costs
 - C. Scope
 - D. Requirements
15. Which of the following is not one of the PMBOK® Guide's nine (9) knowledge areas?
- A. Cost management
 - B. Human resources management
 - C. Requirements management
 - D. Quality management
16. Which of the following is not one of the PMBOK® Guide's nine (9) knowledge areas?
- A. Time Management
 - B. Risk management
 - C. Communications management
 - D. Contract management
17. Which of the following is not a key element to understanding the project environment?
- A. Understanding specific government regulations
 - B. Understanding the cultural and social environments
 - C. Understanding the international and political environments
 - D. Understanding the physical environment
18. Which of the following is not a term used to define application areas?
- A. Technical elements, such as a specific kind of engineering
 - B. Financial elements, such as a knowledge of reading financial statements
 - C. A management specialization, such as government contracting
 - D. Industry groups or verticals, such as telecommunications, automotive, or financial
19. Which of the following is the best definition of a standard?
- A. A government requirement, which specifies product, process or service characteristics
 - B. A document established by consensus and approved by a recognized body that provides for common and repeated use
 - C. A guideline that describes a preferred approach
 - D. Mandated compliance by some governmental organization

-
20. Which of the following is not a key common element of understanding the project environment?
- A. The cultural and social environment
 - B. The international and political environment
 - C. The outside environment
 - D. The physical environment
21. Which of the following best represents the definition of a program?
- A. A temporary endeavor undertaken to create a unique product or service
 - B. A group of related efforts managed in a coordinated way to obtain benefits and control not available from managing them separately
 - C. A collection of efforts or groups of efforts and other work that are grouped together to facilitate effective management of that work to meet strategic business objectives
 - D. None of the above
22. Which of the following statements is a key element of a subproject?
- A. They are based on the project processes
 - B. They often involve specialized technology
 - C. The subproject can consist of a series of even smaller subprojects
 - D. All of the above
23. Which of the following is not true about a project management office?
- A. A PMO should always have direct control over all project activities in the organization.
 - B. A PMO is an organizational unit to centralize and coordinate the management of projects.
 - C. A PMO oversees the management of a project, programs or a combination of both.
 - D. PMOs can operate on a continuum from providing project management support functions to software, policies, and actual direct management of projects.
24. What does a project life cycle define?
- A. What technical work to do in each phase
 - B. What the deliverable dependencies are
 - C. Who will complete each deliverable
 - D. How each deliverable is approved

-
25. Which of the following is a characteristic that most project life cycles share in common?
- A. Projects might or might not have phases, but are defined by deliverable handoffs.
 - B. Phases are usually sequential and are usually defined by some sort of technical information transfer or component handoff.
 - C. Projects are defined by iterative phases that continue for a predefined period.
 - D. Projects do not have phases and are usually defined by the need to have requirements defined at the beginning of the project.
26. Which of the following is not common for a project's life cycle?
- A. Cost and staffing levels tend to be low at the start, peak during the intermediate phases and drop rapidly as the project concludes
 - B. The level of uncertainty and risk of failure is highest at the beginning and improves throughout the project
 - C. The cost of project changes and correcting errors gets progressively lower as the project continues
 - D. The ability of stakeholders to influence the project's characteristics is highest at the beginning and gets progressively lower
27. When are project phases generally considered to be completed?
- A. When a review of the accomplished work and the deliverables has taken place, and they have been accepted
 - B. When a managerial decision to continue to the next phase has been made
 - C. When the deliverables have been accepted
 - D. A & B
28. Two characteristics of a deliverable are:
- A. They are quantified and usable
 - B. They are part of the process and are tangible
 - C. They are measurable and verifiable
 - D. None of the above
29. Bob is a project manager whose project has been closed at the end of the third phase of the five phases that were initially planned. What should Bob's next course of action be in terms of the current project?
- A. Seek a review with the key stakeholders
 - B. Seek a review with the project sponsor
 - C. Complete a review with the project team
 - D. Nothing, this is a legitimate decision

-
30. Which of the following is not part of formal phase completion?
- A. Review of the completed phase deliverables
 - B. Acceptance of the phase deliverables
 - C. Review of any phase documents
 - D. Authorization of the subsequent phase
31. Which of the following is not a name used for a phase-end review?
- A. Milestones
 - B. Phase exits
 - C. Phase gates
 - D. Kill points
32. Which of the following is true about projects?
- A. Most projects are not linked to the ongoing work of the organization
 - B. Some projects can be initiated informally for a limited amount of time to secure formal approval for additional phases or activities
 - C. The preliminary planning process is never handled as a separate project
 - D. All of the above
33. Which of the following is a justification to initiate a project?
- A. A business problem
 - B. A change in the competitive marketplace
 - C. Regulatory requirements
 - D. All of the above
34. Which of the following is a key distinction between projects and operations?
- A. Operations often require key resources
 - B. Projects have limited budgets
 - C. Operations are ongoing and repetitive
 - D. All of the above
35. Which of the following statements about a project's life cycle is true?
- A. The project life cycle defines what resources will be involved and what work is to be completed in each phase
 - B. The project life cycle defines which resources will complete each deliverable
 - C. The project life cycle defines what deliverables are required
 - D. The project life cycle defines when deliverables are to be completed
36. When participating on a project over time, stakeholders have varying levels of what?
- A. Responsibility and authority
 - B. Authority and influence
 - C. Responsibility and influence
 - D. Influence and support

-
37. In dealing with stakeholders, which group is most often overlooked?
- A. Stakeholders who have little organizational influence
 - B. Stakeholders who are challenging to work with
 - C. Stakeholders whose view of the project is negative
 - D. Subject matter experts
38. Which of the following is not considered a key stakeholder on every project?
- A. The end user
 - B. The project team
 - C. The PMO
 - D. The general public
39. The single most important responsibility for a project manager in terms of the stakeholders is what?
- A. Manage stakeholder expectations
 - B. Clearly define stakeholder requirements
 - C. Provide visibility to negative stakeholders
 - D. Ensure stakeholders approve all critical scope changes
40. Your project sponsor approaches you and asks for a detailed project schedule. Which of the following would be required to meet her request?
- A. Work Breakdown Structure
 - B. An approved budget
 - C. Quantitative risk assessment
 - D. All of the above
41. Early in the project management planning process, a key stakeholder argues that he should take charge of the project. Based upon the standards for professional project management who should be in charge of the project at this juncture?
- A. The stakeholder in question
 - B. The project manager
 - C. The project sponsor
 - D. The technical lead
42. Which of the following is not a stakeholder management responsibility?
- A. Exceeding stakeholder expectations
 - B. Meeting stakeholder expectations
 - C. Managing stakeholder expectations
 - D. None of the above
43. In which of the following process groups can stakeholders be identified?
- A. Initiating and planning
 - B. Planning, monitoring and controlling
 - C. Initiating, planning, and monitoring and controlling
 - D. Any of the process groups

-
44. A project manager comments to a coworker that she is having a lot of trouble with a large number of scope changes in her project. Which of the following is a likely cause of the large number of changes?
- A. Not involving stakeholder early enough in the project
 - B. Having too many project stakeholders
 - C. Not having a senior enough sponsor
 - D. All of the above
45. Management by Objectives works only if:
- A. The process is well documented
 - B. The processes do not impact the objectives
 - C. It is supported by the management team
 - D. The processes are defined in the project charter
46. In which of the following process groups are stakeholders not identified?
- A. Initiating
 - B. Closing
 - C. Executing
 - D. Stakeholders can be identified in any process group
47. Jane is a project expediter working at a manufacturing company. Her main project is currently in the planning process. Her project sponsor comes to her and asks for information about the project management methodology the company has decided to deploy. He asks her why they are using it and where it came from. What should Jane do?
- A. Provide the information to the project sponsor
 - B. Advise the owners of the new methodology of the request
 - C. Provide the sponsor with the appropriate templates
 - D. All of the above
48. Sam is a project manager working for a consulting company. He is currently responsible for a large multi-million dollar effort with resources in seven locations. One day three stakeholders come into his office and are very upset because they just realized that requirements they see as critical are not included in the project scope. What is the most likely cause of the absence of these requirements?
- A. The sponsor decided against including their requirements
 - B. The stakeholders in question were not involved early enough in the process
 - C. The stakeholders are new to the organization
 - D. All of the above

-
49. Linda is a project manager for a major engineering project. She is in her third year on the project and has been in charge since project's inception. Her boss, the Vice President of Engineering, walks into Linda's office one day to inform Linda that it is likely that her project is going to be postponed because several of the project's major stakeholders are unhappy with the project. Which of the following is likely the cause of Linda's problems?
- A. Linda has been late with deliverables
 - B. Linda's project is over budget
 - C. Changes in the triangle have caused a reduction in project scope
 - D. Any of the above
50. Iain is a program manager at a small engineering firm. He is currently leading a project with 14 resources that provides a new design for a major urban hub. He is almost through with the execution phase. Iain just learned that several environmental interest groups intend to protest his design at an upcoming public hearing. What is the most likely cause of their issues?
- A. They are extremist groups
 - B. The interest groups were not included early in the project process
 - C. Key elements of project scope have been dropped
 - D. All of the above
51. Regina is a project manager for a major engineering project. She is in her third year on the project and has been in charge since project's inception. Her boss, the Vice President of Engineering, walks into Regina's office one day to inform Regina that it is likely that her project is going to be postponed because several of the project's major stakeholders are unhappy with the project. What should Regina do?
- A. Revisit the scope statement
 - B. Ask to freeze the project
 - C. Try to convince her boss that the project can be saved
 - D. Open a dialogue with unsatisfied stakeholders
52. What is the relationship between the project manager and the stakeholders?
- A. The project manager is a stakeholder
 - B. The project manager supervises the stakeholders
 - C. The project manager reports to the stakeholders
 - D. The project manager communicates with the stakeholders
53. In Scrum, the team activity is monitored and coordinated on the following basis:
- A. Hourly
 - B. Daily
 - C. Weekly
 - D. Monthly

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54. The Product Owner of your project is absent due to a planned vacation. Who should assume the Product Owner's responsibilities at a sprint planning meeting?
- A. The ScrumMaster
 - B. The Team
 - C. A person selected by the Team
 - D. The CEO
55. You are new on an internal Agile project for a company with well developed processes. You need to find the list of prioritized project requirements. Where will you most likely find this list?
- A. Sprint Backlog
 - B. Product Backlog
 - C. Iteration Backlog
 - D. The Release Plan
56. In a Scrum Project, the typical length of an iteration is:
- A. Between 2-6 weeks
 - B. 30 days
 - C. 45 days
 - D. 90 days
57. Which of the following statements BEST describes the relationship between Agile Development and the PMBOK Guide?
- A. The PMBOK Guide represents PMI's methodology for executing projects. While Agile Development represents a software development framework.
 - B. Agile Development represents the newest way to execute a project while the PMBOK Guide represents the old way of executing a project.
 - C. The PMBOK Guide represents the overall framework for executing projects and Agile Development represents a set of specific methodologies used in project execution.
 - D. Agile Development represents the overall framework for executing projects and the PMBOK Guide represents a set of specific practices used in large scale projects.
58. Which of the following terms refers to a staging and scheduling strategy in which the various parts of the system are developed at different times or rated and integrated as they are completed?
- A. Iterative development
 - B. Incremental development
 - C. Staged development
 - D. Agile development

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59. Which comparing traditional linear development to agile, which of the following statements is most likely to be true?
- A. Agile development makes extensive use of best resourcing to ensure optimal productivity while traditional development uses WIP.
 - B. Both traditional development and Agile make use of best resourcing to ensure optimal productivity.
 - C. Both traditional development and Agile make extensive use of WIP to ensure optimal productivity.
 - D. Agile development makes extensive use of WIP while traditional development uses best resourcing to ensure optimal productivity.
60. Which of the following concepts represents the idea that information, requirements and facts will be seen over time as the project progresses?
- A. Convergence
 - B. Emergence
 - C. Self-organization
 - D. Dynamic evolution

Exercise 4 — The Basics of Project Management Answers

1. **Answer C.** PMBOK® Guide p. 5 – Manufactured products represent operations because of their mass produced, repetitive nature.
2. **Answer B.** PMBOK® Guide p.6 – Projects and operations share many of the same characteristics. However, projects do not attempt to produce the same product over and over again.
3. **Answer C.** PMBOK® Guide p.7 – The objective of an ongoing operation is to sustain the business. A project’s goal, on the other hand, is to attain a specific objective and terminate.
4. **Answer A.** LGd PMP® Exam Prep Course – Projects have unique charters, goals and defined start and end dates. Operations have semi-permanent charters, semi-permanent organizations, maintain an existing set of practices, provide a standard product or service, and are continuous.
5. **Answer C.** PMBOK® Guide – Project-based organizations are those whose operations consist primarily of projects. These organizations generally fall into two categories: organizations that derive most of their revenue from projects or organizations that have adopted management by projects.
6. **Answer B.** PMBOK® Guide p. 27 – Each of the items except technical certifications is listed as a factor in the PMBOK Guide influencing culture.
7. **Answer: D.** PMBOK® Guide 2008, p.13 – The project management team must define what good practice means in each project on a case-by-case basis.
8. **Answer B.** PMBOK® Guide 2008, p.13 – According to the PMBOK® Guide, “The Primary purpose of the PMBOK® Guide is to identify the subset of the Project Management Body of Knowledge that is generally recognized as good practice.”
9. **Answer C.** PMBOK® Guide p.5 – Projects are temporary endeavors undertaken to create a unique product or service. This rarely includes repetitive work.
10. **Answer A.** PMBOK® Guide p. 5 – Because of the definition of projects, the project team seldom outlives the project. They are by definition temporary and so are their teams.
11. **Answer A.** PMBOK® Guide p.7 – Progressive elaboration means developing a project in steps, and continuing in increments. This often necessitates that definitions are broad at the beginning and get more specific as time progresses.
12. **Answer D.** PMBOK® Guide p. 10 – Each of the examples represent justifications to create a unique product or service using a defined team, budget and schedule.

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13. **Answer B.** PMBOK® Guide p.19 – According to PMI every project—regardless of development methodology—uses the process groups of Initiating, Planning, Executing, Monitoring & Controlling, and Closing. This process is often iterative.
 14. **Answer D.** The triple constraints of project management include time, costs, and scope and quality.
 15. **Answer C.** PMBOK® Guide – The nine knowledge areas include: integration, scope, time, cost, quality, human resources, communications, risk and procurement management.
 16. **Answer D.** PMBOK® Guide – The nine knowledge areas include: integration, scope, time, cost, quality, human resources, communications, risk and procurement management
 17. **Answer A.** PMBOK® Guide – Although understanding specific governmental regulations is key to project success, this is not considered a part of project environment.
 17. **Answer B.** PMBOK® Guide – Although important, understanding business finance is part of general business management and skills and is not considered an application area of knowledge for most projects.
 18. **Answer B.** PMBOK® Guide p. 13– While several of the options deal with standards, only B is the actual definition.
 19. **Answer C.** PMBOK® Guide – The outside environment is not a key element in understanding the project environment.
 20. **Answer B.** PMBOK® Guide – The first answer is the definition of a project. The third is the definition of a portfolio. B is a program.
 21. **Answer D.** PMBOK® Guide – Each of the included statements could be true for a given subproject. When projects are divided into more manageable components, these pieces are often referred to as subprojects.
 22. **Answer A.** PMBOK® Guide – Although it would be very nice, a project management office does not have to have direct control over all projects.
 23. **Answer A.** PMBOK® Guide – Project life cycles generally define: What technical work to do in each phase. When the deliverables are to be generated in each phase. Who is involved in each phase. How to control and approve each phase
 24. **Answer B.** PMBOK® Guide – The PMBOK Guide lists four major characteristics that projects share. One of these is the handoff of work packages or deliverables.

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25. **Answer C.** PMBOK® Guide – The cost of project changes and the correction of errors gets progressively higher on most projects because of the amount already invested and because of the fact that changes or errors often force the rework of already-produced deliverables. It is this fact that often justifies the significant amount of work done at the beginning of the project to define requirements.
 26. **Answer A.** PMBOK® Guide – A project phase is generally considered concluded when the key project stakeholders have actually accepted the deliverables from that phase. This might also include an overt decision to continue to the next phase. However, this does not preclude multiple phases from occurring at the same time.
 27. **Answer C.** PMBOK® Guide – A deliverable is a measurable, verifiable work product such as a specification, feasibility report, detailed design document, or working prototype. Some deliverables can correspond to the project management process, whereas others are the end products or components of the end products for which the project was conceived.
 28. **Answer D.** PMBOK® Guide – The answer is nothing because according to the PMBOK® Guide a phase can be legitimately closed without the decision to initiate any other phases for a wide variety of reasons.
 30. **Answer D.** PMBOK® Guide – Formal phase completion does not include authorizing the subsequent phase. For effective control, each phase is formally initiated to produce a phase-dependent output of the Initiating Process Group, specifying what is allowed and expected for that phase.
 31. **Answer A.** PMBOK® Guide p. 23 – Phase-end reviews can be called phase exits, phase gates, or kill points. Milestones are significant points or events in the project such as when the phase-end review has been completed, but they are not the review itself.
 32. **Answer B.** PMBOK® Guide – Many projects are linked to operational work of the organization while other organizations only formally approve projects after the completion of a feasibility study, or manage the preliminary planning phase as a separate project. Some projects can initially be informal for a limited amount of time before formal approval has been secured.
 33. **Answer D.** PMBOK® Guide – The driving forces that creates the stimuli for a project are typically referred to as problems, opportunities, or business requirements.
 34. **Answer C.** LGd PMP® Exam Prep course. While it is true that operations often require key resources, projects do also. Projects and operations also both have limited budgets. However, whereas operations are ongoing and repetitive, projects are fixed to a set time.
 35. **Answer A.** LGd PMP® Exam Prep Course. The project lifecycle defines what resources will be involved in each phase and what work is to be done in each phase.

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36. **Answer A.** PMBOK® Guide p.24 – This is an example of the kind of question on the exam where multiple answers look right. According to the PMBOK Guide, responsibility and authority is the correct answer—even though project managers must watch the stakeholders’ influence and their level of support throughout the project.
 37. **Answer C.** PMBOK® Guide p. 23 – Negative stakeholders are often overlooked by the project team and because of this they risk failing to bring their projects to a successful end.
 38. **Answer D** PMBOK® Guide p. 25 - This is one of the many questions where your ability to select the best answer—as seen by PMI®—becomes critical. Many select the PMO because not every company has a Project or Program Management Office. However, this is not the best answer. The PMO is listed in the PMBOK® Guide as a key stakeholder, but the general public is not.
 39. **Answer A.** PMBOK® Guide p. 23 – All of these items are important. But because stakeholders often have very different or conflicting objectives, it is most important that the project manager manage the stakeholder expectations.
 40. **Answer A.** In the project management process the approved budget and the quantitative risk assessment both come after the project schedule. Only the WBS is required from this list.
 41. **Answer B.** In the project management process, the project manager should be named as early as possible and should take charge of the project upon their assignment. It is considered a poor choice to allow a stakeholder to take charge of the project.
 42. **Answer A.** Exceeding stakeholder expectations is the same as gold plating. Gold plating is a key evil according to PMI® that should never be done.
 43. **Answer D.** Stakeholder management is an ongoing part of the project management process. The identification of stakeholders is a key element of this and must be done in all of the process groups.
 44. **Answer A.** Many projects involve a significant number of stakeholders or suffer from not having a senior enough sponsor. These issues do not necessarily have any impact on scope change. However, not having stakeholders involved at an early enough stage can dramatically increase the amount of scope change.
 45. **Answer C.** Any management methodology requires the management team to support it in order to be effective.
 46. **Answer D.** Stakeholders can be identified at any point in the PM process.
 47. **Answer B.** This question is another example of a question requiring you to determine what you would do first. In this situation it would be best if you immediately notified the owners of this request. In many cases this is going to be a PMO.

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48. **Answer B.** The most common cause of disconnected stakeholders and requirements is a failure to engage the stakeholders at an early enough point in time. Stakeholders should be engaged in the project as early as possible.
 49. **Answer C.** The single most likely cause of the loss of stakeholder support is a reduction in scope that causes the loss of deliverables desired by the stakeholders. Unless proper stakeholder management is done, the project manager will not know which stakeholders have strong attachments to which deliverables and, as a result, difficulties will ensue when scope changes occur.
 50. **Answer B.** Public interest groups are often one of the most difficult groups of stakeholders with which to work. However, they are project stakeholders, and as with all stakeholders it is critical that the project manager engage with them as early as possible as the number one cause of stakeholder issues is a failure to engage them at an early enough point.
 51. **Answer B.** This is another example of the “what would you do first” type of question. In this case, although you might do several of the items, you would first freeze the project.
 52. **Answer A.** Although several of these answers might be true, the only thing that is definitely true is that the project manager is also a project stakeholder.
 53. **Answer B.** The Rules of Scrum advocate a daily fifteen minute standup meeting done face-to-face called the daily scrum.
 54. **Answer A.** In the absence of the Product Owner, it is the responsibility of the ScrumMaster to prepare adequate product backlogs for the sprint planning meeting. Source: Ken Schwaber, Agile Project Management with Scrum Appendix A.
 55. **Answer B.** The Product Backlog is designed to hold prioritized project requirements. Source: Ken Schwaber, Agile Project Management with Scrum, Chapter 1.
 56. **Answer B.** The typical length of an iteration is one complete cycle within a project and is usually 20 business days or 30 sequential calendar days. Source: Ken Schwaber, Agile Project Management with Scrum, Appendix B.
 57. **Answer C.** The relationship between Agile Development and the PMBOK® Guide has traditionally been contentious. Many Agilists try to argue Agile Development and the PMBOK Guide are at odds. However, nothing could be further from the truth. The PMBOK Guide represents generally accepted principles and practices. It does NOT represent a methodology that can be followed step-by-step. Many Agilists also claim that their particular concepts are a framework representing a loose scaffolding. However, most thinkers agree Agile represents an aggregation of methodologies.

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58. **Answer B.** Alistair Cockburn defines Incremental development as a staging and scheduling strategy in which the various parts of the system are developed at different times or rated and integrated as they are completed. This means that the features or requirements do not have to be completed as part of a single release. When a team uses incremental delivery they are able to deliver features or requirement in a wide range of orders defined by the team. This fundamentally changes how projects are executed. Suddenly, it what is delivered at any point in the project. This notion is somewhat similar to the ideas surrounding Object Oriented Programming where features and requirements are delivered as discrete objects independent of others.
59. **Answer D.** Agile Development makes extensive use of WIP or Work In Progress. Although there is no rule or requirement to do so, most traditionally managed projects use a concept called Best Resourcing. In Best Resourcing whichever resource possesses the highest skill level is assigned to execute the task. WIP argues that we want to limit the amount of Work In Progress occurring at any single point. The principle can be thought of like a water main. The objective of the Water Department is to ensure the maximum amount of water is constantly available to the end users when they turn on their faucets. Contrary to what you might think, the best way to ensure high water pressure is to ensure the mains are less than 100% full. Remember, the mission is to get each drop to the customer as quickly as possible. If you ask your friendly neighborhood civil engineer, they will confirm that the water will travel the fastest when the pipe is less that 100% full. We do the same thing with our project tasks when using WIP.
60. **Answer B.** Emergence is the idea that information, requirements and facts will emerge as the project progresses. The key is that the team uses processes, tools, and techniques capable of harnessing new information as it becomes available for the betterment of the project.

Integration Management

Overview

The Integration Management Knowledge Area is found in the fourth chapter of the PMBOK® Guide. For many PMP® candidates it is one of the most difficult knowledge areas to learn. Students struggle with Integration Management because the topic comes up very early in the course but it is about bringing other processes together — processes with which they are not yet very familiar. This creates a problem. When should we discuss Integration Management? At the very beginning of the course when students are not yet familiar with the other processes? Or at the end after they have learned about everything else that must be brought together? For the sake of consistency, we have chosen to handle the Integration Management Knowledge Area in the same order as the PMBOK® Guide.

What is Integration Management anyway? Integration Management is where all the other processes are brought together and reconciled. The PMBOK® Guide says this a little bit differently. The PMBOK® Guide (p.63) defines Integration Management as “the processes and activities needed to identify, define, combine, unify and coordinate the various processes and project management activities within the project management process groups.” According to PMI®, Integration management is the **ONLY** knowledge area that **CANNOT** have its accountability transferred to a specialist. It must be managed by the project leader. It is the project leader that is ultimately responsible for the project as a whole. As you go through this chapter, it is important that you remember these processes can be iterative.

The Integration Management Knowledge Area is comprised of six individual processes. There is one process found in the initiating, planning, executing and closing process groups and there are two processes found in the monitoring and controlling process group. The seven processes involved with integration management include:

- ⇒ 4.1 — Develop project charter
- ⇒ 4.2 — Develop project management plan
- ⇒ 4.3 — Direct and manage project work
- ⇒ 4.4 — Manage project knowledge
- ⇒ 4.5 — Monitor and control project work
- ⇒ 4.6 — Perform integrated change control
- ⇒ 4.7 — Close project or phase

4.1 Develop Project Charter

The first process found in the integration management knowledge area is the develop project charter process. Notice how the process title appears. It is in verb/noun format. Every one of the 49 processes are titled the same way. They are always verb/noun format. This can help you with the memorization process. Developing a well formed project charter is critical to the overall success of the



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All
PMBOK®
Guide
processes
are in verb/noun
format

project. However, in the real world project charters are often not done well — or even done at all. To understand why they are often not done correctly we have to begin with an understanding of the purpose of the project charter.

The primary purpose of the project charter is to authorize work to begin on the project. However, the charter also provides some other basic information. In addition to authorizing work to begin, the charter does the following:

- ⇒ Names the project manager and project sponsor
- ⇒ Explains how the project supports the organizational strategy
- ⇒ Explains the business need and why the need exists
- ⇒ Defines any constraints and assumptions that exist (this includes any deadlines, budget limitations, resource limitations, any known risks, and scope must-haves)
- ⇒ Defines the project success criteria (it is always recommended that success criteria be quantitative in nature as subjective success criteria usually leads to project failure)

The charter does **NOT** include detailed requirements, the project schedule, the project budget or other detailed information. Remember, from PMI's perspective the project has not started yet. The charter is the document that authorizes the project manager to begin the planning process and to determine what it is going to take to successfully complete the project. Once the plan is submitted, the sponsors maintain the right to cancel the project if they deems the plan not what they desire.

The inputs to the develop project charter process include:

- ⇒ **.1 Business documents** — When discussing business documents the PMBOK® Guide is primarily referring to the business case and benefits management plan. The business case is a document written from the perspective of the business that explain how the expected project outcomes justify the necessary investment. The second document referred to in the PMBOK® Guide is the benefits management plan. This is a documented explanation defining the processes for creating, maximizing, and sustaining the benefits provided by a project or program.
- ⇒ **.2 Agreements** — Agreements are used to define the initial intentions for a project. They may take many different forms such as memorandums of understanding (MOUs), service level agreements (SLAs), contracts, etc.
- ⇒ **.3 Enterprise environmental factors** — Enterprise environmental factors represent the first of a number of items we like to call *freebes*. Freebes represent items that almost always appear in the listing of inputs, tools and techniques, or outputs. Enterprise environmental factors represent the things going on around the project that could impact it. They are almost always an input to a defined process. It is far easier to memorize the few times they do not appear than it is to try and learn all the times they do appear. Examples of enterprise environmental factors include things like governmental or industry standards, organizational infrastructure, and marketplace conditions.



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- ⇒ **.4 Organizational process assets** — Organizational process assets are the second *freebie*. Process assets include things like organizational policies, processes, templates, or historical information that could be used by the project. Again, they are almost always an input.

Notice the numbering that appears before each of the inputs. These numbers help to locate the information for the item in the PMBOK® Guide. Each chapter in the PMBOK® Guide is numbered. As has been previously mentioned, Integration Management is chapter four. Since the Develop Project Charter Process is the first process in the chapter it is process 4.1. Each of the inputs are further defined with a .1 before the final numeric identifier appear.

At this point more time is warranted on the business case. The business case tries to answer the question why should we do this project? There are two different ways to answer this question. The two different ways to determine business value are as follows:

- ⇒ **Benefit measurement methods** — These are comparative tools that are used to look at one potential project versus another. They include peer reviews and scoring models as well as the kind of economic models that will be described in detail in just a few moments.
- ⇒ **Constrained optimization methods** — These are advanced mathematical models that are used to calculate project value. The methods that are included in this class are linear, integer, dynamic and multi-objective programming.

As was mentioned above, there are a number of economic models with which you must be comfortable. They include the following:

- ⇒ **Payback period** — The Payback Period represents the amount of time (typically expressed in months) before the money invested to complete the project is returned in profit. That point is referred to as the break even point.
- ⇒ **Future value** — The Future Value represents the value of an investment at some future point based upon a provided interest rate. Very few test candidates, if any, have to calculate the future value. But understanding it is necessary to answer the comparative questions that are more common. It is defined by the formula:

$$FV = PV * (1 + i)^n$$

where *PV* = Present Value, *i* = Interest Rate and *n* = Term in Question

- ⇒ **Present value** — The present value, or discounting, refers to a future value that has been discounted to express it in today's currency. For example, imagine you had \$100 buried in a coffee can in your backyard. Twenty-five years later you dig up the coffee can and find the \$100 bill. Does it still have the same purchasing power? Absolutely not! Inflation has made that \$100 worth significantly less. This equation also is not often seen on the exam, but it is necessary to understand the next formula. The equation for the present value is:

$$PV = FV / (1 + i)^n$$

where *FV* = Future Value, *i* = Interest Rate, and *n* = Term in Question



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The Future Value Calculation



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The Present Value Formula

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- ⇒ **Net Present Value (NPV)** — The Net Present Value is almost identical to the present value. In the Present Value calculation you discount the value—typically representing a revenue stream—to account for inflation or some other similar rate. Net Present Value does the same thing, but it also takes into consideration the money that must be spent to complete the project over time. To do so it costs the Present Value from the net costs to obtain the NPV.
 - ⇒ **Internal Rate of Return (IRR)** — If you have followed these equations carefully, you might have noticed the variables in each are largely the same. In addition, each equation assumes that the term and interest rates are provided. In an Internal Rate of Return equation, it is the interest rate that must be determined. Unfortunately, there is no simple equation to calculate the internal rate of return. To solve for the IRR you must use the NPV calculation and select the middle-most interest rate of the four potential answers. You are looking for an interest rate which produces an NPV of zero. Based upon the result from the first calculation you can determine if you need a larger or smaller value. You should not have to calculate the NPV more than twice to determine the correct IRR.
 - ⇒ **Benefit / Cost Ratio (BCR or BCI)** — Most people are used to talking about a cost / benefit ratio and this is the same thing. The only difference is that the benefits are always placed in the numerator and the costs in the denominator. This is done so that any value greater than one is good.
 - ⇒ **Depreciation** — These are calculations used to reduce the value of a large asset primarily for tax purposes. This takes into account the wearing out of equipment. Although possible, it is unusual to select a project based upon depreciation. The four most common methods of depreciation are discussed later in this course.
 - ⇒ **Opportunity Cost** — Opportunity cost is the value of the next highest alternative—assuming the alternatives are mutually exclusive. It defines what you are giving up by making the choice.
 - ⇒ **Sunk Costs** — Sunk costs refer to the money that has already been spent on the project. It cannot be recovered. You should never make a project decision based upon sunk costs because it could be good money following bad.
 - ⇒ **Economic Value Added (EVA)** — This concept rarely appears on the exam, but references whether the project returns more value to the organization than it costs to produce.
 - ⇒ **Working Capital** — Working Capital is an accounting term defined as the current assets minus the current liabilities. It shows how much money the organization has available to invest on projects.
 - ⇒ **Law of Diminishing Returns** — The Law of Diminishing Returns argues that with every process you reach a point where adding one more dollar of cost will not add an equal return of value. If you discover that increasing the costs by a dollar does not provide at least a dollar return, you should not invest any more.



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The most common type of questions seen on the PMP® exam that deals with these equations doesn't actually require you to calculate anything. The most common type of test question simply asks you to compare several projects where no two projects have the same kind of data. One project might provide an NPV while another revenue, a third the Future Value, and the last one has a BCR. At first glance this might be impossible to solve. However, it is actually very simple. You need to first look for any BCR data. Remember that any value greater than one is good. There is no set value with FV, PV, NPV or IRR that is guaranteed to be good. When taking the test you should never assume information that is not provided. This means you cannot assume a positive value just because of the size of the value unless you are given the Benefit / Cost Ratio.

Although these determination methods appear in the business case, they are also tools and techniques that are available to develop the project charter. The tools and techniques used in the develop project charter include:

⇒ **.1 Expert judgment** — Expert judgment is simply relying on your subject matter experts (SMEs). It is PMI's preferred tool and technique in many situations — in fact, it is the most common tool and technique. It is always a good guess if you have no idea. Almost every process has expert judgment as a tool and technique.

⇒ **.2 Data gathering** — These include a diverse set of tools such as brainstorming, focus groups and interviews. Brainstorming represents a group creativity technique where the team attempts to find a conclusion by gathering information through a spontaneous discussion by the members. Typically, a dry erase board or other tool is used to capture the information for both historical purposes and to help the team maintain focus.

A focus group is often used for specific product research. In a focus group a demographically diverse group of people is brought together for a guided, open discussion about a product, service or project result. The goal is to use the information collected from the small group to represent expected results from a larger populations. The keys are that the discussion is led by a facilitator and that the members of the group are free to talk with other group members. Throughout the process researchers observe the group taking notes for future analysis.

Interviews require the team to meet with stakeholders to elicit information about the product, service or results of the project.

⇒ **.3 Interpersonal and team skills** — Techniques such as conflict management, facilitation, and basic meeting management are commonly cited here. We will discuss these concepts in the communications and resource management knowledge areas.

⇒ **.4 Meetings** — Meetings are perhaps the easiest tool or technique used in this area. The important thing to remember about them for the purposes of the test is that they are held with key stakeholders to define the key project drivers such as success criteria, requirements, milestones, etc.

The easiest part of the develop project charter process is the output. This process only has two outputs. As you have probably already guessed, the first output to the develop project charter process is the project charter. Upon receiving the signed charter the project manager begins the real work on the project. Above all else remember that no project ever begins without a charter. Charters empower the project manager and provide the team with their success criteria. They also **MAY** provide other information necessary to get the project off the ground.

The second output from the develop project charter process is the assumption log. This document is used to track all assumptions and constraints throughout the project life cycle.

4.2 Develop Project Management Plan

The second process in the integration management knowledge area appears in the planning process group and is the develop project management plan. The develop project management plan process is one of the most important processes found anywhere. It is the process that aggregates the outputs from the other processes found in the planning process group. It also defines which project management processes will be used in the project, as well as how the project will be executed, monitored, controlled, and closed. Remember that the project management plan is a living, breathing document that must be updated throughout the project's life. The develop project management plan process is made up of four inputs that include:

- ⇒ **.1 Project charter** — The project charter was just completed as one of the very first processes done in the project. It set a marker notifying everyone that there was a project and you were its leader. It also defined the project success criteria and a number of other critical elements you need to move forward regardless of methodology. If your organization uses an agile methodology like scrum, this document was called a project vision.
- ⇒ **.2 Outputs from planning processes** — As soon as the team enters the planning stage, something PMI® calls the planning process group a lot begins to happen. If you have already scanned the PMBOK® Guide, you likely already noticed the fact that virtually every knowledge area has a process that calls out the creation of some form of a plan. These documents define the rules used to manage that particular area and therefore become part of the overall project management plan. The processes used to create these subsidiary plans are often occurring at the same time the team is developing their overall project management plan. Be careful and do not let this confuse you.
- ⇒ **.3 Enterprise environmental factors** — As was stated in the develop project charter process, enterprise environmental factors are almost always at play. As the team begins to develop the guidelines and plans they intend to use many so called environmental factors can influence their work. The most important



Image 20: Develop PM Plan

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ones include any legal or regulatory requirements, industry standards, or organizational best practices.

- ⇒ **.4 Organizational process assets** — Just like environmental factors, organizational process assets are almost always in play. For developing a project management plan these include things like organizational policies, processes, and procedures or templates the organization has. Perhaps the most important potential process assets come in the area of change control processes and procedures the organization might have or require.

There are a lot of different ways teams develop their project management plans. A lot of that has to do with all the different methodologies the team might also choose. PMI® does not require the use of any one methodology. Therefore, they also must provide significant flexibility in how the project is planned. The tools and techniques used by the team include:

- ⇒ **.1 Expert judgment** — The single most common way of getting anything done according to PMI® is to trust your subject matter experts. They are the people who must do the work. They also usually have the specific knowledge about the various tools the team will use along with the specific resources, skills and other resourcing aspects.
- ⇒ **.2 Data gathering** — In the last process we discussed the importance of data gathering and listed a number of specific techniques. Each of those techniques apply here plus one additional. PMI® describes checklists as being another data gathering technique used to develop the project management plan. A checklist is a standardized list of items the team must consider as part of the planning processes. It guides the team in developing the project plan and helps ensure items are not forgotten. However, checklists also can be dangerous as people often consider everything complete because they have “checked all the boxes” or they end up dealing with checklists that are unnecessarily long. The important thing to remember is that checklists are meant to be guides and should never be considered 100% accurate.
- ⇒ **.3 Interpersonal and team skills** — Interpersonal and team skills deals with the soft skills required to relate to other members of your team. They include ideas such as conflict management, facilitation, and meeting management. We will discuss these areas when we reach resource management and communication management.
- ⇒ **.4 Meetings** — Much to many team members chagrin, much of our time is spent in meetings discussing various project aspects. When we are examining the develop project management plan process one meeting in particular is important. It is the kickoff meeting.

A kickoff meeting is a special, and very important kind of project meeting. It is the first official meeting of the project and should be done regardless of intended methodology. The kickoff meeting provides the team an opportunity to get their initial understanding of the project requirements beginning with the project success criteria presented from the project charter. A kickoff is typically conducted with both the project team and the major project stakeholders present to ensure both

groups hear the same information. It is often conducted using a variety of games or brainstorming techniques to capture the stakeholders' initial input while the team listens without providing solutions. For the exam, remember that a kickoff can be done to initiate either the project or a new project phase.

The only output for the develop project management plan process is the project management plan. As has been stated, the project management plan is the aggregation of the outputs from the other processes found in the planning process group. But what does that really mean? For many practicing project managers this is a point of much confusion. Many believe a project plan is a Microsoft Project® file and/or a schedule. Neither of these is a true project plan. A real project plan potentially includes a lot of different components. In addition, there are even more items that are considered project documents, but not part of the project management plan. The documents are important even if they are not part of the official plan document. The table below shows the items that form the basis of a project management plan and those basic items that are considered project documents. As you examine the list notice that almost all of the knowledge areas found in the PMBOK® Guide produces a plan document. Don't be overwhelmed by the size of the list. Remember, not every document is used on every project. It is up to the team to decide which apply to every specific project.

Below is a sampling of the various plans that give you a flavor of their purpose. Notice how each one establishes a set of basic rules for the management of that particular area.

Project Management Plan	Project Documents	
1. Scope management plan	1. Activity attributes	19. Quality control measurements
2. Requirements management plan	2. Activity list	20. Quality metrics
3. Schedule management plan	3. Assumption log	21. Quality report
4. Cost management plan	4. Basis of estimates	22. Requirements documentation
5. Quality management plan	5. Change log	23. Requirements traceability matrix
6. Resource management plan	6. Cost estimates	24. Resource breakdown structure
7. Communications management plan	7. Cost forecasts	25. Resource calendars
8. Risk management plan	8. Duration estimates	26. Resource requirements
9. Procurement management plan	9. Issue log	27. Risk register
10. Stakeholder engagement plan	10. Lessons learned register	28. Risk report
11. Change management plan	11. Milestone list	29. Schedule data
12. Configuration management plan	12. Physical resource assignments	30. Schedule forecasts
13. Scope baseline	13. Project calendars	31. Stakeholder register
14. Schedule baseline	14. Project communications	32. Team charter
15. Cost baseline	15. Project schedule	33. Test & evaluation documents
16. Performance measurement baseline	16. Project schedule network diagram	
17. Project life cycle description	17. Project scope statement	
18. Development approach	18. Project team assignments	

Image 21: The Project Management Plan and Project Documents, PMBOK® Guide 6th ed. p. 89



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- ⇒ **The scope management plan** — The scope management plan describes how the team plans to define, develop, monitor control and validate scope.
 - ⇒ **The requirements management plan** — The requirements management plan describes how requirements will be identified, collected, managed and controlled. It is part of the scope management process.
 - ⇒ **The change management plan** — The change management plan deals with all potential variances to baselines. This includes scope and requirements variances as well as variances to schedule, costs, quality, and any other area of the project. The goal is to prevent negative changes and to enhance positive changes. No matter what, the key is to follow the change management plan.
 - ⇒ **The configuration management plan** — What version of your plan are you on? Doesn't it make sense to ensure that everyone has the correct version of any document? That's what the configuration management plan is all about. It defines how any changes to documents are made and how people are notified of those changes.
 - ⇒ **The process improvement plan** — A key element of project management for PMI® is the idea of continuous process improvement. Every project needs a plan for how you will continue to get better.

For the exam, it a good idea to assume you have all these plans included as part of your project management plan. To give you a sense of the other project documents potentially involved with managing a project we define some of those documents as well. The key is not that you memorize the list, but instead focus on the trends you see. Notice the number of items that represent baselines, logs, and registers.

- ⇒ **Scope baseline** — The scope baseline includes the scope statement, work breakdown structure (WBS), and WBS dictionary.
- ⇒ **Milestone list** — The milestone list is a listing of the major, defined milestones for the project.
- ⇒ **Resource calendars** — A good project manager knows when their resources will be available to complete project work and does not assume they will simply be there when the schedule says they will.
- ⇒ **Schedule baseline** — The schedule baseline represents a snapshot or picture of the schedule as promised to the sponsor. It is critical that the project manager is always comparing the actual delivered results to the scheduled results found in the schedule baseline.
- ⇒ **Cost baseline** — The cost baseline is the same as the Schedule Baseline, except it is focused on the project budget instead of the schedule.
- ⇒ **Risk register** — The risk register is a critical document for project success. The risk register documents all the known potential risks, their triggers, categories, owners, and the response strategies. The risk register is discussed extensively in the risk management knowledge area.

The scope, schedule and cost baselines combine to form the **performance**



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management baseline. *Image 22* shows the documents that make up a true project management plan.

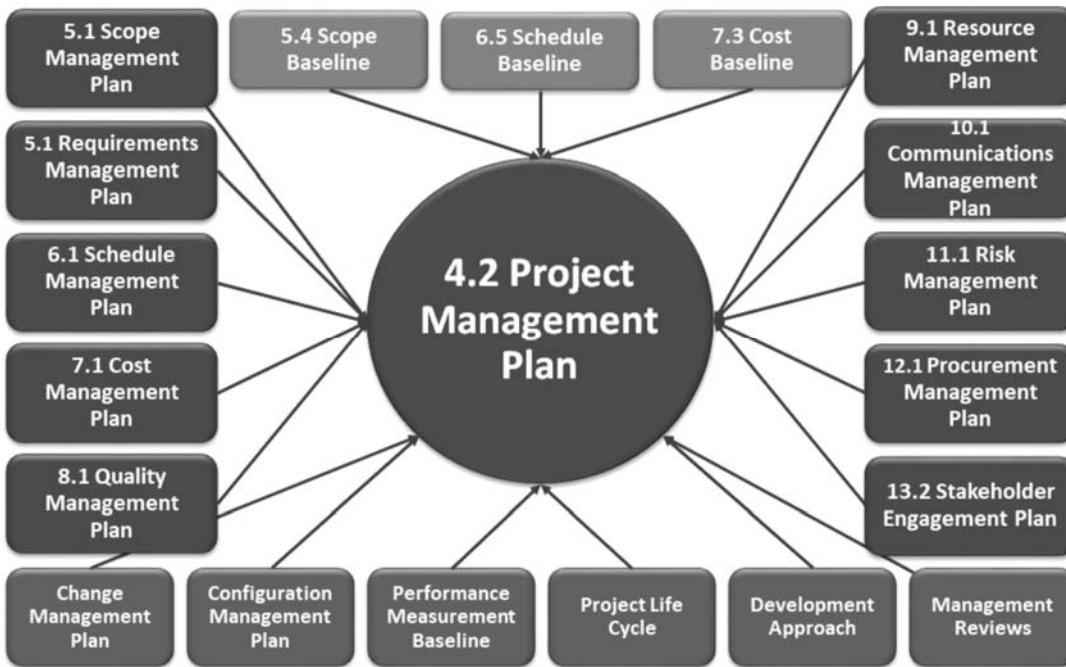


Image 22: The Project Management Plan

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4.3 Direct and Manage Project Work

The next process found in the integration management knowledge area is direct and manage project work. Just as the develop project management plan process is the key to the planning process group, this is the big process for the executing process group. It is here that the project manager and the project team ensure that the deliverables are completed according to plan, that plans are updated, and that change requests are managed. Be very careful about this section on the exam. Make sure you read the questions carefully as it is very easy to confuse the executing process group with the direct and manage project execution process. They are not the same! The key to doing well in this section is understanding that it is the project manager's responsibility to do what ever it takes to ethically ensure the completion of the project. The project manager must often act as the intermediary between the stakeholders and the team and is responsible for ensuring a common understanding of the project. On the exam — just as in the real world — if a project goes badly it will be the project manager's fault. You must do everything you can to help others and ensure everyone is on the same page.

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The direct and manage project work process has five inputs. The inputs to the direct and manage project work process includes the following:

- ⇒ **.1 Project management plan** — When executing the project it is the project manager's responsibility to ensure that the team is following the plan.

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- ⇒ **.2 Project documents** — For the direction and management of project work several project documents that are important including the change log, lessons learned register, milestone list, project communications, the project schedule, requirements traceability matrix, risk register, and the risk report.
- ⇒ **Approved change requests** — Notice that the input here is not “change requests,” but “approved change requests.” Only approved change requests should ever alter the actions of the project team. Approved change requests in this context also includes corrective action, preventive action and defect repair.
- ⇒ **.3 Enterprise environmental factors** — Here is our old friend again. Like most processes, the directing and managing project execution process can be influenced by enterprise environmental factors.
- ⇒ **.4 Organizational process assets** — Organizational process assets often influence the directing and managing of project execution. They are also one of the constants.

There are three tools and techniques used in the direct and manage project execution process. They include the following:

- ⇒ **.1 Expert judgment** — As always, expert judgment is a tool and technique used in this process.
- ⇒ **.2 Project Management Information System** — The PMIS is used to contain the information about the project. Therefore it is critical to the direct and manage project work process.
- ⇒ **Meetings** — Meetings come primarily in three types: informational exchange, decision making, or brainstorming, option evaluation or design.

The outputs to the direct and manage project work process create problems for some candidates. Take some time to study them carefully. They include the following:

- ⇒ **.1 Deliverables** — Be careful with the deliverables. Recognize that they are not the same thing as the final product, service or result of the project. They are components which make up that final output.
- ⇒ **.2 Work performance data** — This refers to the information from project activities that is specifically related to the results. It includes deliverable status, schedule progress, and any costs incurred. They are raw observations at the lowest level of detail.
- ⇒ **.3 Issue log** — An issue log is a document used to track conditions or situations that may have an impact on one or more project objective.
- ⇒ **.4 Change requests** — Some students find it confusing that “approved change requests” is an input to a process whereas “change requests” is an output. Don’t let it confuse you. This is a looping, ongoing process. As approved changes occur they can cause other changes to be requested.
- ⇒ **.5 Project management plan updates** — As the changes are approved and made the project documentation must be updated to reflect the changes. This might include any of the documents in the plan.

⇒ **.6 Project document updates** — There are some project documents that are not considered part of the project management plan. As execution occurs and changes happen these documents must be updated. These documents include:

- ◇ Requirements documents
- ◇ Project logs (such as issue or assumption)
- ◇ Stakeholder register

⇒ **.7 Organizational process assets updates** — Organizational process assets are documents, templates and other tools used to drive organizational processes. It is not unusual for the team to learn new things as the project progresses that can impact various processes used by the organization. Additionally, the project may cause changes to occur with one or more process. These changes can require updates.

4.4 Manage Project Knowledge

The manage project knowledge process is new in the 6th edition of the PMBOK[®] Guide. It is a process designed to use existing knowledge and create new knowledge to deliver the desired business results. It also affords the team an opportunity to contribute to organizational learning. This process takes the components of the project management plan and other project documents as they are being used in the direct and manage project work process and integrates the various enterprise environmental factors and organizational process assets to generate updates to these documents along with lessons learned. An easy way to think about this process is to think of it as the formalization of continuous improvement.

For project managers, you must deal with two types of knowledge explicit knowledge or knowledge that is easy to explain to others and tacit knowledge which represents knowledge that is very personal such as know-how or experience. The goal of every project manager is to ensure every member of the team has the knowledge they need to deliver the desired project results. The real question is how do you get knowledge out of peoples' heads and into the culture or environment so everyone know the same information?

The inputs to the manage project knowledge process include:

- ⇒ **.1 Project management plan** — Managing project knowledge requires the team to look at the complete project management plan to ensure maximum understanding.
- ⇒ **.2 Project documents** — If you recall from our last process, there is a very long list of documents included in the set called project documents. For the management of project knowledge it is especially important to include the lessons learned register, project team assignments, the resource breakdown structure or RBS, the source selection criteria, and the stakeholder register.
- ⇒ **.3 Deliverables** — Deliverables represent our project results. To improve or gain new knowledge the team must review the results they produce using the defined tools and techniques.



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- ⇒ **.4 Enterprise environmental factors** — When attempting to manage project knowledge the project leader must clearly understand the organizational culture along with any specific regulatory and legal constraints. In many project environments issues of geographic dispersion will be important as well. Finally, the leader must also understand the knowledge held by the team at that time.
 - ⇒ **.5 Organizational process assets** — When dealing with knowledge management, the project leader must understand all formal knowledge-sharing and information-sharing procedures within the organization along with specific communication requirements and all policies, processes and procedures.

The project leader and their team is required to take these inputs and apply four tools and techniques to deliver the desired outputs. Fortunately, these are largely common sense. Stop and think for a moment. If you are tasked with leading a project and need to ensure any knowledge your team develops is incorporated into the organization for future use how would you do it? The tools and techniques would likely include:

- ⇒ **.1 Expert judgment** — Like most of the processes described in the PMBOK® Guide, managing project knowledge requires extensive use of expert judgment. Good project leaders understand the importance of trusting the people who actually do the project work.
- ⇒ **.2 Knowledge management** — On this surface this tool or technique might appear a little ambiguous. From PMI's perspective it is not. It represents a set of practices such as networking, the creation of communities of practice, meetings, internships or shadowing, knowledge sharing events, workshops, storytelling, and many other not named. The notion here is that the project leader finds way to connect people so they can create new knowledge based on the project work.
- ⇒ **.3 Information management** — Information management is closely related to knowledge management. It represents methods for documenting explicit knowledge for lessons learned, information gathering and making use of the project management information system for documentation purposes. It is doing the work to connect people to information.
- ⇒ **.4 Interpersonal and team skills** — These skills are similar to expert judgement in that they are used over and over again throughout the PMBOK® Guide. In this case it is referring to skills such as active listening, facilitation, leadership, networking, and political awareness. Political awareness is new for the 6th edition of the guide and draws special attention to the requirement for good project leaders to understand the political environment in which they operate. Every organization has politics. A good leader understands them well.

Once these tools and techniques are applied within the manage project knowledge process three outputs are created.

- ⇒ **.1 Lessons learned register** — The lessons learned register is created early in the project life cycle. This document is specific to the project, and once the

initiative is complete the information is moved to the lessons learned repository.

- ⇒ **.2 Project management plan updates** — The process of managing project knowledge creates the potential for changes with any of the documents found in the project management plan. However, these changes must go through the change management process as defined by the team.
- ⇒ **.3 Organizational process updates** — According to PMI, all projects create new knowledge and part of the processes of project management is to take this new knowledge and incorporate it into the existing knowledge base.

4.5 Monitor and Control Project Work

It is now time to move into the fifth integration management process which is found in the monitoring and controlling process group. There are two integration management processes found here. The first of these processes is 4.4 monitor and control project work. This process is concerned with tracking, reviewing, and regulating project progress to meet the performance objectives that have been defined in the project management plan. It is most importantly about comparing actual results to the promised plan and forecasting the expected results. When taking the exam it is important to remember that unless it is stated otherwise you should assume that you are leading a relatively large project that might require a significant amount of monitoring. This means you would likely not have first hand knowledge of the actions of all your resources.

There are seven inputs to the monitor and control project work process. They include the following:

- ⇒ **.1 Project management plan** — This process is all about tracking actuals to forecasts, therefore the plan is a critical input.
- ⇒ **.2 Project documents** — The 6th edition of the PMBOK® Guide makes a significant change in the project documents included in this process. In attempting to monitor and control project work there are many documents necessary including the assumption log, basis of estimates, cost forecasts, issue log, lessons learned register, milestone list, quality reports, risk register, risk report, and schedule forecasts. Hopefully, it makes sense that managing and controlling the project work requires all the information the team can have on hand.
- ⇒ **.3 Work performance information** — Whereas most data lacks context, work performance information is correlated and contextualized and therefore provides a sound foundation for project decisions. When work performance data is compared with project management plan components, project documents and other project variables it becomes work performance information.
- ⇒ **.4 Agreements** — The agreements described in this section are procurement agreements that include specific terms and conditions with which the team must comply. If the team is using contractors, these agreements define the oversight of the contractors.



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- ⇒ **.5 Enterprise environmental factors** — As always, enterprise environmental factors are at play. For this process the Work Authorization System is used. This is the system that the project manager uses to authorize work to begin on a specific work package.
 - ⇒ **.6 Organizational process assets** — Like enterprise environmental factors, organizational process assets are almost always in play.

The tools and techniques used in the monitor and control project work process include the following:

- ⇒ **.1 Expert judgment** — The best place to start is always having subject matter experts to provide critical information.
- ⇒ **.2 Data analysis** — When monitoring and controlling project work there are a number data analysis tools and techniques including alternatives analysis, cost-benefit analysis, earned value analysis, root cause analysis, trend analysis, and variance analysis. Later in this course we will evaluate each of these techniques in greater detail.
- ⇒ **.3 Decision making** — There are many different ways the team can make decisions. Leaders can be autocratic, making all the decisions on their own or they can use the strength of the group. Each decision making type has implications that we will discuss later in this course as well.
- ⇒ **Analytical techniques** — These techniques can be advanced mathematical methods such as a regression analysis or as simple as grouping methods.
- ⇒ **Project management information systems** — Considered part of the enterprise environmental factors, these provide key information such as scheduling, cost, resourcing, performance indicators, or others.
- ⇒ **.4 Meetings** — Sometimes it just makes sense to talk to people. Don't over think this stuff. In many cases the simple answer is best.

The monitor and control project work process has four outputs to it. They include the following:

- ⇒ **.1 Work performance reports** — When work performance information is combined, recorded, and distributed to cause the team and organization to make decisions, take action or become aware of. This information becomes work performance reports.
- ⇒ **.2 Change requests** — As the project progresses and work is monitored and controlled, the needed or desired changes become apparent. These requests take three specific forms: corrective action, preventive action, and defect repair. Corrective action represents intentional activity that realigns the performance of the project. Preventive action is an intentional activity that ensures the future performance of the project work. Defect repair is an intentional activity that modifies a nonconforming product or product component.

- ⇒ **.3 Project management plan updates** — Updates to the project management plan become necessary as changes occur.
- ⇒ **.4 Project document updates** — If the changes require you to change documents found in the project management plan, there is a high probability that they will also cause changes to other non-project plan documents.

4.6 Perform Integrated Change Control

The other integration management knowledge area process found in the monitoring and controlling process group is perform integrated change control. Changes can impact any area or process of a project. The potential for significant change makes it critical that every project has processes established to deal with those changes. perform integrated change control represents that process. It is the single process that brings the change control efforts from each of the other knowledge areas together. Using a few simple PMIisms can dramatically improve your success with this critical process.

- ⇒ Always analyze the impacts of potential changes before doing anything else
- ⇒ Always bring forward options based on the completed analysis
- ⇒ Always have a change control process
- ⇒ Always follow your change control process
- ⇒ It is critical that you understand the root cause of changes to prevent future unwanted or unexpected changes
- ⇒ Expectation management is a critical aspect of change management that cannot be overlooked
- ⇒ Make sure your documentation reflects the actions taken

In many organizations, a defined part of the change management process is the change control board (CCB) or change review board (CRB). Regardless of the name, these boards perform the same function. It is their job to review recommended actions and requested changes and provide approval. They typically have final authority over changes on large projects.

The inputs to the perform integrated change control process include:

- ⇒ **.1 Project management plan** — Our old friend the project management plan is never far away. Changes are only changes if there is something to change from. The project management plan is that something. PMI® specifically calls out change management plan, the configuration management plan, the scope baseline, schedule baseline, and the cost baseline. Each of these baselines represents a snapshot of that item at a point in time.
- ⇒ **.2 Project documents** — For most of the processes found in the PMBOK® Guide, if you use the project management plan you also use the project documents. For this process, PMI® specifically calls out your basis of estimates, the requirements traceability matrix and risk reports.
- ⇒ **.3 Work performance reports** — This is information from project activities related to various results including deliverable status, schedule progress, and any costs incurred.



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- ⇒ **.4 Change requests** — As has already been often stated, changes can be requested at almost any time.
- ⇒ **.5 Enterprise environmental factors** — Our old friends are at work in the Perform Integrated change control process.
- ⇒ **.6 Organizational process assets** — Items such as the change control procedure, procedures for approving and issuing change authorizations, and the process measurement database (which is used to aggregate data about process and product measurements) are all included in the organizational process assets.

The tools and techniques used in the integrated change control process include the following:

- ⇒ **.1 Expert judgment** — Expert judgment is especially valuable when dealing with changes.
- ⇒ **.2 Change control tools** — Be very careful with the change control tool. Do not confuse change control with configuration control. According to PMI[®], configuration control deals with the specification of both the deliverables and the processes. Change control deals with identifying, documenting, and approving or rejecting changes to the project documents, deliverables or baselines. Within the description of the tools, PMI[®] says the should support both activities for configuration control and change management.
- ⇒ **.3 Data analysis** — Data analysis uses both alternatives analysis and cost-benefit analysis
- ⇒ **.4 Decision making** — Decision making techniques used for performing integrated change control include voting, autocratic decision making and multicriteria decision analysis.
- ⇒ **.5 Meetings** — The specific meeting discussed in this area is the change control board or CCB. A CCB is a group of leaders who are tasked with deciding whether or not charges are approved or not. They also must communicate with all members of the organization.

The outputs of the integrated change control process include:

- ⇒ **.1 Approved change requests** — The requests the CCB chooses to approve are the critical output of this process.
- ⇒ **.2 Project management plan updates** — Changes can cause required updates to the project management plan.
- ⇒ **.3 Project documents updates** — Just like the Project Management Plan, the other project documents might require updates due to changes.

4.7 Close Project or Phase

The close project or phase process is the process where all the activities across all of the project management process groups are brought to a conclusion. This is necessary for the project (or phase of the project) to be successfully closed. This



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process ensures that all the required project work has been completed correctly and that the project has met its objectives. It also establishes the procedures to follow if a project is terminated before completion, i.e., how to investigate and document the reasons for the actions taken. Do not underestimate the importance of this section. According to PMI[®], proper project closeout is an often overlooked process.

The inputs to the Close Project or Phase Process include the following:

- ⇒ **.1 Project charter** — The project charter defines the project success criteria, and is necessary to close any phase or the project as a whole.
- ⇒ **.2 Project management plan** — It is impossible to determine whether or not you have completed all that you are supposed to unless you have a Project Management Plan that makes it possible for you to comparison what happened with what was supposed to happen.
- ⇒ **.3 Project documents** — The huge list of potential documents are all inputs to the process of closing a project
- ⇒ **.4 Accepted deliverables** — Good project managers are those who manage deliverables not tasks. It is the aggregation of deliverables that creates the final product, service or result.
- ⇒ **.5 Business documents** — Both the business case and the benefit management plan are inputs to closing the project or just a phase because they provide a detailed explanation of why the organization needed the project completed. It is more information than provided in the charter.
- ⇒ **.6 Agreements** — Those contracts used to obtain components and work from those outside the organization are critical to closing the project.
- ⇒ **.7 Procurement documentation** — Agreements are the actual contracts necessary to complete the project. Procurement documentation represents all the other documents such as payment records, manuals, or inspection results.
- ⇒ **.8 Organizational process assets** — Many organizations have processes, templates and/or practices that are used throughout the organization to complete a project.

The tools and techniques used in the close project or phase include the following:

- ⇒ **.1 Expert judgment** — This applies almost everywhere. Closing a project or a phase requires it as well.
- ⇒ **.2 Data analysis** — This is also a previously discussed tool. Don't lose sight of the simple ideas—they have great power.
- ⇒ **.3 Meetings** — This is another common sense tool that appears in the standards.

There are only two outputs to the close project or phase process. If you look back at the basic PMI[®] process model you can easily see what they are.



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- ⇒ **.1 Project documents updates** — Most are a little surprised to see that project document updates appear before the final product, service or result. These updates appear first in the lessons learned register.
 - ⇒ **.2 Final product, service or result** — This is it. It's *the* reason for doing the project. This is the only spot where the final product, service or result is an output.
 - ⇒ **.3 Final report** — The project's final report provides a summary of how the team did throughout the project. It addresses issues like the scope objectives and all the other objectives. It also provides a summary of the validation information for the final product, service or result.
 - ⇒ **.4 Organizational process assets updates** — As has been mentioned earlier, continuous process improvement is a key concept for the exam. This means looking at the processes you currently have and improving them based upon lessons learned.

Integration Management Summary

As you conclude your studies of the Integration Management Knowledge Area focus in on these points:

- ⇒ The role and components of the charter
- ⇒ The charter issued by party external to the project
- ⇒ The project management plan is a collection of other plans, and the level of detail depends on the project
- ⇒ Change control must happen throughout the project
- ⇒ Project closure equals both deliverables **AND** project records
- ⇒ No matter what, environmental factors are at play



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Exercise 5—Integration Management



Exam 5 — Integration Management

1. Which of the following is the first process in the integration management knowledge area?
 - A. Develop project charter
 - B. Develop project scope statement
 - C. Develop project management plan
 - D. Distribute Information
2. Which of the following is not part of the integration management knowledge area?
 - A. Direct and manage project work
 - B. Develop project management plan
 - C. Distribute information
 - D. Monitor and control project work
3. Which of the following information is not captured in the project charter?
 - A. Initial constraints and assumptions
 - B. The name of the project manager
 - C. The project management plan
 - D. All of the above are captured
4. When should the organization's business needs be documented?
 - A. Throughout the entire project process
 - B. In the planning process
 - C. In the initiation process
 - D. Before beginning the initiation process
5. When is a project officially authorized?
 - A. When the required information has been captured
 - B. When the project charter is approved
 - C. When the initial assumptions and constraints have been reviewed
 - D. When the Project Manager has been selected
6. Which of the following is not a reason to repeat the initiating process group at the start of each project phase?
 - A. To keep the project focused on the business need that the project was undertaken to address
 - B. It allows the project team to evaluate whether or not the business need no longer exists
 - C. It allows the project team to evaluate whether or not the project will be able to satisfy the business need
 - D. It ensures project success

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7. Involving the customers and other stakeholders in the initiation process is important because:
 - A. It improves the probability of shared project ownership
 - B. It improves the likelihood of deliverable acceptance
 - C. It improves stakeholder satisfaction
 - D. All of the above
 8. The initiating process group does all of the following except:
 - A. Provides for the project management plan
 - B. Defines the project's purpose
 - C. Identifies project objectives
 - D. Authorizes the project manager to begin work
 9. Which of the following project management processes is part of the initiating process?
 - A. Develop project management plan
 - B. Develop project charter
 - C. Define scope
 - D. Collect requirements
 10. Which of the following project management processes is part of the Initiating Process Group?
 - A. Identify stakeholders
 - B. Define scope
 - C. Collect requirements
 - D. Develop project management plan
 11. The initiating process group feeds into or accepts input from each of the following project management process groups except:
 - A. The planning process group
 - B. The executing process group
 - C. The closing process group
 - D. All of the above
 12. The development of the project charter is primarily concerned with which of the following?
 - A. Assigning the project team
 - B. Authorizing the project
 - C. Providing constraints and assumptions
 - D. Providing the limits of the project manager's authority

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13. The progressive detailing of the Project Management Plan—which indicates that planning is an iterative and ongoing process—is often called what?
- A. An iterative feature plan
 - B. A project management plan
 - C. A rolling wave plan
 - D. All of the above
14. Which of the following statements is not true about stakeholder involvement in the planning process group?
- A. The project team should involve only the senior stakeholders and sponsors in the initial scoping of the project.
 - B. The project team should use stakeholders in project planning since the stakeholders have skills and knowledge that can be leveraged.
 - C. The project team is responsible for creating an environment in which stakeholders can contribute.
 - D. All of the above are true.
15. Who (or what) ensures that feedback and refinement do not continue indefinitely in the planning processes?
- A. The project manager
 - B. The project sponsor
 - C. The project management plan
 - D. Organizational policies and procedures
16. According to the PMBOK® Guide, how stringently must a project manager ensure that all the defined process interactions occur?
- A. There is a great deal of flexibility because interactions within the planning process are dependent on the nature of the project
 - B. There is not significant flexibility because interactions within the planning process are not dependent on the nature of the project and only depend on the PMBOK Guide.
 - C. Interactions within the planning process group are not dependent on the nature of the project, but there is significant flexibility based on the definitions in the PMBOK® Guide.
 - D. None of the above is true.
17. How do you document the results of the various iterations within the planning processes?
- A. Within the various deliverables
 - B. As updates to the scope statement
 - C. As updates to the risk management plan
 - D. As updates to the project management plan

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18. What typically happens to the project management processes when the project is divided into phases?
- A. Nothing. The project management processes are designed to work with many methodologies.
 - B. The process groups are normally repeated within each phase.
 - C. The process groups must be altered because they are not designed for a phased-based methodology.
 - D. None of the above
19. Which of the following statements is true about processes?
- A. Not all of the project management processes are needed on every project
 - B. All of the processes are required on every project
 - C. All of the process interactions are required
 - D. None of the above
20. Which of the following statements is not true about projects?
- A. Not all of the project management processes are needed on every project
 - B. Not all of the interactions apply to all project phases
 - C. Projects dependent on unique resources might skip the definition of roles and responsibilities as they are already defined
 - D. None of the above
21. Can process inputs be predefined on a project as constraints?
- A. Rarely
 - B. Never
 - C. Often
 - D. Occasionally
22. Which of the following is not a process from the integration management knowledge area?
- A. Create WBS
 - B. Develop project charter
 - C. Close project or phase
 - D. Develop project management plan
23. In which of the following processes would you develop a high-level narrative of the project?
- A. Develop project charter
 - B. Develop preliminary project scope statement
 - C. Develop project management plan
 - D. All of the above

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24. Which of the following statements about the project charter is true?
- A. Chartering a project links the project to the ongoing work of the organization
 - B. The project charter helps define the organizational strategy
 - C. A project is not informally recognized until it is chartered
 - D. All of the above
25. Which of the following is an acceptable reason to need to re-baseline your \$25,000,000 project?
- A. The IT department deploys a new project management control system
 - B. Your primary vendor requests the use of a new Earned Value reporting methodology
 - C. Your sponsor approves a \$1,500,000 change in scope.
 - D. The most expensive deliverable on the project comes in 20% under budget.
26. What kind of project justification would it be if a chemical manufacturer authorized a project as a result of new national guidelines for handling of toxic materials?
- A. A business need
 - B. A legal requirement
 - C. A market demand
 - D. A social need
27. Which of the following either directly or indirectly should be addressed by the project charter?
- A. Requirements that satisfy stakeholder needs, wants and expectations
 - B. Summary milestone schedule
 - C. Functional organizations and their participants
 - D. All of the above
28. Which of the following describes whether the expected outcomes of the project justify the investment?
- A. Contract
 - B. Business case
 - C. Business needs analysis
 - D. Project justification
29. What kind of project estimate is typically included in the preliminary project charter?
- A. Rough order of magnitude estimate
 - B. Detailed budget estimate
 - C. Budget estimate
 - D. None of the above

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30. Who is responsible to ensure that the knowledge, skills, and processes of project management are applied as needed by the project?
- A. The project team
 - B. The project sponsor
 - C. The project manager
 - D. All of the above
31. Which of the following is usually a core area of emphasis for effective project integration?
- A. The technical expertise of the team
 - B. Effective use of the change management process
 - C. Efficient and effective communication throughout the key interfaces
 - D. Efficient and effective product control
32. Which of the following is a key driving force for communication on a project?
- A. Performance
 - B. Differentiation
 - C. Optimization
 - D. Integration
33. You are a project manager meeting with a coworker over lunch. You explain that you spend a lot of time reviewing historical records from previous, similar projects to prepare for your current project. Which of the following describes the best use of those records?
- A. Project planning, creating lessons learned, and risk management
 - B. Life cycle costing, estimating and lessons learned
 - C. Estimating, risk management and project planning
 - D. Life cycle costing, lessons learned and project planning
34. You are a relatively new project manager in your organization and have been given a mentor to help you succeed. While meeting with your mentor she suggests that when it comes to change, your attention should be given to:
- A. Following your change management process
 - B. Making the changes
 - C. Tracking and recording the changes
 - D. Preventing unnecessary changes
35. When designing an effective change management plan it should include all of the following except:
- A. Lessons learned
 - B. Policies
 - C. Procedures
 - D. Meetings

-
36. You have just been hired by a company and are a new project manager. You receive your first project and are preparing to begin your role. To improve your chances of success, it would be best in this situation to rely on what during the planning stage?
- A. Lessons learned repository
 - B. Stakeholder input
 - C. Certification training
 - D. Scope verification
37. When attempting to lead a project, you struggle because your project is experiencing a significant number of changes to the project charter. As you work through these changes, who has the primary responsibility to decide if the changes are necessary?
- A. Project manager
 - B. Project team
 - C. Project sponsor
 - D. Project stakeholders
38. You are a project manager at ABC Corp. Which of the following explanations would most accurately describe your project management plan to a coworker?
- A. A Gantt chart showing the project schedule and resources
 - B. The project scope document
 - C. A scope management plan, risk management plan combined with six other management plans
 - D. The project management plan is the document that describes how the project will be executed, monitored and controlled, and closed.
39. As a project manager your boss instructs you to develop a realistic plan. Which of the following is the best method for achieving a realistic plan?
- A. You create the plan with input from the sponsor
 - B. You create the plan with input from the project team
 - C. You create the plan with input from the stakeholders
 - D. The team creates the plan with your input
40. As a new project manager, you discover that you will be required to have 11 stakeholders sign off on your charter. Which of the following is your greatest concern?
- A. The amount of time spent on configuration management
 - B. Defining your change management process
 - C. Managing the sponsors
 - D. Defining your reporting structure

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41. As a professional project manager you know that many of the processes are ongoing efforts that potentially overlap. In the real world, which of these processes are you most likely to combine?
- A. Collect requirements and create WBS
 - B. Create WBS and define activities
 - C. Plan communications and develop human resources plan
 - D. None of the above—you should not combine these processes in the real world
42. All of the following are part of performing integrated change control except which one:
- A. Project management plan
 - B. Change management plan
 - C. Project management information system
 - D. Work performance reports
43. You are an information technology project manager and have been asked to lead a traditional engineering project. You delegate the various processes to the project resources who are subject matter experts and you serve as the coordinator of activities and an arbiter for disagreements. What results do you expect based upon this approach?
- A. A team that functions as a cohesive unit with both commitment and collaboration
 - B. A team that might start out slow with a large amount of confusion, but eventually gets organized and performs well
 - C. A team with strong technical focus and performance, but little interest in the overall goal
 - D. A team with poor performance, low morale, significant conflicts and a significant amount of turnover
44. As a project manager you build your project plan and schedule based upon a commitment from the senior management that you will have several senior level resources completely dedicated to your project. When it actually comes time to do the work you are provided with much less skilled resources. The best thing to do is which of the following:
- A. Remind management that you were promised senior level resources
 - B. Show management the impact of having the less experienced resources assigned to your project
 - C. Rework the project schedule with the new, less experienced resources
 - D. Crash the project

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45. You are six months into an 18-month project when you receive a change request from the customer that will not affect the project schedule and is easy to complete. What should you do first?
- A. Evaluate the change's impacts on the other constraints
 - B. Get the sponsor's approval before making the change
 - C. Get the change completed as soon as possible
 - D. Go to the CRB
46. You are a project manager within a large PMO. Currently, the PMO is at about 75% capacity when your company wins a new, very large contract that will require significant organizational resources to execute. What is the first thing you should do once you hear about the new project?
- A. Ask management if you can lead the new effort
 - B. Ask management how the new project will use organizational resources
 - C. Fast track your project
 - D. Ask management how the new project will affect your project
47. You are a project manager and get asked to take over for a retiring coworker. You meet with the current project manager as part of your transition and discover that the project is currently on schedule. The current project manager tells you that the project is only on schedule because he has constantly pushed the project team to perform. What is the first thing you should do?
- A. Determine your management strategy
 - B. Determine the exact SPI
 - C. Determine the current cost performance
 - D. Meet with your new team to outline your objectives
48. During the project you determine that additional material needs to be purchased. You call your team together to plan exactly how to make the required change. This is an example of what?
- A. Management by consensus
 - B. Lack of a change management plan
 - C. Good team relations
 - D. Management by objectives
49. Linear programming is an example of what type of project selection criteria?
- A. Regression analysis
 - B. Benefit cost measurement
 - C. Quantitative scoring
 - D. Constrained optimization

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50. Your company is evaluating three different projects, but can do only one. Project A has an NPV of \$120,000 and will take 6 years to complete. Project B will take 3 years and has an NPV of \$91,500 and Project C has an NPV of \$83,000. Based on this information, which project would you pick?
- A. Project A
 - B. Project B
 - C. Project C
 - D. Not enough information to determine
51. A project manager is interested in obtaining a position within his organization's project management office. As part of the hiring process the PMO reviews the project manager's past performance on projects within the organization. The project manager has four projects that are reviewed. One project finished ahead of schedule and had a CPI of 1.04. That project sponsor provided a recommendation for the project manager. The second project had an SPI of 0.92 and a less than 10% cost variance. In discussions with the sponsor the PMO team discovers that these results were achieved due to fast tracking the schedule, that some rework was required after project completion, and that the product of the project has never been used. The third project was a large project for the organization with significant visibility throughout the firm. This project experienced three restarts due to changes that were 30% greater than other projects within the organization and was completed with 17 items remaining on the issue log. The final project was relatively low in the organizational priority system and had an SPI of 0.76, had struggled with several unexpected items on the risk register, and had to rework their project charter twice.
- The PMO decides not to hire this project manager based on the past performance. Which of the following statements best justifies this decision?
- A. The project manager had consistently missed schedule and cost targets showing he does not have the skill to work in the PMO.
 - B. The project manager consistently failed to involve stakeholders showing he does not have they skills to work in the PMO.
 - C. The project manager failed to properly use a risk register showing he does not have the skills to work in the PMO
 - D. The project manager consistently showed problems managing change showing he does not have the skills to work in the PMO.
52. Your project has changed significantly and requires changes be made to the project charter. Who has primary responsibility to decide if these changes are necessary?
- A. The project manager
 - B. Key stakeholders
 - C. The project team
 - D. The sponsor

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53. Which of the following best describes the project manager's role as an integrator?
- A. The project manager puts all the pieces of a project into a cohesive whole
 - B. The project manager puts all the pieces of the project into program
 - C. The project manager helps the team become familiar with the pieces of the project
 - D. The project manager gets the project team together into a cohesive unit
54. As a new project manager you are tasked with delivering an important project in a short time window. In this situation what would it be best to rely on in order to improve your chances of success?
- A. The organization's configuration management system
 - B. Your PMP training
 - C. Historical information
 - D. Stakeholder input
55. Which of the following is NOT one of the four fundamental categories acting upon organizations illustrating the context of a project?
- A. Meet regulatory, legal or social requirements.
 - B. Satisfy senior leadership's vision of the future.
 - C. Implement or change business or technological strategies.
 - D. Create, improve, or fix products, processes, or services.
56. In what kind of life cycle is the project scope, time and cost determined in the early phases and then any changes are carefully managed?
- A. Predictive
 - B. Iterative
 - C. Incremental
 - D. Adaptive
57. What kind of life cycle is agile, iterative, or incremental with the detailed scope being defined and approved at the start of an iteration?
- A. Iterative
 - B. Incremental
 - C. Adaptive
 - D. Hybrid
58. Which of the following is represents the raw observations and measurements identified during activities performed to carry out the project work?
- A. Work performance reports
 - B. Work performance information
 - C. Work performance data
 - D. Work results

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59. The selection of project management processes, inputs, tools, techniques, outputs, and life cycles phases is called what?
- A. Methodology selection
 - B. Governance
 - C. Project initiation
 - D. Tailoring
60. Which of the following often precedes the business case?
- A. A benefits case
 - B. A needs assessment
 - C. A project charter
 - D. An alternatives analysis

Exercise 5 — Integration Management Answers

1. **Answer A.** PMBOK® Guide p. 71 – Before anything else can be done on a project the charter must be developed.
2. **Answer C.** PMBOK® Guide p. 360 – Distributing information is part of the manage communications process.
3. **Answer C.** PMBOK® Guide p. 75-81 – The initial scope description and the resources that the organization is willing to invest are further refined during the initiation phase. If he or she has not already been assigned, the project manager is selected. Initial assumptions and constraints are also documented. The Project Management Plan is created as part of the planning processes.
4. **Answer D.** PMBOK® Guide p. 30-31 – Before beginning the Initiating Process Group, the organization’s business needs or requirements are documented. This may blur the project boundaries. To create the charter a major input is the business case.
5. **Answer B.** PMBOK® Guide p. 77 – If he or she has not already been assigned, the project manager will be selected and initial constraints and assumptions will also be documented. All of this information is captured in the project charter and the project becomes officially authorized when it is approved.
6. **Answer D.** PMBOK® Guide p. 19-24 – Repeating the initiating process at the start of each project phase (methodology or time based development process) does not ensure success. However, it does serve to keep the project focused on the business need, it allows the project team to determine if the business need still exists, and it allows the project team to determine if the project can satisfy those needs. Therefore it definitely improves the likelihood of project success.
7. **Answer D.** PMBOK® Guide p. 19-24 – Involving all stakeholders—including the customers—in the initiating process is important because the easiest time to change the project is at this early stage. Additionally, it helps improve the probability of shared ownership, improves the likelihood of deliverable acceptance, and improves stakeholder satisfaction.
8. **Answer A.** PMBOK® Guide p. 77-81 – The primary output of the Initiating Process Group is the Project Charter. This document provides information on the project’s purpose, identifies the project objectives and, most importantly, authorizes the project manager to begin work. However, it does not provide the for the project management plan. That is an output of the Planning Process Groups.
9. **Answer B.** PMBOK® Guide p. 71 – This is NOT simply a duplicate question to #8. It is supposed to be here. The only two processes within the Initiating Process Group are the Develop Project Charter Process and the Identify Stakeholders Process. All other choices are part of the Planning Process Group.

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10. **Answer A.** PMBOK® Guide p. 25 – The only two processes within the Initiating Process Group are the Develop Project Charter Process and the Identify Stakeholders Process. All other choices are part of the Planning Process Group.
 11. **Answer C.** PMBOK® Guide p. 18 – Because the Initiating Process Group is supposed to be done at the beginning of each project phase, there is a need to communicate with each of the other process groups (except the Closing Process Group) when the project has ended.
 12. **Answer B.** PMBOK® Guide p. 75-77 – The development of the Project Charter (4.1) is primarily concerned with authorizing the project. It also names the project manager and will often include any constraints or assumptions. However, its core function is project authorization.
 13. **Answer C.** PMBOK® Guide p. 160, 185 – Significant changes occurring throughout the project cycle often trigger a need to revisit one or more of the project management processes. Although the frequency might vary, this progressive detailing of the project management plan is the very definition of a rolling wave plan.
 14. **Answer A.** PMBOK® Guide p. 34-35 – It is critical that the project team gets as many of the stakeholders involved in the project as early as possible and keeps them involved throughout the project. To do this, the project manager and team must create an environment that is conducive to stakeholder participation. A wide range of stakeholders can have information that can help the project succeed.
 15. **Answer D.** PMBOK® Guide p. 21-23 – Because the feedback and refinement process can continue indefinitely if left unchecked, procedures set by the organization identify when the planning effort ends.
 16. **Answer A.** PMBOK® Guide p. 19-23 – Interactions among the processes within the planning process group are dependent on the nature of the project. This makes significant refinement and iterations possible—as well as reordering of some of the relationships due to the fact that in many projects information is simply not available until later in the process.
 17. **Answer D.** PMBOK® Guide p. 22-23 – The results of the iterations within the planning process are documented as updates to the project management plan.
 18. **Answer B.** PMBOK® Guide p.19-21 – When a project is broken into phases the project management process groups usually repeats it an iterative manner because they are designed to work in either an iterative or linear manner.
 19. **Answer A.** PMBOK® Guide p. 22 – Not all of the processes are needed in all projects. This is because flexibility is a key concept for project management.
 20. **Answer D.** PMBOK® Guide p.21-23 – A key concept with the project management process groups is flexibility. This requirement means that not all processes are needed on every project and not all of the interactions apply to every project phase. Unique resources are often predefined.

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21. **Answer C.** PMBOK® Guide p. 28,39 – It is not at all unusual for process inputs to be locked into place as a constraint. This usually happens when they are predefined.
22. **Answer A.** PMBOK® Guide p. 25 – Creating the WBS is part of Scope Management. All others are part of Integration Management.
23. **Answer A.** PMBOK® Guide p. 75-77 – The high level narrative is part of the project charter.
24. **Answer A.** PMBOK® Guide p. 75-77 – According to the PMBOK Guide, chartering a project links the project to the ongoing work of the organization. The charter does not define the organizational strategy. Additionally, the charter formally recognizes the project.
25. **Answer C.** PMBOK® Guide p. 87 – The integrated change control process is performed throughout the project. This is because no project runs perfectly. As part of this process, it is critical to maintain only changes that have been approved. Significant changes in scope may require re-baselining the project.
26. **Answer B.** PMBOK® Guide p. 7 – Projects can be justified for a number of reasons that include:
- A market demand
 - A business need
 - A customer request
 - A technology advance
 - A legal requirement
 - A social need

In this case, the situation describes doing a project because of a legal need. The key indicator is the national guideline, law or regulation.

27. **Answer D.** PMBOK® Guide p.75-77 – The project charter is one of the most important project documents. It is created prior to beginning the project. The charter should address the following information either by reference or directly:
- Requirements that satisfy stakeholder needs
 - Business needs
 - The project purpose or justification
 - Assigned project manager and their authority level
 - Summary milestone schedule
 - Stakeholder influences
 - Functional organizations and their participations
 - Organizational, environmental and external assumptions
 - Organizational, environmental and external constraints
 - Business case justifying the project including ROI
 - Summary budget
28. **Answer B.** PMBOK® Guide p. 77 – The project statement of work (SOW) is a narrative description of products or services to be supplied by the project.

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29. **Answer A.** PMBOK® Guide p. 706 – The Rough Order of Magnitude Estimate has a variance of -50% to +50% and is the first estimate completed in the project process.
30. **Answer C.** PMBOK® Guide p. 51-52 – The project manager—in collaboration with the project team—is always responsible for determining what processes are appropriate, as well as the appropriate degree of rigor for any given process.
31. **Answer C.** PMBOK® Guide p. 72 – This point cannot be emphasized enough. Communication is key to managing projects successfully. It is the starting point for all other efforts.
32. **Answer D.** PMBOK® Guide p. 72 – This question goes back to the constant battle between the need for differentiation (or subject matter expertise) and the need for integration (or team members working together). The need for integration is the key reason to focus on communication.
33. **Answer C.** PMBOK® Guide p. 104 – Historical records are not typically used for lessons learned, life cycle costing, or status reports.
34. **Answer D.** A key component of project management is ALWAYS being proactive. In this question only one choice is proactive and that is preventing unnecessary changes.
35. **Answer A.** PMBOK® Guide p. 104 – Lessons learned are reviews of the policies and procedures and are not part of the process itself.
36. **Answer A.** PMBOK® Guide p. 104 – In this case, it would be best to rely on historical information about the results from past projects within the organization. Although stakeholder input might help it also might not be trusted. The only other possible answer is certification training, which taught that these things are situational.
37. **Answer C.** PMBOK® Guide p. 75-77 – The project sponsor is supposed to approve the charter. They are also responsible for approving any changes to that charter.
38. **Answer D.** PMBOK® Guide p. 86 – A true project management plan is made up of plans from each of the knowledge areas except Integration Management.
39. **Answer B.** PMBOK® Guide p. 82-83 – The project manager is responsible for creating the plan with the input from their subject matter experts and the team.
40. **Answer A.** Two key issues are likely to impact this project. This first is communication. This is the same on every project, but here the number of signoffs will make communication even more important. The second is configuration management. Since communication is not one of the choices, configuration management is the best choice.

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41. **Answer B.** PMBOK® Guide p. 156-161 – In the real world, many of these processes are ongoing and overlap. Additionally, not every process is required on every project. It is up to the project manager to decide when these processes are appropriate. In this case, the most commonly combined processes (yes, it is allowed) are to create the WBS and to define the activities—because the activities are often simply extensions of the work packages.
 42. **Answer C.** PMBOK® Guide p. 113 – The project management information system is part of Direct and Manage Project Execution but not Performing Integrated Change Control.
 43. **Answer D.** To be successful, the project manager must actually manage the project. When he or she acts as a simple coordinator the project will most likely fail and the resources will become frustrated.
 44. **Answer B.** Remember that a project manager must always be proactive. This means the PM must get in front of the situation. In this case, the project manager needs to bring alternatives and recommendations to management. The answer that most reflects this concept is showing management the impact of having the less experienced resources assigned to the team.
 45. **Answer A.** The first thing the project manager should do is evaluate the change for impacts against the major constraints.
 46. **Answer D.** The first thing you should do is obtain or complete an evaluation of how the new project will impact your project. Only then can you make an informed choice about what to do next.
 47. **Answer A.** Successful project management has a lot to do with aligning strategy with project management. This is just such a case. The first thing you should do is determine your own management strategy and then move forward.
 48. **Answer B.** This is a clear example of the absence of a change management plan—or at the very least a failure to follow the plan. It should be unnecessary to bring the team together in this case.
 49. **Answer D.** Linear programming is a form of constrained optimization that uses advanced mathematics to evaluate choices.
 50. **Answer A.** The years are irrelevant to this question as the whole point of NPV is to convert the project value into today's dollars. In this case, project A is the correct choice with an NPV of \$120,000 because it has the highest value.
 51. **Answer B.** This is one of the longest questions you might see. Be careful. Much of the information in the question is there to misdirect you. This question takes you back to a core PMism. One of the most common problems is a failure to engage stakeholders early and often enough. This problem is evidenced in the question by the significant scope changes, the remaining issue log items and the fact of having to redo the charter.

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52. **Answer D.** PMBOK® Guide p. 77 – The authorization of a charter comes from a party outside the project team, typically the sponsor, and that party has final authority over any changes to the charter.
53. **Answer A.** PMBOK® Guide p. 52-59 – Although the project manager does have the responsibility to get the team to function as a cohesive unit, that is not their role as an integrator. The role of integrator requires the project manager to put all of the pieces of the project into a cohesive whole.
54. **Answer C.** PMBOK® Guide p. 52-59 – When you lack the personal experience, your first resource should be expert judgment . When that is not available turn to historical information.
55. **Answer B.** PMBOK® Guide p. 7 – Organizational leaders initiate projects in response to factors acting upon their organizations. There are four fundamental categories for these factors:
- ⇒ Meet regulatory, legal, or social requirements;
 - ⇒ Satisfy stakeholder requests or needs;
 - ⇒ Implement or change business or technological strategies and
 - ⇒ Create, improve, or fix products, processes, or services.
56. **Answer A.** PMBOK® Guide p. 19 – In a predictive life cycle, the project scope, time, and cost are determined in the early phases of the life cycle. Any changes to the scope are carefully managed. Predictive life cycles may also be referred to as waterfall life cycles.
57. **Answer C.** PMBOK® Guide p. 19 – Adaptive life cycles are agile, iterative, or incremental with the detailed scope being defined and approved at the start of an iteration?
58. **Answer C.** PMBOK® Guide p. 26 – Work performance data represents the raw observations and measurements identified during activities performed to carry out the project work.
59. **Answer D.** PMBOK® Guide p. 28 – Tailoring is the process of selecting the inputs, tools, techniques, outputs, and life cycle phases used to manage a project.
60. **Answer B.** PMBOK® Guide p. 30 – A needs assessment often precedes the business case.

Scope Management

Overview

Scope management is chapter five in the PMBOK® Guide. For most PMP® exam takers scope is one of the easiest knowledge areas on the exam. But that does not mean you can ignore it! Make sure to take some time to study this section like all the others and watch your test scores. Remember that your goal is to score 90% or better on all exams before you take the real test.

Scope management is the process of defining what work is required and then making sure all that work — and only that work — is done [PMBOK® Guide p.129]. Remembering a few simple concepts will dramatically improve your performance on the exam in this area.

- ⇒ You must always plan your work and then work your plan. No project is ever conducted without a plan.
- ⇒ A work breakdown structure must be created for all projects.
- ⇒ You must involve all the project stakeholders in the gathering of requirements and not just the project sponsor.
- ⇒ You must obtain approval of the project scope before execution ever begins.
- ⇒ Do not ever gold plate the project. Complete only the agreed upon work and nothing else.
- ⇒ Scope changes are allowed so long as they follow the change management process and have been agreed to by the sponsor and/or key stakeholders. As part of following the approved change control process, make sure to analyze any potential changes for the way they will impact time, cost, resource needs, risks, etc.

One of the few areas of confusion when discussing scope is the fact that there are two types of scope involved in the scope management knowledge area. These are:

- ⇒ **Project Scope** — The work that must be performed to deliver a product, service or result with the specified features and functions [PMBOK® Guide 2017 p. 131].
- ⇒ **Product Scope** — The features and functions that characterize a product service or result [PMBOK® Guide 2017 p. 131].

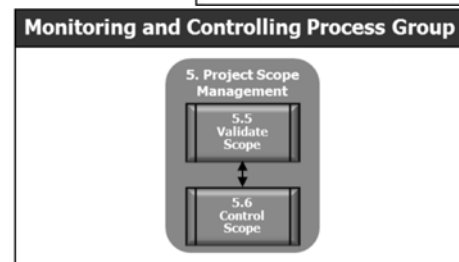
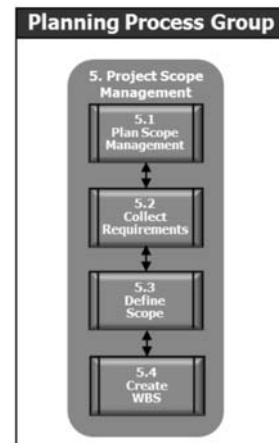


Image 23: The Processes of Scope Mgmt.



Slide 120



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Notice that product scope is all about the characteristics of the product, service or result of the project. Project scope, on the other hand, is concerned with the work that must be completed to deliver that product, service or result. As the project manager, you are responsible for both. An easy way to make a mistake on the exam is by not reading the question carefully and neglecting to notice the type of scope being discussed. Be careful and read each question twice to ensure you do not make this simple mistake.

Another common exam mistake is to assume that you must determine the requirements of the project as part of your project management processes. A requirement is not the same as scope. A requirement is a condition or a capability that must be met or possessed by a system, product, service or component in order to satisfy a contract, standard, specification, or other formally imposed document. Requirements include the quantified, and documented needs, wants, and expectations of the sponsor, customer and other stakeholders. In short, Requirements are *what* the customer needs. Product scope refers to all the requirements that must be met for the specific result to be created. Project scope refers to all the work that must be done to deliver those requirements/product scope.

In the integration management chapter you learned that every one of the knowledge areas produces some type of management plan. Usually they are simply named after the knowledge area. That's the case when dealing with scope. The management plan is the scope management plan. However, unlike integration management and the project management plan, the scope management plan does not have a specific process where the plan is called out as an output. Instead, you must recognize that the scope management plan is one of the many plans produced by the develop project management plan process. As with all the management plans, the scope management plan defines how you will manage that particular area of the project. The scope management plan answers questions such as the following:

- ⇒ How will you determine the product scope for the project? This includes the specific requirements of the product, service, or result.
- ⇒ How will you balance the needs of all your stakeholders?
- ⇒ What tools and techniques will the project team specifically use?
- ⇒ Are there enterprise environmental factors and organizational process assets that must be accounted for or used?
- ⇒ What will the scope change management process be?
- ⇒ How will you measure scope performance and adjust to variances as needed?

In addition to these questions, the PMBOK® Guide outlines a five step process for scope management. You must be familiar with this process and keep the steps in order. The steps are as follows:

- ⇒ Determine the product, service, or result requirements. Make sure all the requirements tie back to the business need described in the charter.



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- ⇒ Balance the needs of the various stakeholders to determine the correct requirements.
- ⇒ Develop a Work Breakdown Structure according to PMI® standards that is focused on being deliverable.
- ⇒ Verify that the scope that has been specified is being accomplished according to the plan.
- ⇒ Measure the project scope performance and adjust it according to the Scope Change Management Plan.

Because there are two different types of scope, there are also two key measure of it. Completion of the project scope is measured against the project management plan. This answers the question did the team do the work they said they would complete. Completion of the product scope is measured against the project requirements.

With the 6th edition of the PMBOK® Guide, PMI® introduces a much stronger focus on non-linear life cycles. When discussing scope management one significant change occurs when implementing an adaptive life cycle. The collect requirements, define scope and create WBS processes get repeated in each iteration. This is different than a linear methodology where these processes are done at the beginning of the project and only updated as necessary. In adaptive or agile life cycles the team also repeats the validate scope and control scope process with each iteration as the major stakeholders provide continuous feedback to the team.

5.1 Plan Scope Management

The first process found in the scope management knowledge area is plan scope management. This was a new knowledge area first included in the 2013 edition of the PMBOK® Guide. It represents the process of defining how the project will be defined, validated and controlled. In short, it creates the roadmap from which scope is managed on a project. The goal of this process is to create two key documents:

- ⇒ **The scope management plan** — This plan describes how the project scope is defined, developed, monitored controlled and verified. The primary components of the Scope Management Plan include the following:
 - ◇ The process for preparing the scope statement.
 - ◇ The process used to create the WBS from the scope statement.
 - ◇ The process use to maintain and approve the WBS.

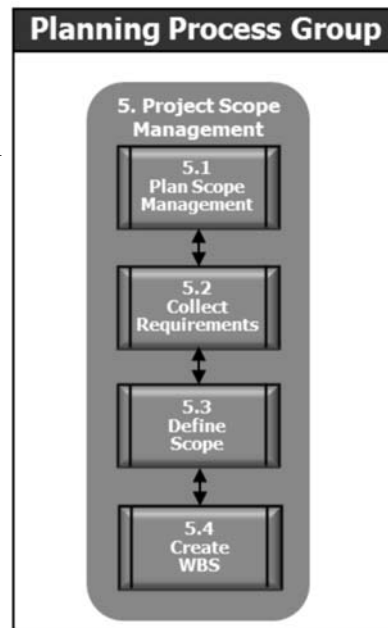


Image 24: 5.1 Plan Scope Management



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- ◇ The process for formally accepting project deliverables
 - ◇ The process for requesting and approving scope change
- ⇒ **The requirements management plan** — This plan describes how the requirements are analyzed, documented, and managed. Common components of the Requirements Management Plan include:
- ◇ How requirements activities will be planned, tracked, and reported
 - ◇ Configuration management activities including the following: initiating product changes, impact analysis, tracing tracking and reporting changes and then required authorization levels for changes
 - ◇ Requirements prioritization process
 - ◇ Product metrics with use justification
 - ◇ Traceability matrix

The inputs to the plan scope management process include:

- ⇒ **.1 Project charter** — The project charter includes a high level description of the product, service or the result of the project. The charter is necessary to complete the requirements collection process.
- ⇒ **.2 The project management plan** — The various sub-plans which make up the project management plan are used with other factors to determine how to manage project scope.
- ⇒ **.3 Enterprise environmental factors** — Items such as culture, infrastructure, personnel administration and marketplace conditions are just examples of factors to consider here.
- ⇒ **.4 Organizational Process Assets** — Any processes, tools, policies, or templates the organization has should be used to benefit the project.

The tools and techniques used in the Plan Scope Management process include the following:

- ⇒ **.1 Expert judgment** — One of the most common traits of great project managers is that they listen and trust their subject matter experts.
- ⇒ **.2 Data analysis** — In analyzing data for project scope it might be important to examine alternatives and use other common sense tools.
- ⇒ **.3 Meetings** — Once the project manager has a trusted team, they must get together to develop the scope management plan.

The two outputs for the plan scope management process have previously discussed and are the scope management plan and the requirements management plan.

5.2 Collect Requirements

The second process found in the scope management knowledge area is the collect requirements process. Requirements can be thought of as what the stakeholders need from both the project and the product, service, or result of the project. The key is to collect the requirements that solve the business problem defined in the



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Project charter. Requirements can also include constraints and assumptions specified by the stakeholders.

Remember that the high-level product, service, or result of the project is defined in the charter. So the collect requirements process is about taking those high level needs and making them detailed and specific. This is not about defining the specific product or service that will meet those needs. There are five inputs to the collect requirements process. These inputs include the following:

- ⇒ **.1 Project charter** — The project charter includes a high level description of the product, service or result of the project. The charter is necessary to complete the requirements collection process.
- ⇒ **.2 Project management plan** — The project management plan includes many other plans providing critical information about how the team intends to manage the project. This is critical to collecting requirements.
- ⇒ **.3 Project documents** — There are a lot of documents not included in the project management plan. To collect requirements you may need to look at all of them.
- ⇒ **.4 Business documents** — This is primarily a signpost for the business case which describes required, desired and optional criteria that meets the business needs.
- ⇒ **.5 Agreements** — The primary type of agreement is a contract that allows the team obtain any externally provided deliverables or contractors necessary to deliver the project. These agreements can contain project and product requirements.
- ⇒ **.6 Enterprise environmental factors** — As always we must take into account what is going on around the organization. Specifically, the team might need to consider the organization's culture, infrastructure, personnel administration, and marketplace conditions.
- ⇒ **.7 Organizational process assets** — Many organizations have processes, tools and techniques that impact the collection of requirements. Most importantly, it is critical that the team examine historical information and lessons learned repository.

Your first large section of tools and techniques comes in the collect requirements process. To get a handle on these items, focus on using common sense. In the real world there are a number of ways you could gather your requirements on a project. In most cases a project manager will not use just one of these techniques, but will

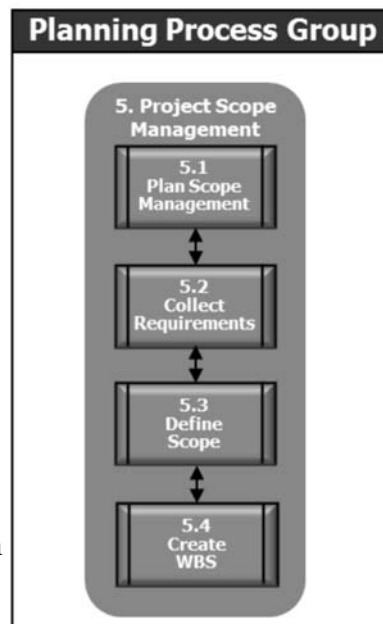


Image 25: 5.2 Collect Requirements



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use several of them to ensure all the requirements are captured. The possible tools and techniques include the following:

- ⇒ **.1 Expert judgement** — Many of the requirements come from your subject matter experts. It is critical that the project leader listens to them.
- ⇒ **.2 Data gathering** — The PMBOK® Guide suggests a number data gathering techniques including:
 - ◇ **Brainstorming** — Brainstorming is a group participation activity where members of a group verbally collect information about a topic typically in a free form fashion. Often, a facilitator acts as a note taker writing ideas on a white board or poster paper. We will talk repeatedly about brainstorming.
 - ◇ **Interviews** — Interviews represent either a formal or informal process of obtaining information from stakeholders by asking both prepared and spontaneous questions of participants, usually in a one-on-one environment. Interviews are important to project leaders because they often allow the discovery of key information unavailable through any other manner.
 - ◇ **Focus groups** — Focus groups are small groups of individuals brought together for the purpose of discussing a specific topic. The focus group is typically led by a trained facilitator who asks pointed questions to its members and leads it through a discussion that is either video taped or watched by others. Focus groups are typically designed to create a more informal discussion amongst a small group about a topic.
 - ◇ **Questionnaires and surveys** — Imagine having an organization with hundreds or thousands of stakeholders. It would be unreasonable to expect the team to speak to all of them. Questionnaires and surveys provide a solution. They represent written sets of questions that can be compiled and responses quantified for more robust analysis.
 - ◇ **Benchmarking** — Benchmarking is tool used to compare best practices, products or services, and practices from both inside and outside the organization. It allows the team to compare themselves against the performance of others.
 - ◇ **Nominal group techniques** — This is similar to brainstorming but it requires the group to vote to establish a prioritized listing of the defined topic items.
 - ◇ **The Delphi technique** — This is a three step survey process that makes use of surveys and subject matter experts. It has three steps:
 1. Survey the selected subject matter experts.
 2. Aggregate their responses.
 3. Feed the aggregated results back to the subject matter experts for agreement.



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Make sure to know the Delphi Technique

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- ⇒ **.3 Data analysis** — In this case, much of the data analysis involves examining documents. The list of documents includes agreements, business plans, business processes, marketing literature, policies and procedures and a lot of others.
- ⇒ **.4 Decision Making** — Groups make decisions using a lot of different techniques. PMI® calls out three specific ways that groups make decisions including voting, autocratic decision making, multicriteria decision analysis.
- ◇ **Voting** — This is exactly what it sounds like. Decisions are made based upon the opinions of a group. There are a number of ways this can be done:
 - ⇒ **Unanimity** — This is where everyone agrees on a course of action.
 - ⇒ **Majority** — This is a process where the majority of members in the group decide direction. Anything over 50% wins.
 - ⇒ **Plurality** — This is used when a simple majority is not possible. In these cases, whichever group has the largest number wins—even though it is not a majority.
 - ◇ **Autocratic decision making**— This is a fancy way of dictatorship. In this method, one person makes the decision for the group.
 - ◇ **Multicriteria decision analysis** — Multicriteria decision analysis represents the process of examining situations where teams are dealing competing decision criteria. Sometimes referred to as MCDA, it was made popular by Stanley Zionts in 1979. It establishes a basic framework for making a decision when the team is looking at important aspects in conflict with each other. A common example is the relationship between cost and quality.
- ⇒ **.5 Data representation** — Data representation addresses the question of how does the team display information. Two examples of data representation include affinity diagrams and mind mapping.
- ◇ **Affinity Diagrams** — Affinity diagrams represent a technique used to sort through a large number of ideas and place them into groups for review and analysis based upon their natural relationships. They were originally created in the 1960s by Jiro Kawakita. Teams use affinity diagrams when they are dealing with a lot of facts that appear in chaos or when the team is deal with issues seem too large or complex to grasp. Affinity diagrams are also a good tool when group consensus is necessary. Affinity diagrams are also known as affinity charts, K-J method or thematic analysis.
- The process for actually doing affinity diagrams is simple. Typically, affinity diagrams are used after a brainstorming exercise or after analyzing verbal. The affinity diagramming process begins with sticky notes and markers. The team begins by writing all their ideas on



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stickies. The stickies are then spread around a table for everyone to see. In the second step, the team silently moves the stickies into groups. It is OK if the items are moved multiple times until everyone agrees with the groupings. The team then discusses the groupings that may lead to some other changes. The team finally comes up with titles for the groups.

- ◇ **Idea/mind mapping** — Mind, or idea mapping is a diagramming technique used to visually organize information, and is considered a type of spider diagram. There are a number of different ways to build mind maps. Typically, these visual tools are hierarchical and show the relationship of a component or idea to the whole. Mind maps were made popular by Tony Buzan who suggested ten guidelines for creating them:

1. Start in the center with an image of the topic, using at least 3 colors.
2. Use images, symbols, codes, and dimensions throughout your mind map.
3. Select key words and print using upper or lower case letters.
4. Each word/image is best alone and sitting on its own line.
5. The lines should be connected, starting from the central image. The lines become thinner as they radiate out from the center.
6. Make the lines the same length as the word/image they support.
7. Use multiple colors throughout the mind map, for visual stimulation and also for encoding or grouping.
8. Develop your own personal style of mind mapping.
9. Use emphasis and show associations in your mind map.
10. Keep the mind map clear by using radial hierarchy or outlines to embrace your branches.

- ⇒ **.6 Interpersonal and team skills** — This primarily refers to brainstorming for which there actually is a defined process. It has four steps:

1. A question or problem is posed to the group and each member silently generates and writes down their ideas.
2. The moderator writes down the ideas on a flip chart until all the ideas are recorded.
3. Each recorded idea is discussed until all group members have a clear understanding.
4. Individual vote privately to prioritize the ideas, using a scale of 1 to 5, with 1 being the lowest and 5 being the highest. After each vote the ballots are counted and the team revote until the highest option is selected.

- ◇ **Observations/conversation** — In this process the project team simply observes stakeholders doing activities that would involve the product, service or result of the project in order to better understand the user community's needs. The team also needs to have conversations with the stakeholders.



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- ◇ **Facilitation** — Perhaps no skill is as important to a project manager than facilitation. It is the ability to get groups of people to have often difficult conversations. There are a lot of tools a good PM can use including agile tools such as user stories, use cases, joint application design/development, or quality function deployment.

⇒ **.7 Context Diagrams** — Context diagrams are a type of scope model. They visually depict the product scope of the project by showing how people interact with a business system. If you are at all familiar with use cases, you will quickly understand context diagrams. However, it is important that you recognize that they are **NOT** the same as they do not show the entire process with actors. A context diagram can be described as the highest level view of a system. It show the interactions between the major components of a system and both its inputs and outputs to and from external systems or actors. A context diagram is a powerful tool especially early in a project because they force the team to think about the overall context of the project solution thereby helping to discover unknown requirements.

True context diagrams are made up of boxes and lines. At the center of the diagram is a labeled box representing the system. This is often referred to as the process and is usually shown as a rounded rectangle designed to show the process at the highest level. It is important to note that this process **MUST** react in a preplanned way where data is transformed, stored or distributed. Around this central box are multiple boxes for each external actor. These are represented by traditional rectangles. An external actor or entity either triggers the process or receives the output from the process. Finally, connecting the two types of boxes are lines that define the relationship. These are thought of as data flows. The two most common ways of displaying context diagrams are using the Gane-Sarson or Yourdon-De Marco symbol sets.

It is important to remember that context diagrams are high level tools so they do not include detailed information about alternatives or anything not part of the main function. They also never show workflows or actors who initiate data flows.

⇒ **.8 Prototypes** — Prototypes are used in many different methodologies. When prototyping the team develops individual components of functionality (or a small version of the final product) in order to prove capability or understand functionality. Storyboarding is a prototyping technique commonly used in agile development.

The outputs from the collect requirements process include the following:

⇒ **.1 Requirements documentation** — There can be many different forms of requirements documentation. PMI® does not specify what form a project manager must use. Instead, the PMBOK® Guide simply states, “requirements documentation describes how individual requirements meet the business need for the project.” It is fully expected that these requirements will start out being generic and get refined as the project progresses. However, before the project can be baselined, the requirements must be unambiguous, traceable, complete, consistent, and acceptable to all key stakeholders.

- ⇒ **.2 Requirements traceability matrix** — The requirements traceability matrix is a table that lists requirements and their origins and then traces them through the project lifecycle.

5.3 Define Scope

Once the requirements have been defined, the project is ready to move into the next scope management process, which is the define scope process. This process is all about taking the detailed requirements defined in the collect requirements process and developing a detailed description of the product or service that will meet those needs. If you put the three big pieces together it makes sense. The charter defined the business need and requirements at a high level. The collect requirements process took those high level ideas and added all the details. The define scope process then answers the question what specific product meets those needs.

The inputs to the define scope process include the following:

- ⇒ **.1 Project charter** — The charter represents the foundation of the project so it is a critical input to these early processes. Hopefully the number of times you have seen the project charter has highlighted the absolute importance of this document. Every project should have a charter.
- ⇒ **.2 Project management plan** — The Scope Management Plan defines the process used to develop the project scope.
- ⇒ **.3 Project documents** — From the large list of potential project documents PMI® asks that you look at the assumption log, requirements documentation, risk register.
- ⇒ **.4 Enterprise environmental factors** — No matter what you do enterprise environmental factors are at play.
- ⇒ **.5 Organizational process assets** — Any processes, tools, policies, or templates the organization has should be used to benefit the project.

Once the inputs for the define scope process are obtained, it is time to move on to the tools and techniques. The tools and techniques for the define scope process include the following:

- ⇒ **.1 Expert judgment** — As with almost every process, expert judgment is a key tool to be used. Trusting your subject matter experts is important for project success.
- ⇒ **.2 Data analysis** — It is key that the project team and major stakeholders

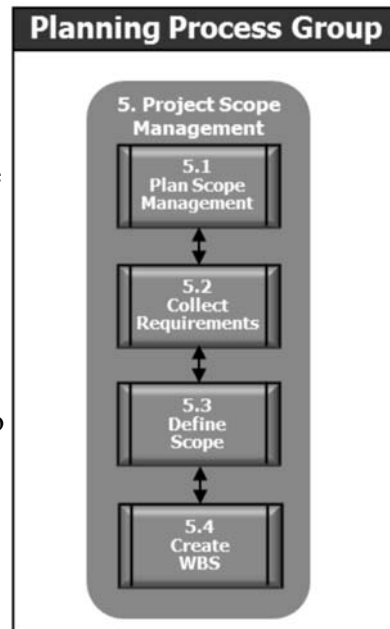


Image 26: 5.3 Define Scope



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clearly understand the desired product. This often requires a careful examination or analysis of the end product and the examine potential alternatives.

- ⇒ **.3 Decision making** — There are a lot of different ways the team can make decisions. One of the ways is to use multicriteria decision analysis.
- ⇒ **.4 Interpersonal and team skills** — A great leader knows they have to use interpersonal and team skills.
- ⇒ **.5 Product analysis** — To successfully complete the project team must understand the product or service of the project. Doing product analysis might use techniques such as systems analysis, systems engineering, value analysis, and value engineering.

The outputs to the define scope process include the following:

- ⇒ **.1 Project scope statement** — The project scope statement describes the project’s deliverables and the work required to create those deliverables in detail. This statement is critical. It creates a common reference point for stakeholders and is often used to manage stakeholder expectations. A scope statement includes the product scope description, product acceptance criteria, project deliverables, project exclusions, and project constraints. Many students confuse a project charter and a project scope statement. Both documents are important, but they are different. The next page offers a comparison of the two documents. Make sure you understand the differences.

Project Charter	Project Scope Statement
Project purpose	Project scope description (progressively elaborated)
Measurable project objectives and related success criteria	Project deliverables
High-level requirements	Acceptance criteria
High-level project description, boundaries, and key deliverables	Project exclusions
Overall project risk	
Summary milestone schedule	
Preapproved financial resources	
Key stakeholder list	
Project approval requirements (i.e., what constitutes success, who decides the project is successful, who signs off on the project)	
Project exit criteria (i.e., what are the conditions to be met in order to close or to cancel the project or phase).	
Assigned project manager, responsibility, and authority level.	
Name and authority of the sponsor or other person(s) authorizing the project charter	

Image 27: The Charter vs. Scope Statement



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A project charter initiates the project. It defines the project success, empowers the project leader, defines any constraints and assumptions and prioritizes the project. The scope statement gives description of the project scope and names the project deliverables along with the things the team will not deliver.

- ⇒ **.2 Project document updates** — As with most of the 49 defined processes, the define scope process can cause updates to the documents outside the project plan. However, it should not cause alterations to the project management plan itself.

5.4 Create WBS

The work breakdown structure, or WBS is one of the most important and most under utilized documents in the project management world. Much of the under utilization stems from a lack of understanding of exactly what a WBS is and how it should be used. A WBS is a deliverable-oriented, hierarchical decomposition of the work to be executed by the project team. It enables them to accomplish the project objectives and create the required product, service, or result. This is a fancy way of saying that the WBS is a picture that resembles an organization chart, but for deliverables. Although it has absolutely nothing to do with resources, it does have boxes organized into a tree like an organization chart. Each box is a deliverable. Being deliverable-focused is a very important aspect of a well formed WBS. It is not supposed to be a listing of the tasks or activities that are to be accomplished.

In the real world, project managers work very hard to avoid creating a WBS based upon project phases.

However, when taking the exam you should remember that such time-based structures are not technically wrong. If you have spent any time in project management you already know a number of documents that help you understand when work is to be done. It wouldn't make any sense to simply have another time-based tool!

When preparing for the exam, it is critical that you spend a significant amount of time studying work breakdown structures. They are very important to PMI®. You must understand the WBS and how to use it. Let's begin with a number of key terms for a WBS:

- ⇒ **Work packages** — Each individual box in the WBS structure is a unique deliverable or work package. The two terms are synonymous.
- ⇒ **Decomposition** — Decomposition is the process of breaking deliverables down into smaller and smaller deliverables until they can be easily understood and managed. It is the process used to create the WBS.

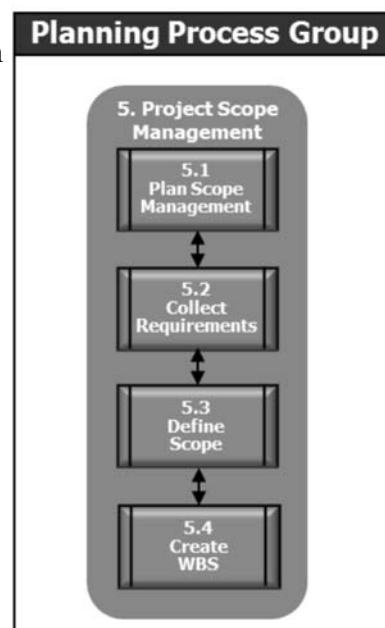


Image 28: 5.4 Create WBS



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- ⇒ **Progressive elaboration** — Progressive elaboration adds the element of time to the WBS. It simply means that the WBS is not something that is created at the beginning of a project and then set aside. The WBS is constantly maintained and more detail is added as it is discovered.
- ⇒ **Placeholder work packages** — In some cases, it is not reasonable to have all the details when creating the initial WBS. The team knows the name of the deliverable, but has no idea what it really means. In those cases it makes sense to place a box with the title of the work package in the WBS and then come back to it when more information is reasonably available.
- ⇒ **Control account** — The control account is a management control point where scope, budget, actual costs, and schedule are integrated and compared to Earned Value for performance measurement [PMBOK® Guide 6th ed. p.161]. In simplest terms, it's the level of the WBS where you measure.
- ⇒ **Planning package** — A planning package is a WBS component below the control account and above the work package with known work content but without detailed activities.
- ⇒ **Feature breakdown structure** — A diagram very similar to a well formed WBS, but focused on project features or deliverables without listing tasks.

A well formed WBS is made up of three elements:

- ⇒ **The WBS** — The Work Breakdown Structure is the picture of the project that is made up of the individual deliverables and resembles an organization chart. *Images 26* on the following page shows a sample WBS.
- ⇒ **The WBS Dictionary** — If the only thing that made up a WBS was the structure itself, it would not be very useful because the boxes simply do not contain much information. That's where the WBS Dictionary comes in. The WBS Dictionary is where you find a detailed description of each work package.
- ⇒ **The code of accounts** — The code of accounts is a numbering system that creates a unique ID for each work package. The most common form that the code of accounts takes is simple numbers that are separated by a period as the work packages are subdivided into smaller pieces. *Image 29* shows a sample WBS with a code of accounts.

The inputs to the create WBS process include the following:

- ⇒ **.1 Project management plan** — The project management plan gives the team a lot of information about the project.
- ⇒ **.2 Project documents** — The project scope statement is the primary output of the last step. It describes the product or service being created in detail. This is necessary to create the WBS, which is a visual representation of the same thing. Requirements documentation is also included as an input to the WBS.
- ⇒ **.3 Enterprise environmental factors** — Industry specific standards specific to the nature of the project may be used to determine the enterprise environmental factors.



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Any time the WBS is used so is the WBS Dictionary.



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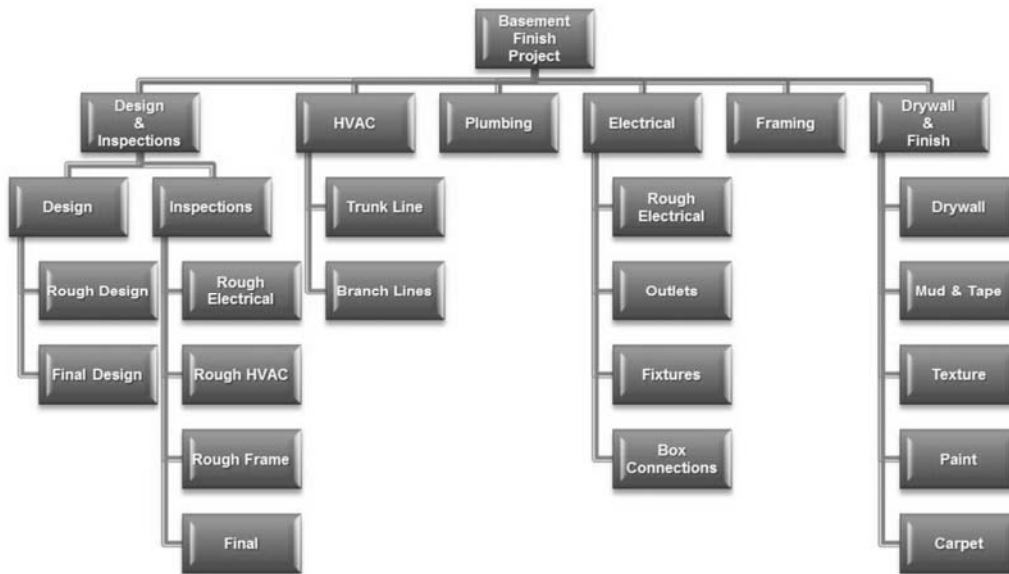


Image 29: A Sample WBS

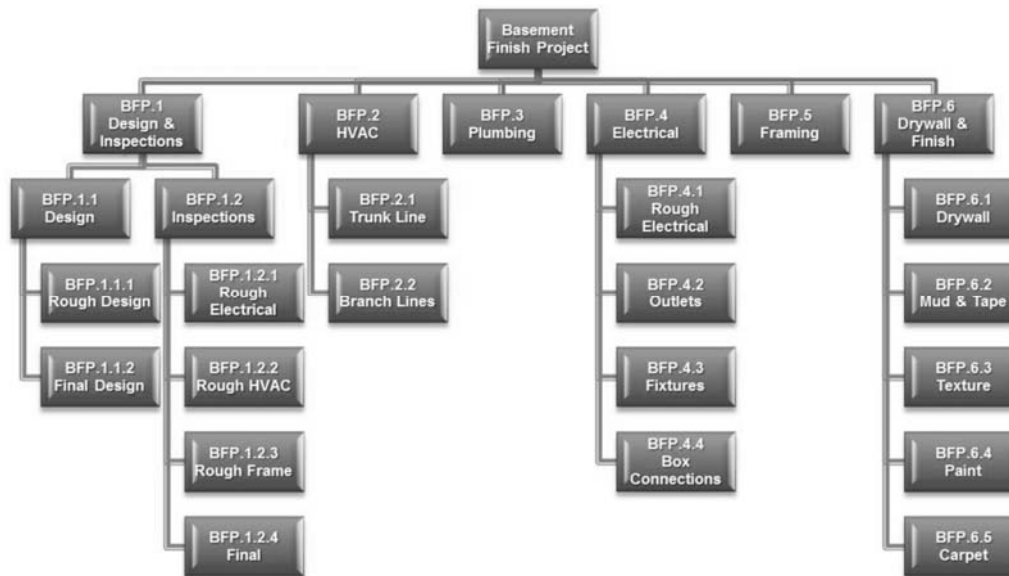


Image 30: A Sample WBS with the code of accounts



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⇒ **.4 Organizational process assets** — Although enterprise environmental factors are not listed, you might have organizational process assets such as WBS templates.

The two tools and techniques used in the create WBS process are old friends. They are decomposition and expert judgment. Remember, decomposition represents the process of breaking larger items into smaller more manageable ones.

There are two outputs to this process:

- ⇒ **.1 Scope baseline** — As soon as the WBS and WBS Dictionary are complete the project has its scope baseline. From this point forward the project will be reporting on what was originally promised in terms of scope, versus what was really produced.
- ⇒ **.2 Project documents updates** — The information collected in the steps taken to generate the WBS may necessitate updates to some of the non-plan project documents.

To understand the process of decomposition that is used to Create the WBS Process, you must know the four questions that allow the user to determine if they have broken the structure down far enough. These questions are as follows:

- ⇒ Can you accurately estimate the resources required to do the work?
- ⇒ Can you accurately estimate the time it will take those resources to complete the deliverables?
- ⇒ If you had to assign the deliverable to someone else are you confident they would know what to do?
- ⇒ If you complete the deliverables listed in the WBS — and only those deliverables — will you successfully complete the project?

5.5 Validate Scope

Once the WBS has been created it is time to validate scope. This process moves us out of the planning process group and into the monitoring and controlling process group. Validate scope is the process where the project manager and the team review the completed deliverables with the sponsor and key stakeholders in order to ensure they have been completed satisfactorily.

Validating scope requires holding regular meetings — that are part of the plan — with the major stakeholders and sponsor in order to gain formal acceptance of the deliverables. This process is not the same as control quality. In the control quality process the project manager and team are concerned with the correctness of the deliverables. In the validate scope process the only concern is if the deliverable was accepted. But this is not the acceptance of the final product, service or result of the project. It is only the acceptance of the particular deliverables. The inputs to the validate scope process include the following:

- ⇒ **.1 Project management plan** — Three specific parts of the project management plan are important here. They include the project scope statement, the WBS and the WBS dictionary. A good rule of thumb to remember for the exam is that any time the WBS is used the WBS dictionary is used as well. It also includes the scope baseline.

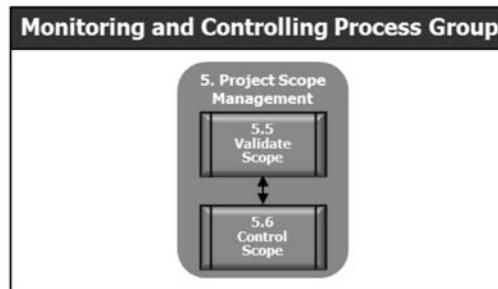


Image 31: 5.5 Validate Scope



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- ⇒ **.2 Project documents** — The project documents specific to validating the scope include lessons learned register, quality reports, requirements documentation, and the requirements traceability matrix provides information about the requirements and their origin.
- ⇒ **.3 Verified deliverables** — Verified deliverables are complete and have gone through the quality control process to ensure correctness.
- ⇒ **.4 Work performance data** — The work performance data might include items such as the degree of compliance with requirements, the number of non-conformities, the severity of non-conformities, etc.

There are only two tools and techniques for the validate scope process: inspection and group decision-making. Inspection is the process of examining the deliverables to ensure that they meet the acceptance criteria. Terms such as reviews, product reviews, audits and walkthroughs are often used as forms of inspection. Group decision-making techniques are methods by which the team makes a decision collectively.

There are four outputs to the validate scope process:

- ⇒ **.1 Accepted deliverables** — This is the single most important output in this process. The verify scope process is about reviewing the completed deliverables and ensuring that the stakeholders approve them. The formal acknowledgment that the deliverables have been accepted is then forwarded to the close project or phase process.
- ⇒ **.2 Work performance information** — This includes all information about the project's progress, such as which items have started or finished or regular updates on status. These might require sponsor sign-off.
- ⇒ **.3 Change requests** — Like many of the processes, when you verify scope it can generate requests to change something in the project. It is common that the verify scope process can cause deliverables to be rejected. The change request can come from those rejections, such as happens with defect repairs.
- ⇒ **.4 Project document updates** — The verify scope process can cause many of the documents outside the project plan to be updated. It is critical to consider lessons learned register, requirements documentation, and requirements traceability matrix.

For the exam, be careful to not confuse the validate scope process with the control quality or the close project or phase processes.

5.6 Control Scope

The final process in the scope management knowledge area is the control scope process. This is the process where the project manager monitors the status of both the project and the product scope in order to manage changes to the scope baseline. A big part of this process is ensuring that all the requested changes and the recommended corrective and preventive actions go through the perform integrated change control process.



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There are four inputs to the control scope process:

- ⇒ **.1 Project management plan** — The control scope process is all about managing scope change. Therefore you have to be able to follow some process to measure impacts of the changes. The project management plan provides those processes. It specifically calls for the scope management plan, requirements management plan, the change management plan, configuration management plan, the scope baseline, performance measurement baseline.
- ⇒ **.2 Project documents** — In case you didn't have enough information, you also look at the lessons learned register, requirements documentation, and the requirements traceability matrix that tells everyone the origins of all the requirements.
- ⇒ **.3 Work performance data** — As part of the work performance data the team must also look at the number of change requests received, the number of requests accepted, and the number of deliverables verified, validated, and completed.
- ⇒ **.4 Organizational process assets** — In the Control Scope Process, the organizational process assets include things like formal and informal policies, procedures and guidelines that relate to scope control as well as any monitoring and controlling processes that exist.

Within the control scope process there is only one tool and technique. That tool and technique is **data analysis**. Data analysis includes both variance analysis and trend analysis. Variance analysis is the process of comparing actual results with the expected outcomes, and measuring the differences. As part of this process it is critical that the project manager determines the cause of the variances and the degree of variance from the baseline. Trend analysis is a process of determining where the variable is moving over time. It is used as a forecasting tool.

The data analysis done within the control scope process produces five outputs:

- ⇒ **.1 Work performance information** — The work performance information include both planned vs. actual technical performance and other scope performance measurements and information.
- ⇒ **.2 Change requests** — As the scope performance is analyzed and variances to the baseline are discovered, change requests (such as preventive or corrective action) may be required.
- ⇒ **.3 Project management plan updates** — Scope control can often cause required updates to the scope baseline—or to any of the other baselines— as changes are affected.

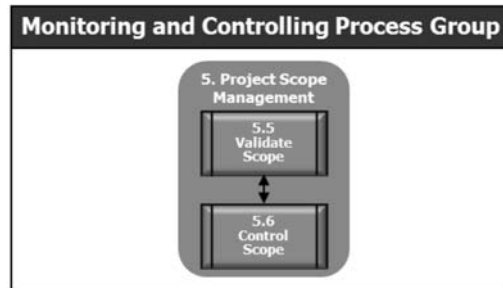


Image 32: 5.6 Control Scope



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- ⇒ **.4 Project documents updates** — As baselines change other documents can require change as well.

Scope Management Summary

The key to the scope control process is remembering that it is a very proactive process. Sometimes this means determining the root cause of change in order to prevent future issues. Remember that the project manager does not function simply as an intermediary who processes change requests. Your job is to control the project so that you can meet all the baselines. To succeed, you must control the project scope!

To be successful on the PMP® exam you must remember the following:

- ⇒ The six processes defined in the PMBOK® Guide — and in which process group they each reside.
- ⇒ The difference between project and product scope.
- ⇒ That both project and product scope are revised throughout project.
- ⇒ The WBS is critical. You must understand it completely. You must understand why it is important and that it is used in many other processes. Also, remember that the WBS is deliverable based.



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Exercise 6 — Scope Management



Exercise 6 — Scope Management

1. In which of the following processes would you expect to create a requirements documentation?
 - A. Define scope
 - B. Plan scope management
 - C. Manage scope
 - D. Collect requirements
2. In which of the following processes would you expect to develop the Scope Statement?
 - A. Define scope
 - B. Collect requirements
 - C. Verify scope
 - D. Create WBS
3. In which of the following processes would you expect to subdivide the major project deliverables and project work into smaller components?
 - A. Define scope
 - B. Collect requirements
 - C. Create WBS
 - D. Validate scope
4. In which of the following processes would you expect to formalize the acceptance of the completed project deliverables?
 - A. Scope sign-off
 - B. Validate scope
 - C. Scope control
 - D. Create WBS
5. In which of the following project processes would you expect to manage changes to the project's scope?
 - A. Control scope
 - B. Scope change control
 - C. Collect requirements
 - D. Validate scope
6. Which of the following defines the features and functions that characterize a product, service or result?
 - A. Project scope
 - B. Project requirements
 - C. Product scope
 - D. Scope definition

-
7. Which of the following defines the work that needs to be accomplished to deliver a product, service or result?
 - A. Project scope
 - B. Product scope
 - C. Project requirements
 - D. Scope definition
 8. When is the scope management plan created?
 - A. During the collection of requirements
 - B. During the definition of project scope
 - C. In the verification of scope
 - D. During the plan scope management process
 9. Completion of the project scope is measured against all of the following except:
 - A. The product requirements
 - B. The project management plan
 - C. The scope statement
 - D. The WBS and the WBS dictionary
 10. All of the following are inputs to the define scope process except:
 - A. Project charter
 - B. WBS dictionary
 - C. Project documents
 - D. Organizational process assets
 11. All of the following are tools and techniques used in the define scope process except:
 - A. Expert judgment
 - B. Facilitation
 - C. Data analysis
 - D. Decomposition
 12. All of the following are inputs to the define scope process except:
 - A. Project scope statement
 - B. Project charter
 - C. Requirements documentation
 - D. Organizational process assets
 13. All of the following are tools and techniques for the define scope process except:
 - A. Alternatives analysis
 - B. Data gathering
 - C. Multicriteria decision analysis
 - D. Product analysis

-
14. All of the following statements concerning the project scope management plan are true except:
- A. The project scope management plan defines the project scope.
 - B. Process that enables the creation of the WBS from the detailed project scope statement.
 - C. Process that establishes how the scope baseline will be approved and maintained.
 - D. Process that specifies how formal acceptance of the completed project deliverables will be obtained.
15. The project scope statement includes all of the following except:
- A. Acceptance criteria
 - B. Requirements
 - C. Deliverables
 - D. Project exclusions
16. All of the following statements are true about decomposition except:
- A. Decomposition rarely is done too much or in too much detail.
 - B. Decomposition is the subdividing of project deliverables into smaller, more manageable components.
 - C. Decomposition may not be possible for a deliverable or subproject that is to be done far in the future.
 - D. Different deliverables can have different levels of decomposition.
17. All of the following are activities involved in the process of decomposition except:
- A. Identifying the deliverables and related work.
 - B. Ensuring that each work package has the appropriate activities assigned to it.
 - C. Developing and assigning identification codes to WBS components.
 - D. Structuring and organizing the WBS.
18. You walk into your office on Monday morning to find an approved change request sitting on your desk that impacts the project scope. This is best defined as which of the following:
- A. Any modification to the agreed upon project scope baseline including the scope statement, the WBS or the WBS dictionary
 - B. Any change to a technical requirement
 - C. Any change to the project management processes
 - D. Any change to project staffing
19. The project scope change control system includes all of the following except:
- A. Necessary documentation
 - B. An assessment process
 - C. Required approval levels
 - D. A tracking and monitoring system

-
20. Which of the following is NOT an example of a constraint?
- A. Your project sponsor setting budget limits
 - B. Union rules
 - C. Specific regulations governing project activities
 - D. Earned value performance measures
21. A code of accounts allows project staff to do each of the following except:
- A. Link work packages with general ledger codes
 - B. Track work package costs
 - C. Estimate the costs of WBS elements
 - D. Identify the level at which the work package is found
22. Creating the single picture of the project found in the WBS is a powerful tool for what kind of communication?
- A. Stakeholder
 - B. Informal written
 - C. Formal written
 - D. Customer
23. At your normal end of week status meeting, one of your resources states that they are not sure how the parts of the project fit together. Which of the following documents would best be explain this?
- A. Activity list
 - B. WBS dictionary
 - C. The project scope management plan
 - D. The project assignment matrix
24. You have been tasked as the project manager for a new, very high profile project within your organization. Your project has gotten to the develop project management plan process and you are struggling to make the plan realistic and not just reflect the desires of certain players in the organization. Which of the following is most likely to be effective at achieving this objective?
- A. Create the plan yourself with input from the project sponsor
 - B. Ask the project sponsor to create the plan with your input
 - C. Create the plan yourself with input from the project team
 - D. Create the plan yourself with input from key stakeholders
25. During your weekly status meeting, one of your technical experts suggest adding additional functionality to the project that they believe would greatly benefit the customer. You promptly document the input and take the suggestion for approval. This is an example of what?
- A. Quality control
 - B. Scope management
 - C. Decomposition
 - D. Progressive elaboration

-
26. When should the validate scope process be done on a project?
- A. Only during the scope validation process
 - B. At the end of the project
 - C. At the end of each phase of the project
 - D. At the beginning of the project
27. You are the project manager on a major project within your organization. You think you have done pretty well. The project had a budget of several million dollars, a CPI of .94 and SPI of .92. The major stakeholders have signed off on the scope validation process at the end of each phase. All issues have been resolved and a majority of your resources have already been released to other projects. Then, one of your primary stakeholders approaches you and wants to make a dramatic change to the project scope. What should you do?
- A. Meet with your remaining team to see if the change is possible.
 - B. Inform your sponsor.
 - C. Ask the stakeholder to describe the change.
 - D. Tell the stakeholder that they need to use the change management process.
28. You are a project manager working for a consulting agency. During a meeting with your customer they inform you that they do not want to pay for the time it will take for you to create a WBS. What is the best thing you can tell the customer?
- A. Tell them you can agree to not charge for the WBS creation time
 - B. Tell them the WBS is very important as it helps prevent work from slipping through the cracks
 - C. Tell them it is required by their contract
 - D. Tell them you will cancel the contract without it
29. You are a senior program manager within your organization. One of your project managers approaches you and wants to talk about the WBS that you asked them to create. They ask why is it so important that they create a WBS. Your best response is which of the following?
- A. It creates a complete picture of the project
 - B. It provides a list of project risks
 - C. It produces a list of project activities
 - D. It helps ensure team commitment
30. As a project manager you are asked to provide some form of documentation to make sure your team clearly knows what the work is in each work package. Which of the following do you provide?
- A. The product scope statement
 - B. The preliminary scope statement
 - C. The WBS dictionary
 - D. The scope management plan

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31. You have just been given the assignment to be the project manager on a very high profile, high value project within your organization. As you leave your boss's office, they hand you the completed Project Charter and Scope Statement. The first thing you should do is what?
- A. Begin work on the project management plan
 - B. Ensure the key stakeholders agree with the project charter
 - C. Create a WBS
 - D. Define the project scope statement
32. You are the project manager for a very important public works project in your community. The project is nearing completion and will enter the final phase in the next week. What should you be focused on most before moving on to the final phase?
- A. Project safety
 - B. Validating the scope
 - C. Losing project resource to other projects
 - D. Variance analysis
33. You are the project manager for a software development project that is using the SDLC and are about to begin integration testing. With what should you be primarily concerned?
- A. Project testing procedures
 - B. Project resources multi-tasking
 - C. Validating the scope
 - D. Variance analysis
34. You are the project manager for a project that is entering the Closing Process Group. As you attempt to close the project your sponsor informs you that they have been approached by several stakeholders who are not happy with the project deliverables. Which of the following processes could have prevented this problem?
- A. Validating scope
 - B. Define scope
 - C. Scope monitoring
 - D. Integrated change control
35. All of the following are part of the scope baseline except:
- A. Project scope management plan
 - B. The WBS
 - C. The project scope statement
 - D. The WBS dictionary

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36. You are the project coordinator for a small project within your organization. One of the primary stakeholders approaches you with a properly completed scope change request form. What should you do next?
- A. Ask the stakeholder to justify the change request
 - B. Complete integrated change control
 - C. Determine how the request was missed during the initial scope definition
 - D. None of the above
37. During which part of the project management process is the project scope statement created?
- A. Prior to beginning the project
 - B. Initiating
 - C. Planning
 - D. Monitoring and controlling
38. Halfway through a project that has a SPI of 0.89 and an CPI of 0.93 the project manager is approached by a senior stakeholder requesting a minor addition to scope. The project sponsor already rejected the same request prior to the approval of the performance management baseline. What is the best thing for the project manager to do?
- A. Tell the stakeholder the scope cannot be added
 - B. Determine the root cause of the request
 - C. Evaluate the impact of adding the scope
 - D. Let the sponsor know of the stakeholders' request
39. When should the Validating Scope Process be done?
- A. At the beginning of the project
 - B. At the end of the project
 - C. Throughout the project
 - D. At the end of each project phase
40. You have just started a job as a project manager for a large manufacturing company. On your first day you are given the completed and signed charter for a new project. What is the first thing you should do?
- A. Begin developing the project management plan
 - B. Create the project scope statement
 - C. Begin creating the WBS
 - D. Confirm all stakeholders had input into the scope

-
41. You are the project manager for a multi-year project and are approximately 80% through the project. You are on schedule and budget, but your sponsor is not happy with the deliverables produced. Which of the following processes could have best prevented this problem?
- A. Define scope
 - B. Control scope
 - C. Close project or phase
 - D. Monitor and control risks
42. You are leading a large multinational manufacturing project. During the process of collecting the percent complete of project work for your monthly status reports, one of your resources asks, “percent complete of what?” You have had issues with this resource on other projects in the past. Instead of reporting the resource to his boss, you attempt to work through the issue with him. Which of the following is most likely the real issue?
- A. You do not have an issue with the resource’s boss
 - B. You should have taken the issue to the resource’s manager some time ago
 - C. The project lacks an adequate rewards system
 - D. You failed to assign work packages
43. You are currently leading a project which has an SPI of 1.06 and a ETC of \$276,500. The BCR of the project is 1.45 and you are more than 70% through the project. Requirements have consistently been changing over the last several weeks no matter what you have tried. Which of the following are you most likely to face in the future?
- A. Not being able to measure completion of the product of the project
 - B. Needing to make sure the customer approves project scope
 - C. Needing to add resources to complete the project
 - D. Needing to cut costs to successfully complete the project

Exercise 6 — Scope Management Answers

1. **Answer D.** PMBOK® Guide p. 147 – Collect requirements, like all the initial processes for the 10 PMBOK® Guide knowledge areas, is where you define how you will be managing your efforts. It is where the plan or roadmap is created.
2. **Answer A.** PMBOK® Guide p. 154 – Define scope is the process where you develop a detailed project scope statement that will be used as a basis for future project decisions.
3. **Answer C.** PMBOK® Guide p. 156 – In the create WBS process you break down the major deliverables into smaller, more manageable components. This process is called decomposition and uses a process called progressive elaboration (getting more detail over time).
4. **Answer B.** PMBOK® Guide p. 163-164 – Validate scope is the process where the acceptance of the completed project deliverables is formalized. This is where you obtain approval from your major stakeholders that confirms that you have correctly delivered the right work packages.
5. **Answer A.** PMBOK® Guide p. 167-168 – Control scope is the process used to control changes to the project's scope.
6. **Answer C.** PMBOK® Guide p. 131 – Product scope is one of two types of scope with which arise in projects. Product scope deals with the features and functions that characterize a product, service or result.
7. **Answer A.** PMBOK® Guide p. 131 – Project scope is one of the two types of scope with which arise in projects. Project scope deals with the work that needs to be accomplished to deliver the product or service of the project.
8. **Answer D.** PMBOK® Guide p. 134 – The scope management plan is created during the plan scope management process.
9. **Answer A.** PMBOK® Guide p. 163-165 – Completion of the project scope is measured against the project management plan, the project scope statement, the WBS and the WBS dictionary. The product scope, on the other hand, is measured against the product requirements.
10. **Answer B.** PMBOK® Guide p. 150 – The inputs for the define scope process includes the project charter, the project management plan, project documents, enterprise environmental factors, and organizational process assets.
11. **Answer D.** PMBOK® Guide p. 154-156 – The tools and techniques used in the define scope process include expert judgment, data analysis, decision making, interpersonal and team skills, and product analysis.
12. **Answer A.** PMBOK® Guide p. 152 – The inputs to the define scope process include project charter, project management plan (includes scope management plan), project documents (assumption log, requirements documentation, risk register), enterprise environmental factors, and organizational process assets.

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13. **Answer B.** PMBOK® Guide p. 150 – The tools and techniques used in the define scope process includes expert judgment, data analysis (alternatives analysis) decision making (multicriteria decision making), interpersonal and team skills and product analysis.
 14. **Answer A.** PMBOK® Guide p. 137 – The scope management plan may be formal or informal. The project scope statement defines the project scope.
 15. **Answer B.** PMBOK® Guide p. 154 – The project scope statement describes the project’s deliverables and the work required to complete those deliverables. It includes, either directly or by reference to other documents: the project objectives, the product scope description, the project boundaries, the project deliverables, the product acceptance criteria, the project constraints, the project assumptions, the initial project organization, any initially defined risks, any schedule milestones, any funding limitations, a cost estimate, the project configuration management requirements, the project specifications, and any approval requirements.
 16. **Answer A.** PMBOK® Guide p.158 – In the decomposition process, beware of the desire to break down the deliverables until they are too small or the team spends too much time on the process. This requires the project manager to maintain a careful balance between too little and too much WBS detail.
 17. **Answer B.** PMBOK® Guide p. 158-161 – Decomposition of the total project work generally involves the following activities: identifying the deliverables and related work, structuring and organizing the WBS, decomposing the upper WBS levels into lower level detailed components. Developing and assigning identification codes to the WBS components, and verifying that the degree of decomposition of the work is necessary and sufficient.
 18. **Answer A.** PMBOK® Guide – When dealing with project scope, an approved change request is any change or modification to the agreed upon project scope that includes the project scope baseline, the project scope statement, the WBS or the WBS Dictionary.
 19. **Answer B.** PMBOK® Guide p. 137 – A project scope change control system—as documented in the project scope management plan—defines the procedures by which the project scope and the product scope can be changed. It includes the documentation, tracking systems, and approval levels necessary for authorizing changes.
 20. **Answer D.** PMBOK® Guide – Constraints are things that specifically limit your options. They are usually outside the project team’s control, and can dictate specific actions that must be performed. Additionally, earned value isn’t a constraint but a performance measurement technique.

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21. **Answer C.** PMBOK® Guide p. 158-161 – The code of accounts is the formal name for the numbering system found in the WBS. It serves two primary functions: First, it allows the project manager to link the work packages to specific accounting codes used for tracking project costs, thereby enabling work package costing. Second, it allows the project manager to identify the level at which the work package is found.
 22. **Answer A.** PMBOK® Guide p. 156-157 – The WBS is one of the most powerful communication tools available to the project manager. It should be used with every stakeholder to envision what the project is all about.
 23. **Answer B.** PMBOK® Guide p. 160-161 – The detailed content of the components contained in a WBS, including work packages, their complete descriptions and control accounts is called the WBS dictionary. It is the best tool for seeing how the project fits together.
 24. **Answer C.** This is a complicated way of asking who creates the Project Management Plan. The answer is always the project manager with input from the project team. Input from the project team is necessary to ensure their commitment to the objectives.
 25. **Answer B.** PMBOK® Guide p. 129 – Project scope management is primarily concerned with defining and controlling what is and is not included in the project. You might debate whether or not the project manager was doing the right thing, but that is not what this question asked. This is an example of scope management.
 26. **Answer C.** PMBOK® Guide p. 129 – Validate scope is the process of obtaining the stakeholders' formal acceptance of the completed project scope and associated deliverables, e.g. making sure all deliverables have been completed satisfactorily. This should be done at the end of each phase of the project.
 27. **Answer C.** This is an example of a PMIism. According to PMI®, your first responsibility is to listen to the stakeholder without committing to anything before you choose a course of action. Only when you understand the desired change can you select the correct path.
 28. **Answer B.** PMBOK® Guide p. 156-162 – This is another example of a PMIism. In this case it is important to remember that PMI views the WBS as very important to the project's success because it helps identify all the deliverables of the project. Therefore we always do them. Furthermore, you do not have enough information in the question to accept the other answers.
 29. **Answer D.** PMBOK® Guide p. 156-162 – For many students this is a tough question because several of the answers are in fact true. But remember that the question was asking for the best response. D is correct because the WBS helps ensure team commitment.

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30. **Answer C.** PMBOK® Guide p. 156-162 – The WBS dictionary provides the detailed description of each of the project work packages and is therefore the best thing to provide in this situation.
31. **Answer A.** PMBOK® Guide p. 82-83 – This is the kind of question where you must simply remember the order of the steps to get the proper answer. After the Charter and Scope Statement have been created your next step is to develop the Project Management Plan.
32. **Answer B.** PMBOK® Guide p. 163-164 – Validating the scope is done at the end of each project phase to ensure that the project deliverables meet with the customers' satisfaction. It is done at the end of each phase before going to the next.
33. **Answer C.** PMBOK® Guide p. 163-164 – Validating the scope is done at the end of each project phase to ensure the project deliverables meet with the customers' satisfaction. It is done at the end of each phase before going to the next.
34. **Answer B.** PMBOK® Guide p. 150-152 – Three of the answers to this question are easy to discount. Scope monitoring, verification and integrated change control are all part of the monitoring and controlling process group and therefore are only helpful if the question deals with fixing the problem. Scope planning is part of the planning process group and is the only one capable of preventing the problem.
35. **Answer A.** PMBOK® Guide p. 150-152 – The project scope management plan is the document that defines how you will manage project scope. The Scope Baseline is an initial snapshot of what is in scope at a specific moment in time.
36. **Answer B.** Although several of these answers are good, this is an example of the need to look for the best answer. In this case the best answer would be to complete integrated change control. This is the step where the scope change is evaluated against the impacts on time, cost and other project variables.
37. **Answer C.** PMBOK® Guide p. 150-152 – The scope statement is the primary output from the define scope process which is part of the planning process group.
38. **Answer B.** You might be tempted to blindly follow your process and determine the impacts of the choice. Or you might want to just say no. But the question asked what was the best choice. In this situation the best thing to do is figure out why the stakeholder keeps asking for something the sponsor has already rejected.
39. **Answer D.** PMBOK® Guide p. 163-166 – On any project the scope should be validated at the end of each phase to ensure that you are still attaining the desired results.

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40. **Answer D.** PMBOK® Guide p. 131-132 – You have to be careful with this question. It is easy to memorize the PMI® process but forget the basics. A basic PMIism is that most projects have scope problems because of a failure to engage stakeholders early or often enough.
41. **Answer A.** PMBOK® Guide p. 150-155 – You have to be careful with this question. The question asks which process could have prevented the problem. Two of the answers are from the controlling process group which means they could have helped manage the problem but not prevent it. One answer is in the closing process group and therefore would not add much value. Only the define scope process offers a change to prevent the problem.
42. **Answer D.** PMBOK® Guide p. 156-161 – A good project manager always manages deliverables and not tasks. One of the main reasons for this statement is that it is almost impossible to get a quantitative evaluation of status on a task.
43. **Answer A.** PMBOK® Guide p. 138-149 – This question has lots of information, most of which doesn't matter. The core issue is that requirements are necessary to measure the completion of the project. Without the requirements, measurement is impossible. Remember, good project managers measure deliverables.

Schedule Management

Overview

For many PMP® candidates, their past experience with project management has largely involved developing a schedule using tools such as Excel® or Project® by Microsoft. Many of these candidates have never learned the tools and techniques necessary to manage a schedule without such tools. While software does make the job easier, not having the skills necessary to manage time without the technology is dangerous. Real project management is a very different animal from what is provided in any software application. For the exam do not assume they are the same thing. The schedule management knowledge area is where PMI® aggregates the information about managing a schedule. If you have always used a software tool to manage your schedules it could be a very difficult section for you. The best advice is to take your time and learn all the models, math and processes described here. Not only will they help you on the test, but they will also make a significant difference in the real world!

PMI® considers the schedule management knowledge area to include the processes required to manage the timely completion of the project. The knowledge area is broken into seven individual processes which include the following:

- ⇒ 6.1 Plan schedule management
- ⇒ 6.2 Define activities
- ⇒ 6.3 Sequence activities
- ⇒ 6.4 Estimate activity durations
- ⇒ 6.5 Develop schedule
- ⇒ 6.6 Control schedule

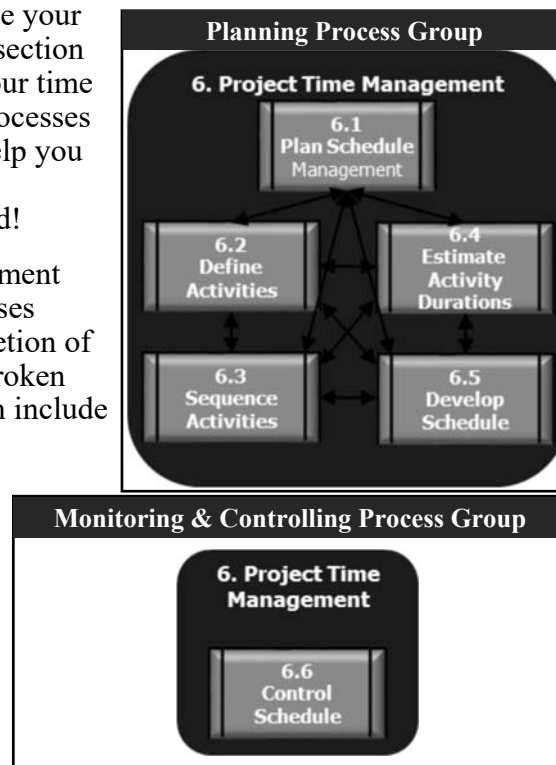


Image 33: The Time Management Processes

6.1 Plan Schedule Management

Like the scope management knowledge area, the schedule management knowledge Area uses the initial plan process to develop the rules used to manage the knowledge area. These rules are referred to as the schedule management plan. The schedule management plan answers several questions including the following:

- ⇒ How will the schedule be created?
- ⇒ How will schedule changes be evaluated and implemented?



Project Management is NOT a software tool!



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⇒ How will the schedule be controlled and variances managed?

Be careful here because many PMP® candidates do not do this level of schedule management on their real projects for a variety of reasons. When preparing for the exam it is important to remember that you are managing a relatively large project that requires more documentation and planning than you might be used to. The schedule management plan includes a number of components:

- ⇒ The scheduling methodology and any scheduling tools such as software to be used.
- ⇒ The schedule baseline against which all progress is measured.
- ⇒ A listing of the key performance indicators and metrics to be used on the project to identify variances and how often those metrics are produced.
- ⇒ Variance thresholds requiring action.
- ⇒ Rules for how the schedule variances will be managed.
- ⇒ A defined schedule change control process with all its procedures.

The inputs to the plan schedule management process include the following:

- ⇒ **.1 Project charter** — Used to provide the limits of authority, business need, justification, constraints and assumptions.
- ⇒ **.2 Project management plan** — Specifically the scope baseline and other information such as cost, risk and communication information.
- ⇒ **.3 Enterprise environmental factors** — Items here might include the organizational culture and structure, the resource availability and skills and commercial information.
- ⇒ **.4 Organizational process assets** — This is an old favorite that you should just assume.

The three tools and techniques used in the plan schedule management process include the following:

- ⇒ **.1 Expert judgment** — This the single most powerful tool that project managers have at their disposal.
- ⇒ **.2 Data analysis** — This can involve selecting various scheduling methodologies, estimating approaches, formats or may detail ways to fast track or crash the project.
- ⇒ **.3 Meetings** — The team may hold meetings to develop the schedule management plan.

There is only the one output for the plan schedule management process and it is the schedule management plan.



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6.2 Define Activities

The first process found in the schedule management knowledge area is the define activities process. This process is a continuation of the create WBS process from the scope management knowledge area. It is the process of identifying the specific activities that need to be performed in order to produce the project deliverables defined in the WBS. This process is done at the lowest level of the WBS, referred to as the “terminating nodes”. The term terminating node simply means that the work package has nothing broken down further underneath it. In the real world, it’s a common practice for project managers to focus on the items that contain real value—the deliverables—but for the PMP® exam it is important to remember that estimates, schedules, and baselines can only be created once the activities are defined underneath the deliverables. This also means you do **NOT** go straight to defining activities. The process starts with establishing the business requirements and success criteria, then moves to defining the deliverables that meet those requirements, and ends with identifying the tasks that produce the deliverables. The problem with this seemingly simple order is that you never have complete information. The only time any project has all the information is when the project is complete. Far too many projects fail because the team attempts to have all the requirements defined at the beginning and then struggles with vast amounts of scope change in frustration. PMI® focuses on the use of progressive elaboration to ensure project success.

Progressive elaboration is a process whereby the team continuously iterates and details the project requirements, features or other characteristics as more information becomes available. It applies to both the scope and the estimates, and is based on the assumption that information is imperfect. A common form of progressive elaboration is the rolling wave plan.

Rolling wave planning requires the team to plan and re-plan the project. Work to be done in the near term is planned in great detail while work calendared for the future is only planned at a high level. As the project progresses, the risks, assumptions, and milestones originally identified become more defined and reliable therefore more detailed plans can, and are produced. This approach is very different from a linear methodology such as waterfall where all the requirements are collected and planned in detail at the very beginning. This is an approach that iteratively plans for a project as it unfolds, similar to the techniques used in other forms of software development. The key is to remember that PMI® says you must plan but they do not say how to plan. *Image 35 on the next page shows a simple timeline for a project using rolling wave Planning. Notice that the example shows a project that uses a linear process.*



Image 34: 6.2 Define Activities



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Estimates, budgets, baselines, and schedules are all built at the activity level for accuracy on the test.

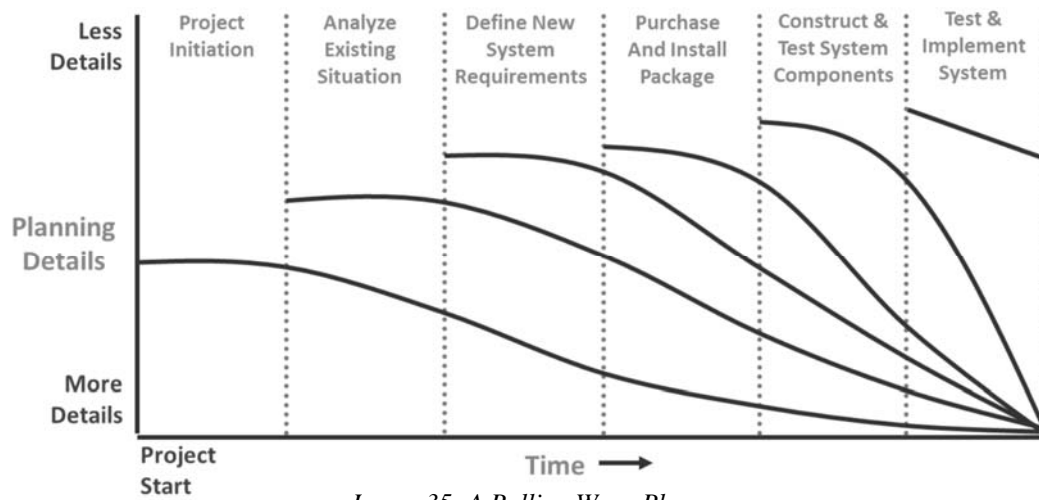


Image 35: A Rolling Wave Plan

Even still, the team must work towards complete information which only occurs at the very end when all the lines come together in the lower right-hand corner. Both progressive elaboration and rolling wave planning are key concepts for the exam.

There are three inputs to the define activities process. As you examine the list of inputs, it is important that you notice the WBS and WBS dictionary are not among them even though the defined activities are an extension of the deliverables defined in the WBS. This is because the project management Plan is inclusive of the WBS and WBS dictionary. If you are unsure of this point, look back to the scope management knowledge area, process 5.4 create WBS and examine the outputs and the explanation. The inputs to the define activities process are as follows:

- ⇒ **.1 Project management plan** — The project management plan is the master planning document for every project so it is naturally the starting point for most processes. In defining activities, the project management plan is bringing the schedule management plan and the scope baseline to the party.
- ⇒ **.2 Enterprise environmental factors** — There are many enterprise environmental factors that can impact the process of defining activities, but the most important is the project management Information system.
- ⇒ **.3 Organizational process assets** — Like almost all the processes, the define activities process may have organizational process assets which must be addressed. It is key to remember a number of things such as existing policies, procedures, guidelines and methodologies used in scheduling and any lessons learned from previous projects regarding scheduling.

The define activities process has four tools and techniques used to produce its outputs. These tools and techniques include the following:



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-
- ⇒ **.1 Expert judgment** — Expert judgment allows the team to examine the defined work packages and break them into the requisite tasks necessary for their creation. Every project needs subject matter experts to ensure the right tasks or activities get defined and completed.
 - ⇒ **.2 Decomposition** — Decomposition is the process of breaking deliverables in to smaller and smaller components until they can be understood and managed. It is the process used to create the WBS as well.
 - ⇒ **.3 Rolling wave planning** — The progressive elaboration technique of rolling wave planning was defined previously. It is important to note that rolling wave planning is an important tool regardless of the methodology being used.

Once the tools and techniques are ready to be used, it's time to produce the five outputs of the define activities process. These outputs are:

- ⇒ **.1 Activity list** — The activity list is simply a comprehensive list of all the activities that must be scheduled and completed to successfully finish the project. The activity list must also contain a unique identifier for the activity and a scope of the work description (understand this to be the WBS dictionary information) in sufficient detail so that the assigned resource knows what they are supposed to do.
- ⇒ **.2 Activity attributes** — Activity attributes have a similar relationship with the Activities list as the WBS dictionary has to the WBS. Activity attributes provide the details about the activities defined in the activity list. Details such as predecessor and successor relationships, leads and lags, resource requirements, imposed dates, and constraints and assumptions are just some of the possible details found here.
- ⇒ **.3 Milestone list** — A milestone is a significant point or event in a project. A milestone list is the list of all the milestones for that project with information about each milestone. Information about milestones can include whether or not they are contractually required, target dates, and/or if they are optional.
- ⇒ **.4 Change requests** — As the team goes through the process of defining project activities they often discover items that were missed in previous steps of the process. Because the stakeholders have theoretically already agreed to what features or requirements are necessary to meet the project success criteria, it is necessary to follow the defined change management process.
- ⇒ **.5 Project management plan updates** — Just as defining project activities might generate changes to the project requirements, they also may generate changes to any other aspect of the project. This means the team may need to update their project management plan to ensure it reflects those changes. The important thing to remember is that regardless of project methodology being used, a lot of the planning activities are iterative. As the team gains new information, they have to be able to incorporate it into the project. It is this ability to adapt that helps to ensure success.

6.3 Sequence Activities

The third process in the schedule management knowledge area is the sequence activities process. This is a logical continuation of the define activities process. In the define activities process the project manager and team create a list of the activities that are required to successfully complete the project. The next step is to take that list and organize it graphically based on the order in which work must be completed. The activity attributes are key because they display the relationships between activities (showing predecessor and successor relationships) and also reveal any required lead and lag time.

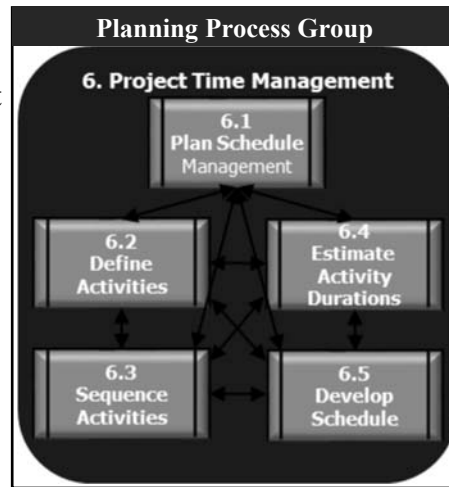


Image 36: 6.3 Sequence Activities

The major output of the sequence activities process is something called a **network diagram**. A network diagram is a graphical representation of the project tasks, activities and/or deliverables that displays the order of the events. A network diagram does not include the duration estimates for each activity because those have yet to be defined. In some cases, network diagrams have been called PERT diagrams. They are not the same thing and so do not confuse the two.

The science surrounding these diagrams originated in the late 1950s and 1960s and was largely the work of four organizations: the U.S. Navy, the U.S. Air Force, Dow Chemical, and DuPont. These organizations created much of what we consider the science of project management because they were leading projects with tens of thousands of resources—some of the largest projects ever completed. In this era there were no computers with fancy scheduling software or even white boards so most schedules were built on large sheets of newsprint taped to conference room walls. Out of these efforts the science of **arrow diagramming** arose. People were quickly broken into two camps—**activity-on-arrow (AOA)** and **activity-on-node (AON)**—depending on whether or not they believed the activities should be placed on the circles or on the arrows in the diagrams. Over the last 50 years most of this debate has been settled and the activity-on-node camp won. However, their victory did not come until a major change was made to the technique.

Precedence Diagramming

The big change that revolutionized sequence diagrams was the move from using circles to using rectangles represent the nodes, or work. Rectangles are necessary because circles only allow one type of relationship between the various tasks, activities or deliverable, a finish-to-finish relationship. In the real world there are several different types of relationships and project managers needed a way to represent that fact.



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A network diagram has nothing to do with PERT!



Make sure you know precedence diagramming well for the exam.

The use of rectangles in diagramming created the graphic technique that almost every scheduling software application uses today, called **precedence diagramming**. You must be capable of using this technique for the PMP® exam.

Precedence diagrams have four types of relationships. Notice that in each of these relationships the left side of each rectangle always represents the start of the task, activity or deliverable and the right side of the rectangle always represents the finish of the task, activity, or deliverable.

The first of the four possible relationships is a **finish-to-start** relationship. This relationship represents tasks, activities or deliverables that must be completely finished before the next one can begin. In this relationship the arrow comes out of the right side of the first task, activity or deliverable and into the

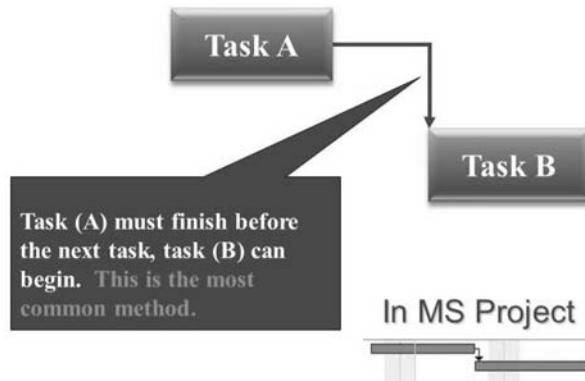


Image 37: A Finish-to-Start relationship

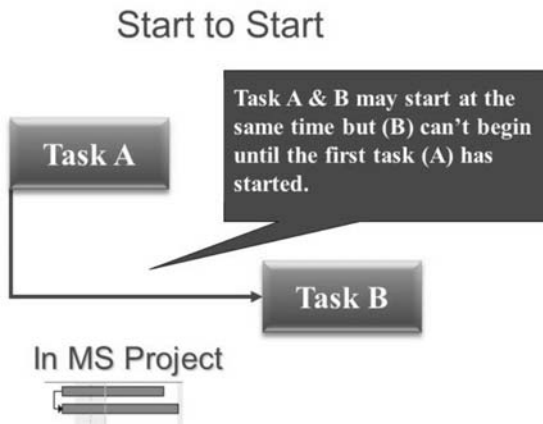


Image 38: A Start-to-Start relationship

or deliverable into the left side of the second task, activity or deliverable.

The third type of relationship is a **finish-to-finish** relationship. Image 39 shows a finish-to-finish relationship. In a finish-to-finish relationship the second task may finish any time after the first task, activity, or deliverable has finished. Notice how the arrow in Image 39 comes out of the right side of the first task, activity or deliverable into the

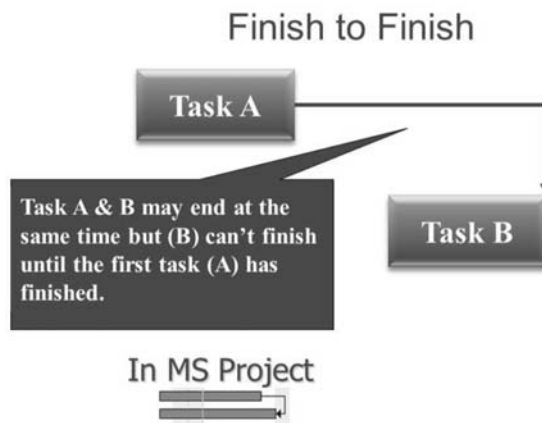


Image 39: A Finish-to-Finish relationship

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left side of the second task, activity or deliverable. This is the most common type of relationship. Image 37 shows a finish-to-start relationship.

The second type of relationship is a **start-to-start** relationship. In a start-to-start relationship the second task, activity or deliverable can begin anytime after the first task, activity or deliverable has begun. Image 38 shows a start-to-start relationship. Notice that the arrow comes out of the left side of the first task, activity

right side of the second task, activity or deliverable. The impact of both the start-to-start and finish-to-finish relationships on a schedule versus finish-to-start relationships is that the schedule becomes compressed.

The fourth and final relationship type in precedence diagramming is a **start-to-finish** relationship. The start-to-finish task type is almost never used in the real world. This is because the start-to-finish relationship means the first task, activity, or deliverable must start

before the second task, activity, or deliverable finishes. Stop and think about that for a moment. It is completely backwards from what is expected. In fact, in most cases if this relationship is seen it means the tasks, activities or deliverables are in the incorrect order. *Image 40* shows a start-to-finish relationship.

If you put these four relationships together a Network or Precedence Diagram is produced as shown in *Image 41*. In the exam, you will almost exclusively see finish-to-start relationships. But the other relationships may show up. To ensure that you understand precedence diagramming, complete Exercise 7 which begins on the next page.

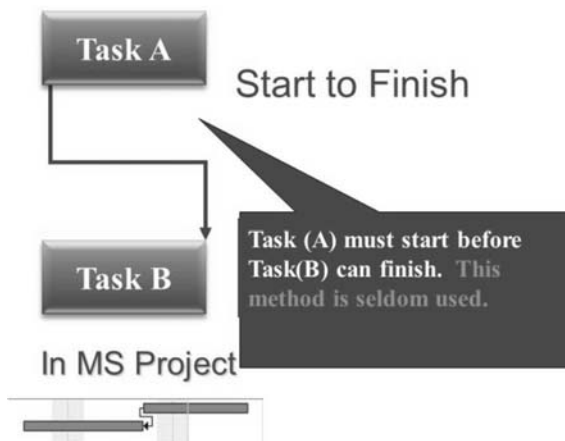


Image 40: A Start-to-Finish relationship

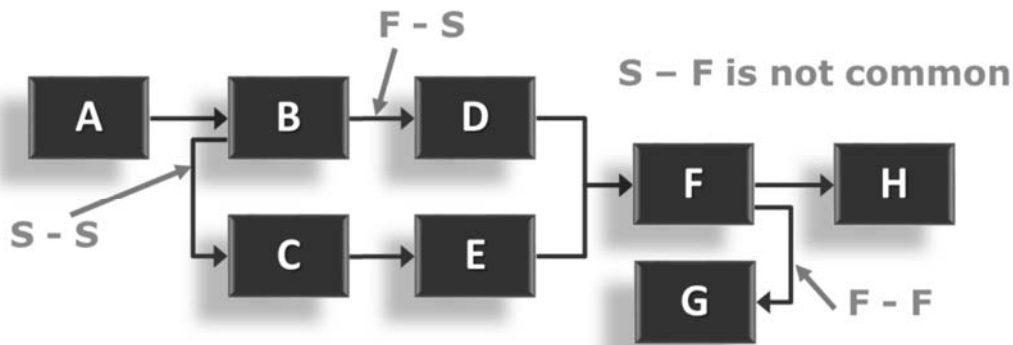


Image 41: A Network or Precedence Diagram

Exercise 7 — Precedence Diagramming

1. Create the precedence diagram based on the following table.

Task	Predecessor
A	N/A
B	A
C	B
D	B
E	C
F	D, E

2. Create the precedence diagram based on the following table.

Task	Predecessor
1	N/A
2	1
3	1
4	2,3
5	4
6	4
7	5, 6

3. Create the precedence diagram based on the following table.

Task	Predecessor
A	N/A
B	A
C	B
D	B
E	B
F	C, D
G	E
H	F, G

4. Create the precedence diagram based on the following table.

Task	Predecessor
1	N/A
2	1
3	1
4	1
5	2
6	3,4
7	5
8	6, 7
9	8



Exercise 7 — Precedence Diagramming

6. Create the precedence diagram based on the following table.

Task	Predecessor
A	N/A
B	A
C	B
D	B
E	C
F	D
G	E, F
H	G
I	G
J	H, I

7. Create the precedence diagram based on the following table.

Task	Predecessor
1	N/A
2	1
3	1
4	1
5	2, 3
6	3, 4
7	5, 6
8	7
9	7
10	8, 9

8. Create the precedence diagram based on the following table.

Task	Predecessor
A	N/A
B	A
C	A
D	A
E	B, C
F	C, D
G	E
H	F
I	F
J	G
K	H, I
L	K
M	J, L

9. Create the precedence diagram based on the following table.

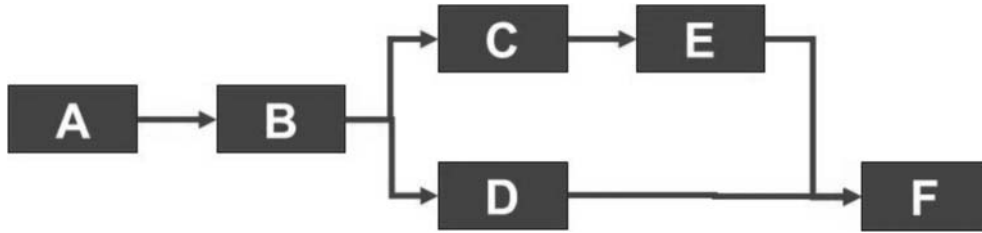
Task	Predecessor
1	N/A
2	1
3	1
4	2
5	2
6	3
7	3
8	4, 5
9	5, 6
10	6, 7
11	8, 9
12	10, 11

10. Create the precedence diagram based on the following table.

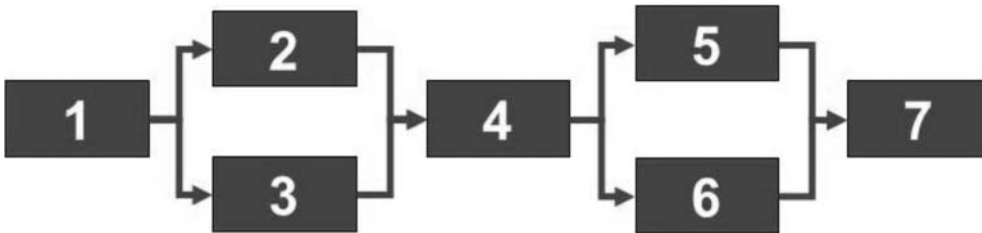
Task	Predecessor	Relationship
A	N/A	N/A
B	A	FS
C	B	SS
D	B	FS
E	B, C	FS
F	C	FS
G	D, E	FS
H	E, F	FS
I	G, H	FS
J	I	FS
K	J	FF
L	J, K	FS

Precedence Diagramming Answers

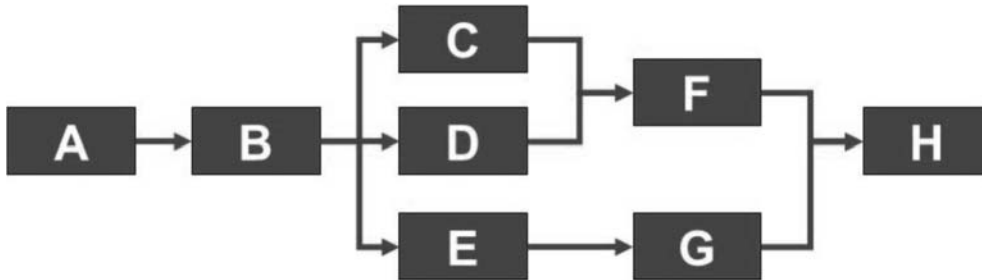
1.



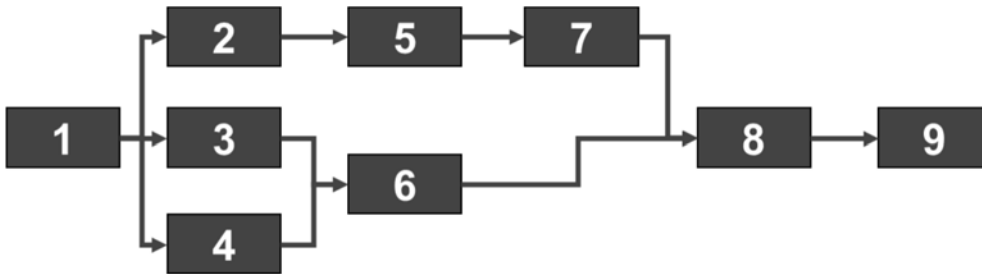
2.



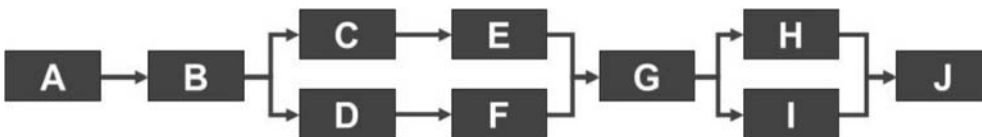
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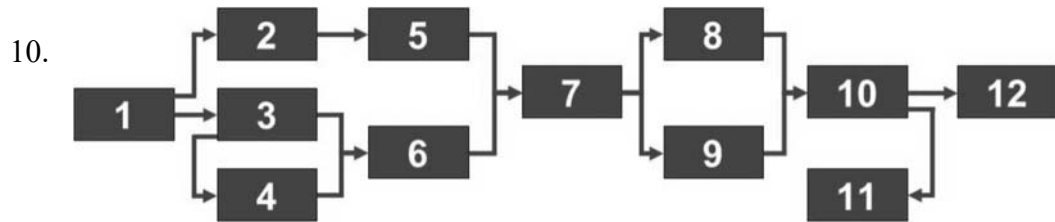
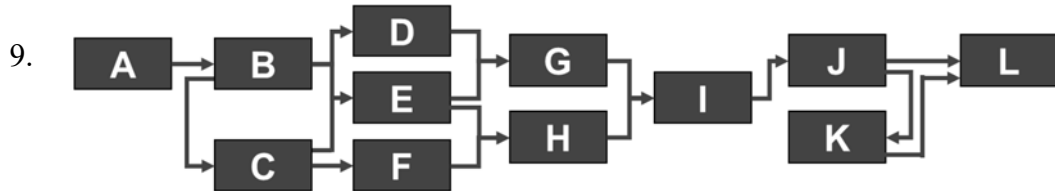
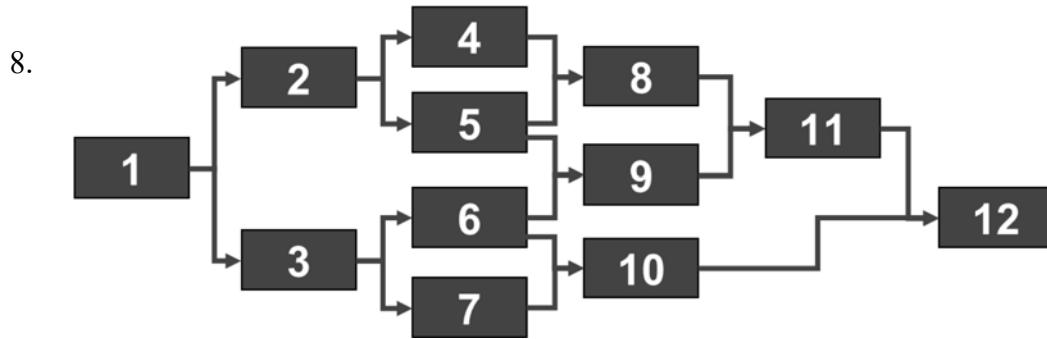
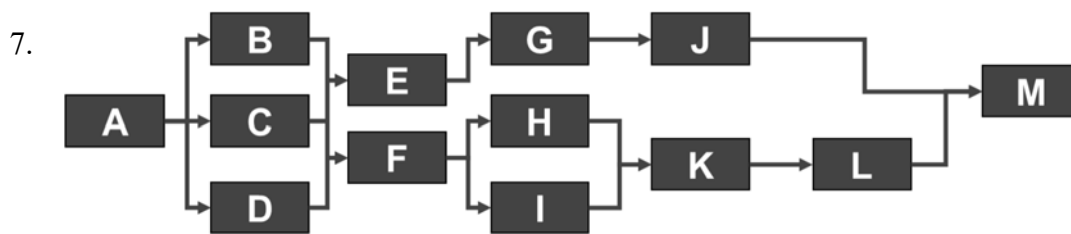
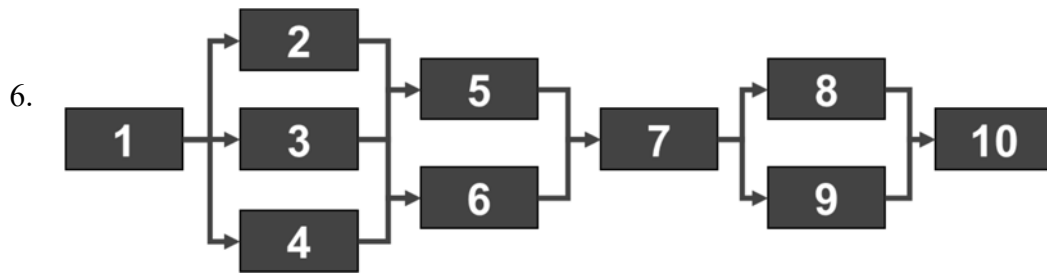


4.



5.





Precedence diagramming is not the only type of network diagram that can be done. However, it is the only type of diagramming you must do well to pass the exam. It is important that you are aware of an alternative technique and know a few key points about it. That technique is called conditional diagramming.

Conditional diagramming affords the project manager the ability to account for probability and create conditional loops. *Image 42* shows a network diagram with conditional looping and probability. In the diagram there is an 80% chance of moving from B to C and there is a 20% chance that you would have to

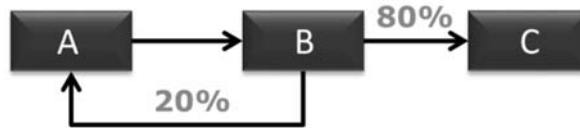


Image 42: A Conditional Diagram

redo task, activity or deliverable A. Another common way of representing conditional diagrams is with the eyeball diagram shown in *Image 43*. The eyeball diagram is used to represent a single situation (the open circle on the left of the image) with two possibilities (shown with the right facing arrows). Readers can tell it is a single situation because the two arrows are connected with the ellipse. It is called an eyeball diagram because it resembles an eyeball from the side. The PMP® exam will not require you to create these diagrams, but you will need to recognize them and remember the acronym **GERT** which stands for **graphical evaluation and review technique**. GERT is the most common form of conditional diagramming. Also remember the advantage of conditional diagramming is that it allows for both probability and looping.

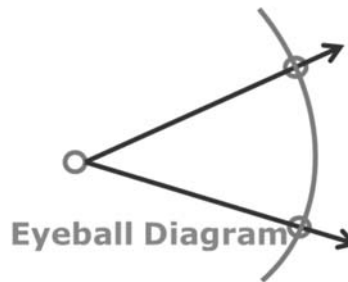


Image 43: An Eyeball Diagram

Dependencies, Leads and Lags

There are several other items that can be represented by network diagrams. The first things that might impact a network diagram are the three dependency types. Dependencies are situations where one task, activity or deliverable is reliant on another for one or more reason. These include the following:

- ⇒ **Mandatory (hard logic)** — Mandatory dependencies are defined as situations where the ordering of task, activities or deliverables is locked into place by the work itself and there is no other alternative path.
- ⇒ **Discretionary (soft logic)** — Discretionary dependencies are situations where there is more than one possible path to complete the project work, but someone has chosen a specific path for some reason.
- ⇒ **External** — External dependencies refer to situations where dependencies are placed on the project team by some outside force, regardless of logic or preference. Regulations and laws are the most common form of external dependencies.

In addition to dependencies, project managers must deal with lead and lag time to determine a network diagram. **Lead time** occurs whenever a finish-to-start



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relationship allows the successor task to start prior to the completion of the predecessor. **Lag time** represents a relationship that requires a delay between the two tasks. Both leads and lags can impact a schedule. Lead time will generally shorten a schedule while lag time will increase it. Make sure you understand the difference.

The inputs to the sequence activities process include the following:

- ⇒ **.1 Project management plan** — The project management plan contains a lot of different components, but the two that are important for sequencing project activities are the schedule management plan and the scope baseline. These two documents establish how the schedule will be managed throughout the project and what has to be completed (e.g. the project's current scope).
- ⇒ **.2 Project documents** — There are four documents specifically called out by PMI® to properly sequence the project activities. The first is the activity list. The list defines the activities that need to be accomplished. The second are the activity attributes which provide the details about the defined activities. The team also need to know about any assumptions that have been made during the planning process so they need the assumption log and they need to know about any established milestones so they must examine the milestone list.
- ⇒ **.3 Enterprise environmental factors** — The factors that might influence the Sequence Activities process include things such as governmental regulations or industry standards, specific tools the team or organization uses, and the work authorization system.
- ⇒ **.4 Organizational process assets** — Many organizations have predefined tools, templates and processes designed to aid in the creation of a sequence diagram.

The tools and techniques used in the sequence activities process include the following:

- ⇒ **.1 Precedence Diagramming Method (PDM)** — Precedence Diagramming is the preferred and most common method used to develop Network Diagrams. It is absolutely critical that you are capable of correctly producing a PDM Diagram to pass the exam.
- ⇒ **.2 Dependency determination and integration** — Dependency determination is simply the process of determining what must come first, second, third, etc. It also defines exactly how each activity is

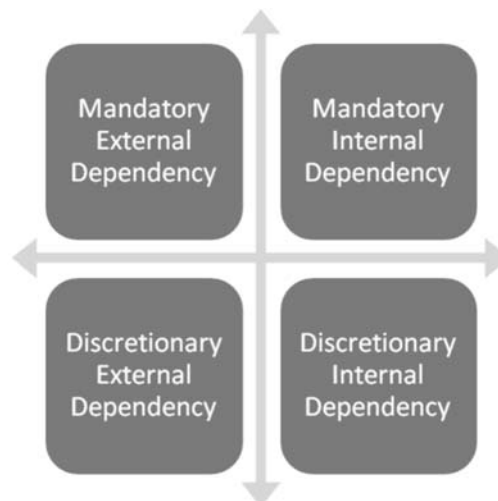


Image 44: Dependency Determination



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dependent. When discussing dependencies, PMI® defines a pair of axis when discussing dependencies. These are whether or not the dependency is mandatory or discretionary and whether the dependency is internal or external.

Mandatory dependencies are either required by some law or contract pertinent to the project or inherent to the work. These dependencies are also referred to as hard logic. Mandatory dependencies do not offer any other alternative. The work must be done in a particular way. These are often obvious dependencies because they are clearly stated in the agreement or law, but project leaders cannot assume this to be the case. Therefore, it is important to review all agreements and regulations to

Discretionary dependencies represent the team’s preferred way of doing things. This preference is often because of the team’s knowledge or experience with the tools or technology being implemented. With discretionary dependencies there are other ways the work could be completed but the team simply prefers to complete the work in the desired fashion. It is very important that the project team documents the discretionary dependencies because they have an impact on the project’s slack or float and may require closer scrutiny at some point.

⇒ **.3 Leads and lags** — Leads and lags add definition to the relationships defined in precedence diagramming. They allow a successor item (the one that comes second) to begin or end either earlier or later than defined by the original relationship. Leads represents the amount of time the second activity can begin ahead of the first activity completing. Whereas lags represent the amount of time an activity must wait before beginning. To help you better understand this concept, return to our PDM conversation. *Image 45* shows

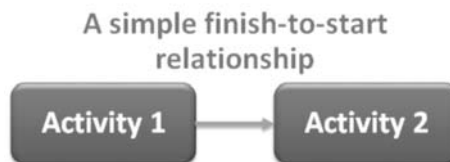


Image 45: A finish-to-finish relationship

A finish-to-start relationship with LEAD time



Image 46: Lead time

between the two activities increasing thereby causing the project to take longer than in *Image 45*.

what should now be a familiar finish-to-finish relationship where the first task completes before the second task begins.

Image 46 shows the same two activities, but notice the change in the finish-to-start relationship because of lead time. In this image Activity 2 begins sooner than in the first diagram theoretically compressing the schedule and allowing an earlier completion date. *Image 47* show lag time which has the exact opposite effect with the distance

A finish-to-start relationship with LAG time



Image 47: Lag time

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- ⇒ **.4 Project management information system** — The PMIS includes the software you use to generate a network diagram, create a schedule, and/or deal with dependent relationships. In the agile world, it includes the tools used to create the product backlog and the iteration plan.

There are only two outputs to the sequence activities process. The most important of these is the project schedule network diagram. The other output is that the sequence activities process can also generate a number of updates to project documents including updates to the activity attributes, the activity list, the assumption log and/or the milestone list. Remember, these documents are considered outside the project management plan, but that does not mean they are not important.

6.4 Estimate Activity Durations

Only when the activities have been sequenced can the activity durations be determined. The estimate activity durations process begins with its inputs which are as follows:

- ⇒ **.1 Project management plan** — As you have already probably gathered, the project management plan, in whatever form, is almost always an input for the various required processes. However, PMI® also regularly calls out specific components of the plan when they are important to the process in question. For estimating activity durations the team must pay special attention to the schedule management plan which defines how the schedule will be planned, managed and changed and the scope baseline which defines the initial snapshot of what work the team must complete.
- ⇒ **.2 Project documents** — Making the project documents an input is a little like saying everything is an input. However, PMI® does provide more extensive guidance by listing off several specific documents needed for estimating activity durations. Most of the list is common sense and includes: the activity list and attributes, the assumption log, the lessons learned register, the milestone list, project team assignments, the resource breakdown structure or RBS, resource calendars, resource requirements, and the risk register. This is the first time you have seen the resource breakdown structure. It represents one of two uses of the acronym RBS. We will see the other when we discuss project risks. A resource breakdown structure is graphical representation of the hierarchical relationships that exist in the project reporting relationships.



Image 48: 6.4 Estimate activity durations



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- ⇒ **.3 Enterprise environmental factors** — As with almost every process, enterprise environmental factors are at play. This includes other projects being conducted by the organization, operational requirements, etc.
- ⇒ **.4 Organizational process assets** — Many organizations have tools in place to assist in the creation of duration estimates. These tools can be physical or electronic.

There are many ways to generate duration estimates within a project. As has been previously stated, PMI's preferred methodology is always to use expert judgment in a bottoms up process. However, that is not the only way to effectively generate duration estimates.

PERT Estimating and Three Point Estimating

One of the more advanced ways to do estimates is to make use of the **project evaluation and review technique or PERT**. This technique assumes that project estimates are inherently inaccurate. It therefore makes use of probability to determine project activity durations. To understand PERT, you must first have a firm grasp on a few basic tenants of the statistics used in probability.

Imagine you were asked to stop at your local grocery store on the way home from work to purchase a gallon of milk. Assuming that you have worked at your current location, lived in the same home, and shopped at the same grocery store for longer than a week or two, how long would it take? If you are like most people you said around 15 or 20 minutes. Why didn't you say exactly 15.35 minutes? Mostly likely it is because you know there are a number of factors that are completely outside your control: traffic, parking, the stock of milk, lines at the checkout lane, and many others. However, if you were to go to the store on 100 consecutive days and buy milk a pattern would emerge. Although it would be unlikely that any two trips would ever take the same amount of time, a large percentage of the trips would be close together and a few of the trips would have times that were significantly different. This pattern is referred to as a **Gaussian distribution, bell curve or normal distribution** and is used to describe any independent variable. An **independent variable** is one where the events in one instance do not impact the results of another instance. *Image 49* shows a Gaussian distribution.

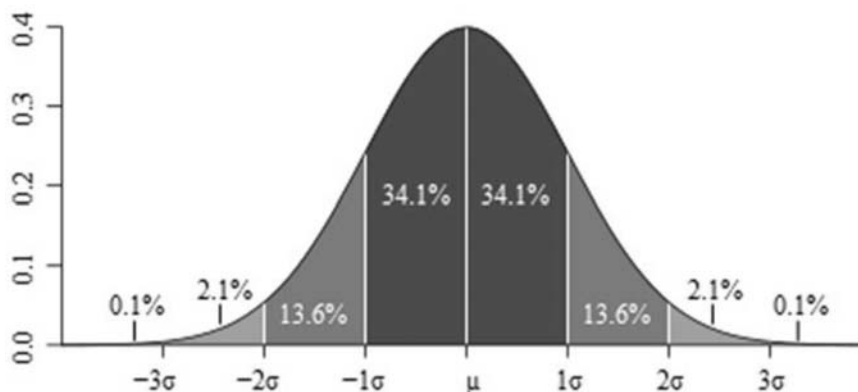


Image 49: A Gaussian Distribution, Normal or a Bell Curve



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Several key factors define the shape seen in a bell curve. The first is the unusual looking U symbol that appears in the exact middle of the curve. It is accompanied by a vertical line that splits the curve into two equal halves. This is the mean of the distribution and may also be represented by an X with a line over it. The **mean** is defined as the sum of the values divided by the number of cases. Next, notice how the image is divided into equal segments that are marked at the bottom of the image with positive or negative values followed by a small symbol. This symbol represents the **standard deviation** or **sigma**. The shape of the bell curve is defined by the fact that within one sigma, or one standard deviation, away from the mean 68% of the cases can be found. Within two standard deviations 95% of the cases can be found, and within three standard deviations 99% of the cases can be found.

Most project managers have neither the time nor the inclination to do a project activity 100 different times. This is where PERT comes into play. PERT provides a technique that allows the project manager to simulate completing the project many times over to get more accurate estimates. The key to using PERT is the use of a three point estimate combined with a Gaussian distribution. PERT requires three estimates: an optimistic estimate, a pessimistic, and a most likely estimate. These three estimates are then used in three different calculations to determine durations.

The first calculation created is the **PERT weighted average**. The weighted average serves as the mid-point, or mean, of the bell curve that is artificially created by the following formula:

$$\text{PERT Weighted Average} = \frac{(4 * \text{Most Likely}) + \text{Pessimistic} + \text{Optimistic}}{6}$$

The most common question concerning this calculation is why does it use four times the most likely case? The answer is that by using four times the most likely case, the formula creates the hump required to produce the bell curve shape. It creates a bell curve with six cases even though there are only three real values. Once the mid-point of the curve is determined, the PERT standard deviation is next.

The **PERT standard deviation** defines the range and shape of the curve. It is necessary to provide the confidence interval of the estimates. Within one PERT standard deviation on either side of the PERT weighted average, 68% of the cases will occur. Within two PERT standard deviations of the PERT weighted average 95% of the cases will occur. And, within three PERT standard deviations of the PERT weighted average 99% of the cases will occur. The formula to calculate the PERT standard deviation is:

$$\text{PERT Standard Deviation} = \frac{\text{Pessimistic} - \text{Optimistic}}{6}$$

The last calculation used in PERT is the PERT variance. Although this calculation is not seen as much on the PMP® exam as the PERT weighted



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The PERT Weighted Average



The PERT Standard Deviation

average or PERT standard deviation, it is still a good idea to be familiar with it. The formula for the PERT variance is:

$$\text{PERT Variance} = \text{PERT Standard Deviation}^2$$

To better understand these three calculations let's take a look at a simple example. Imagine you're leading a small project that has the following duration estimates:

- ⇒ Best Case = 5 Weeks
- ⇒ Most Likely Case = 7 Weeks
- ⇒ Worst Case = 11 Weeks

Notice the change in terminology from pessimistic and optimistic cases to worst and best cases. Do not be confused. They mean the same thing. The first step in the process is to calculate the PERT Weighted Average. In this case the formula would be:

$$\text{PERT Weighted Average} = \frac{11 + (4 * 7) + 5}{6} \quad \text{or} \quad \frac{44}{6} \quad \text{or} \quad 7.33$$

The next step is to determine the PERT Standard Deviation which is:

$$\text{PERT Standard Deviation} = \frac{11 - 5}{6} \quad \text{or} \quad \frac{6}{6} \quad \text{or} \quad 1$$

So what do these calculations tell us?

- ⇒ The 50% probability point is 7.33 weeks (the PERT Weighted Average). This means that 50% of the time it should take that amount of time or less and 50% of the time it should take that amount of time or more.
- ⇒ There is a 68% chance of completing the project between 6.33 and 8.33 weeks (This is the PERT Weighted Average +/- the PERT Standard Deviation).
- ⇒ There is a 95% chance of completing the project between 5.33 and 9.33 weeks (This is the PERT Weighted Average +/- the PERT Standard Deviation twice).
- ⇒ There is a 99% chance of completing the project between 4.33 and 10.33 weeks (This is the PERT Weighted Average +/- the PERT Standard Deviation three times).

Take a few moments to complete the PERT exercise on the following page before continuing.

PERT is just one of several statistical formulas and concepts that can aid a project leader in developing a project schedule. It works because the project manager understands the implications of a standard deviation, but it is not the only statistical deviation that can help. Other distributions that impact projects include a binomial distribution, a uniform distribution, a beta distribution, and a triangular distribution.



The PERT Variance

Exercise 8 — PERT**Exercise 8 —
PERT**

1. A resource gives you a pessimistic estimate of 10 days and an optimistic estimate of 6 days. What is the standard deviation?
 - A. 0.67
 - B. 4
 - C. 7.33
 - D. 6.67

2. A resource gives you a pessimistic estimate of 9 days and an optimistic estimate of 4 days. What is the standard deviation?
 - A. 6.17
 - B. 5.33
 - C. 0.83
 - D. 6.67

3. A resource gives you a pessimistic estimate of 5 days and an optimistic estimate of 2 days. What is the standard deviation?
 - A. 3.83
 - B. 0.5
 - C. 3.33
 - D. 4.33

4. A resource gives you a pessimistic estimate of 15 days and an optimistic estimate of 6 days. What is the standard deviation?
 - A. 8.0
 - B. 11.0
 - C. 9.5
 - D. 1.5

5. A resource gives you a pessimistic estimate of 17 days and an optimistic estimate of 8 days. What is the standard deviation?
 - A. 12.17
 - B. 10.67
 - C. 1.5
 - D. 1.83

6. A resource gives you a pessimistic estimate of 25 days and an optimistic estimate of 15 days. What is the standard deviation?
 - A. 1.67
 - B. 19.33
 - C. 7.07
 - D. 17.67

-
7. A resource gives you a pessimistic estimate of 28 days and an optimistic estimate of 17 days. What is the standard deviation?
 - A. 21.5
 - B. 7.78
 - C. 1.83
 - D. 17.73

 8. A resource gives you a pessimistic estimate of 21 days and an optimistic estimate of 12 days. What is the standard deviation?
 - A. 15.5
 - B. 6.36
 - C. 14
 - D. 1.5

 9. A resource gives you a pessimistic estimate of 54 days and an optimistic estimate of 36 days. What is the standard deviation?
 - A. 3.0
 - B. 12.73
 - C. 3.73
 - D. 42.33

 10. A resource gives you a pessimistic estimate of 31 days and an optimistic estimate of 19 days. What is the standard deviation?
 - A. 8.49
 - B. 2.0
 - C. 24.33
 - D. 3.33

Exercise 8 — PERT Answers

1. **Answer A.** The standard deviation in this case is the PERT standard deviation. The formula for the PERT standard deviation is Pessimistic - optimistic / 6. For this question that equals $10 - 6 = 4$ and then $4/6 = .67$
2. **Answer C.** The standard deviation in this case is the PERT standard deviation. The formula for the PERT standard deviation is Pessimistic - optimistic / 6. For this question that equals $9 - 4 = 5$ and then $5/6 = .83$
3. **Answer B.** The standard deviation in this case is the PERT standard deviation. The formula for the PERT standard deviation is Pessimistic - optimistic / 6. For this question that equals $5 - 2 = 3$ and then $3/6 = .5$
4. **Answer D.** The standard deviation in this case is the PERT standard deviation. The formula for the PERT standard deviation is Pessimistic - optimistic / 6. For this question that equals $15 - 6 = 9$ and then $9/6 = 1.5$
5. **Answer C.** The standard deviation in this case is the PERT standard deviation. The formula for the PERT standard deviation is Pessimistic - optimistic / 6. For this question that equals $17 - 8 = 9$ and then $9/6 = 1.5$
6. **Answer A.** The standard deviation in this case is the PERT standard deviation. The formula for the PERT standard deviation is Pessimistic - optimistic / 6. For this question that equals $25 - 15 = 10$ and then $10/6 = 1.67$
7. **Answer C.** The standard deviation in this case is the PERT standard deviation. The formula for the PERT standard deviation is Pessimistic - optimistic / 6. For this question that equals $28 - 17 = 11$ and then $11/6 = 1.83$
8. **Answer D.** The standard deviation in this case is the PERT standard deviation. The formula for the PERT standard deviation is Pessimistic - optimistic / 6. For this question that equals $21 - 12 = 9$ and then $9/6 = 1.5$
9. **Answer A.** The standard deviation in this case is the PERT standard deviation. The formula for the PERT standard deviation is Pessimistic - optimistic / 6. For this question that equals $54 - 36 = 18$ and then $18/6 = 3.0$
10. **Answer B.** The standard deviation in this case is the PERT standard deviation. The formula for the PERT standard deviation is Pessimistic - optimistic / 6. For this question that equals $31 - 19 = 12$ and then $12/6 = 2.0$

A **binomial distribution** is used whenever there are only two possible outcomes. A perfect example is flipping a coin. Although there is an infinitesimally small change of the coin landing on its side, most people would agree that with each flip the outcome is either heads or tails. Typically, a binomial distribution is graphed using two vertical bars displaying the likelihood of each outcome. Binomial distributions are used in project management as a descriptor in Monte Carlo simulations.

A **uniform distribution** represents a scenario where each value of a random variable has an equal probability of occurrence. The values in a uniform distribution can be continuous, meaning without limit, or they can be discrete meaning they have a set range. A simple example of a uniform distribution is the value shown on a dice when rolled. The values are either 1, 2, 3, 4, 5, or a 6. Each value has a $1/6^{\text{th}}$ probability of being rolled therefore the distribution is flat and is described as a discrete uniform distribution. A uniform distribution is used in project management to obtain a rough order of magnitude estimate where very little information is available or in risk management when the team is dealing with several risks that each have an equal probability of occurrence.

A **triangular distribution** is a continuous probability distribution that begins with a minimum value, ends with a maximum value, and makes use of a mode, or most likely value somewhere along the continuum. A triangular distribution is different from a uniform distribution in that the probability of the random values are not all the same. Remember, in the uniform distribution each of the potential values had the same likelihood of occurring. In a triangular distribution, the minimum and maximum values have a zero probability of happening. The mode is the value most likely to be seen and so is shown as a spike in the graph which creates the triangle when combined with the minimum and maximum. In project management, the triangular distribution is used when an approximation is needed for a beta distribution to estimate activity duration. It is not uncommon to use a triangular distribution as an approximation for a beta distribution which is much more difficult to calculate and graph.

A **beta distribution** represents a distribution of probabilities when we don't know what the probability is. Fortunately, the only time a project manager ever deals with beta distributions is in some advanced software applications and never of the PMP® exam.

The final statistical concept we will add to the conversation here is the **central limit** theorem or CLT. This theorem simply states that the mean of a large population of independent and random variables, each having a finite mean and variance will be normally distributed. Although this theorem might sound complex it impacts project management in a very practical way. Imagine you have a project with more than 100 activities or deliverable. The team has defined three estimates for each one. Is it OK if you use the sum PERT weighted averages to estimate the overall project duration? The answer is yes, because of the CTL we assume the project duration follows a normal distribution and the variance can be calculated by summing the variances of the project activities on the critical path.



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Having completed the discussion of PERT or three point estimating let's examine all the tools and techniques used in the Estimate Activity Duration process. Remember, the techniques used to estimate time will also be used to estimate costs in the next knowledge area. These tools and techniques include:

- ⇒ **.1 Expert judgment** — As always, expert judgment is PMI's preferred way of completing any process. It is always critical that the project manager trusts their subject matter experts. Asking your subject matter experts for a single estimate is sometimes referred to as **one-point estimating**.
- ⇒ **.2 Analogous estimating** — Often referred to as top down estimating, analogous estimating uses the actual results from a previous project to estimate the current effort. Analogous estimating is typically only used in the very early processes of a project because it is often the least accurate of all estimating techniques. Analogous estimating assumes that the two projects are alike and therefore the durations will also be alike. Problems often arise when the details of the two projects diverge.
- ⇒ **.3 Parametric estimating** — Often referred to as mathematical modeling, parametric modeling uses a series of variables to calculate the project estimate. The technique is based on a presumption of the accuracy of the variables. So long as all of the major variables have been addressed, the estimate will be accurate. A simple example is the duration estimate to pour ten miles of a two lane highway. Parametric estimates may also be created using **regression analysis** or a **learning curve**.
- ⇒ **.4 Three point estimating** — Also referred to as PERT Estimating, this technique was discussed at length in the previous section.
- ⇒ **.5 Bottom-up estimating** — Bottom-up estimating is almost always the preferred technique. It requires the team to create estimates for the smallest unit of delivery and then sum those values together to generate estimates for the larger items. It assumes the values of the small items equate to the larger ones without added cost for integration unless specifically added.
- ⇒ **.6 Data analysis** — Two types of analysis or examination are specifically called out by PMI® here. They include alternatives analysis and reserve analysis.
 - ◇ Alternatives analysis is the process of examining the potential different ways the team could execute the project and then calculating the different durations to find the best outcome.
 - ◇ Reserve analysis is the process of determining how much reserve is required. Exam takers must be prepared to address two types of reserves: contingency reserves and management reserves.
 - ⇒ **Contingency Reserves** — These represent reserves controlled by the project manager and they are to be used for know unknowns. This means the project manager and team can plan for an event that they see as possible. Because the



event can be foreseen it can be planned for. Management or sponsor approval is not required to implement the reserve because approval was already obtained when the project's plan was approved.

- ⇒ **Management Reserves** — These represent reserves controlled by the project sponsor or the senior management. They cannot be accessed without their permission. Management reserves are used to respond to unknown unknowns. These are events that cannot be planned for. The most common type of unknown unknowns are acts of God. Management Reserves may also be referred to as general contingency. Often they represent a generic amount of safety or padding that is added to the overall project estimate.

The outputs of the estimate activity durations process include the following:

- ⇒ **.1 Duration estimates** — This process exists in order to arrive at the duration estimates for each individual task, activity or deliverable.
- ⇒ **.2 Basis of estimates** — We have already discussed how the WBS dictionary and activity attributes add detail to the WBS and activity list. The basis of estimates serves the same function for the duration estimates.
- ⇒ **.3 Project document updates** — Often critical information about the project is discovered that requires updates to project documents during the estimate durations process.

6.5 Develop Schedule

Once duration estimates are determined it is time to develop the schedule. For the PMP® exam it is important that you can visualize this process. First comes the WBS. Then the WBS is extended with activities. Those activities are sequenced, resources are estimated and durations are estimated. Only then can a schedule be developed. For the exam it is critical that you remember that schedule development is an iterative process. The schedule will constantly be under review. The goal is to determine the start and end dates for the required activities and the entire project so that it can be used as a comparative baseline against which real results are measured. The single most important part of the develop schedule process is understanding critical path methodology.



Image 50: Develop Schedule

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Critical Path Methodology

Critical path method (CPM) is one of the two major techniques that is used to determine a project's schedule. It is both the oldest and the most widely used technique. The **critical path** of a project is defined as the longest chain of dependent tasks, activities or deliverables with zero slack or float. It is the chain of items through the precedence diagram that defines the overall project duration. The tasks, activities or deliverables in the critical path do not necessarily have the greatest risk or the most importance—but they do define the earliest finish date of the project. There are six key variables used in the critical path methodology:

- ⇒ **The Early Start (ES)** — The early start is the soonest day that the project task, activity or deliverable can begin.
- ⇒ **Duration (DUR)** — The duration is the amount of calendar time the project task, activity or deliverable will take. It was defined for each item in the last process.
- ⇒ **Early Finish (EF)** — The early finish represents the soonest day that the project task, activity or deliverable may be completed based on the dependencies defined in the precedence diagram.
- ⇒ **Late Start (LS)** — The late start is the latest day that the task, activity or deliverable can begin on without impacting the earliest overall delivery date of the project.
- ⇒ **Float** — The **slip, slack, total float, or float** is the amount of time the task, activity or deliverable can slip or extend without impacting the earliest overall delivery date of the project.
- ⇒ **Late Finish (LF)** — The late finish is the latest day that the task, activity or deliverable can end on without impacting the earliest overall delivery date of the project.



Image 51: The CPM Legend

With the definitions in hand let's examine the steps involved in developing a critical path model. Begin by examining the precedence diagram shown in *Image 52*. Notice how the diagram shows the duration estimates for each

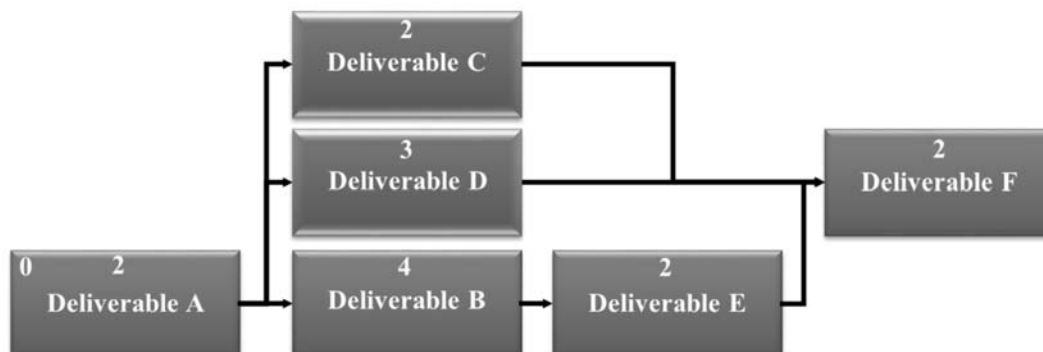


Image 52: A Basic Precedence Diagram with durations and start



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deliverable, task or activity. Also notice that the very first task, activity or deliverable has an early start value in the upper left hand corner, and it is the only early start value defined at this point.

The first rule that must be memorized is that the very first task, activity or deliverable always begins on day zero. This is your anchor point or the beginning of the project. Unfortunately, you cannot go back in time and start your projects two weeks prior to today. To calculate the critical path you will make two passes completely through the network diagram by first going left to right and then going right to left. As you make these passes it is very important that you always work in columns and do not skip ahead.

The first pass through the network is referred to as the **forward pass** because it goes the same way we read, from left to right. The formula you will use in each box is:

$$EF = ES + DUR$$

In this case deliverable A is $0 + 2 = 2$. A two can now be placed in the upper right hand value (the early finish) of deliverable A. Because deliverables B, C, and D all have logical dependencies on deliverable A we also can now place a two in the early start position of deliverables B, C and D. Working in columns as our earlier rule stated, we can now determine the early finish values for B, C, and D.

⇒ Deliverable B: $2 + 4 = 6$
 ⇒ Deliverable C: $2 + 2 = 4$
 ⇒ Deliverable D: $2 + 3 = 5$

Those values are then placed into the upper right hand position for each box before continuing to the next column and deliverable E. Deliverable E is dependent on deliverable B, and since deliverable B has an early finish value of six, that becomes the early start value for deliverable E. The forward pass calculation for deliverable E is now $6 + 2 = 8$.

We have now reached a critical point in the forward pass. Deliverables C, D, and E all feed into deliverable F. This is referred to as a converging (or a convergence point) and occurs whenever two or more tasks, activities or deliverables feed into a single item. The rule for a convergence point on the forward pass is to always take the largest value. In this case we have values of four, five and eight. The eight is selected and placed into the early start position of deliverable F.

The forward pass has now been completed and we have determined that the early finish for the project is 10. The next step is to take the early finish from the last task, activity or deliverable (deliverable F) and make it the late finish as well. deliverable F now has a value of 10 placed in both far right position. Now complete the backward pass. *Image 53* shows the CPM model once all passes are complete. The backward pass begins with deliverable F and progresses from right to left following the logical dependencies in reverse order. The objective of the backward pass is to calculate the late start that appears in the lower left



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The
Forward
Pass

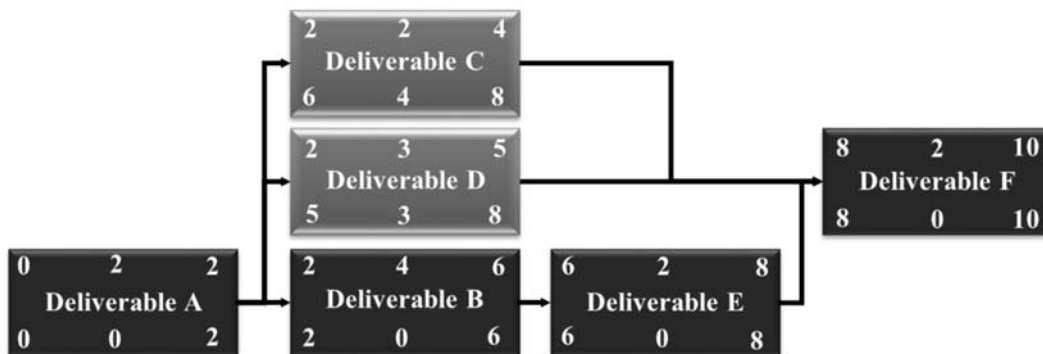


Image 53: A Completed CPM Diagram

corner of each box. The formula that will be used for the backward pass is:

$$LS = LF - DUR$$

Using this formula the calculation for deliverable F is $10 - 2 = 8$. An eight is placed in the lower left corner of deliverable F. The next step is to also place an eight in the lower right position of any deliverable that is a predecessor to deliverable F. In this case, deliverables C, D, and E are all required to complete deliverable F so an eight is placed in the lower right position of each of these boxes as well.

Just as with the forward pass, we always work in columns when completing the backward pass. That means deliverable E is the next value to be calculated. The late start value for deliverable E is $8 - 2 = 6$. The six is placed in the lower left position for deliverable E and also in the lower right position of deliverable B. The column of deliverables B, C, and D can all have their late start calculated.

- ⇒ Deliverable B = $6 - 4 = 2$
- ⇒ Deliverable C = $8 - 2 = 6$
- ⇒ Deliverable D = $8 - 3 = 5$

In the next column is another convergence point as deliverable A is a predecessor to deliverables B, C, and D. Remember the rule on the forward pass for convergence points? It was always take the largest value. On the backward pass, the rule is the exact opposite. On the backward pass, always take the smallest number. In this case, deliverable B has the smallest value with two. Therefore, two is placed in the lower right position of deliverable A and the final calculation for the backward pass is completed. The late start for deliverable A is $2 - 2 = 0$. The zero is placed in the lower left position of deliverable A.

The last task to complete the critical path method is to calculate the slack or float for each task, activity or deliverable. This is done by taking the absolute value difference between the top and bottom corners on either side. It does not matter which side you take as it will have the same result. Be careful here. Although it is theoretically possible to have negative slack or float by taking the real values and not the absolute value difference, it is not something you will see on the exam because that would mean your project should have started in the past. A negative value on the exam is quick clue that you have done something wrong.



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**The
Backward
Pass**

The slack or float appears as the middle value on the bottom of each deliverable. The values for the sample model are therefore as follows:

- ⇒ Deliverable A = $0 - 0 = 0$
- ⇒ Deliverable B = $2 - 2 = 0$
- ⇒ Deliverable C = $6 - 2 = 4$
- ⇒ Deliverable D = $5 - 2 = 3$
- ⇒ Deliverable E = $6 - 6 = 0$
- ⇒ Deliverable F = $8 - 8 = 0$

The critical path is where the slack or float is zero for every task, activity or deliverable. Therefore the critical path for this project is ABEF. So what does this really mean? If any of the tasks, activities or deliverables that are on the critical path slip, the overall delivery of the project will slip by an equal amount. When this happens, the first place the project manager should look to take resources away from is any simultaneous non-critical item. Another way of thinking about this is to ask yourself would you care if deliverables C or D slipped two weeks? The answer is no. In both cases you have at least three weeks slack or float, so such an occurrence would not impact the overall delivery of the project.

There are three additional terms which might appear on the exam, although rarely. These are as follows:

- ⇒ **Near-Critical Path** — This represents a project path that is close in duration to the critical path. A significant delay to the near-critical path could cause it to become critical. The closer these two paths are, the more risk the project has.
- ⇒ **Free Float** — This is the amount of time an activity can be delayed without delaying the early start of the successor activity.
- ⇒ **Project Float** — This is the amount of time an entire project can be delayed without delaying an externally imposed project completion date.

It is absolutely critical that you can successfully calculate CPM models because they often produce series questions on the exam. Because of that, a single model could potentially represent five different questions on the PMP® exam! Exam questions often ask you what the critical path is for a series of items, what the overall project duration is, or how much slack or float any particular item has. To ensure that you are prepared for these types of questions complete Exercise 9.

Exercise 9 — The Critical Path Method (CPM)



Exercise 9 — CPM

1. Using the included table what is the critical path for the project?

- A. B, C, D, F, G, H
- B. A, C, D, E, G, H
- C. A, B, C, D, E, F, G, H
- D. A, B, C, D, F, G, H

Task	Duration	Precedessor
A	5	N/A
B	8	N/A
C	6	A,B
D	7	C
E	3	D
F	4	D
G	9	F
H	4	E,G

2. Using the included table what is the project duration using CPM?

- A. 35
- B. 38
- C. 34
- D. 37

Task	Duration	Precedessor
A	5	N/A
B	8	N/A
C	6	A,B
D	7	C
E	3	D
F	4	D
G	9	F
H	4	E,G

3. Using CPM to evaluate the project represented by the included table, which of the following tasks are not on the critical path?

- A. A
- B. B
- C. D
- D. F

Task	Duration	Precedessor
A	5	N/A
B	8	N/A
C	6	A,B
D	7	C
E	3	D
F	4	D
G	9	F
H	4	E,G

4. What is the critical path for the included table?

- A. 1, 2, 6, 8, 11
- B. 1, 3, 5, 7, 11
- C. 1, 4, 9, 7, 11
- D. 1, 4, 9, 10, 11

Task	Duration	Predecessor
1	10	N/A
2	8	1
3	5	1
4	9	1
5	6	3
6	6	2
7	11	5
8	10	6
9	9	4
10	7	9
11	10	7, 8, 10

5. Using CPM and the included table, what is the project duration?

- A. 44
- B. 42
- C. 45
- D. 51

Task	Duration	Predecessor
1	10	N/A
2	8	1
3	5	1
4	9	1
5	6	3
6	6	2
7	11	5
8	10	6
9	9	4
10	7	9
11	10	7, 8, 10

6. Based upon the included table and CPM, which of the following tasks is not critical?

- A. 1
- B. 2
- C. 4
- D. 10

Task	Duration	Predecessor
1	10	N/A
2	8	1
3	5	1
4	9	1
5	6	3
6	6	2
7	11	5
8	10	6
9	9	4
10	7	9
11	10	7, 8, 10

7. Based upon the included table and CPM, which of the following tasks is not critical?

- A. 4
- B. 9
- C. 6
- D. 10

Task	Duration	Predecessor
1	10	N/A
2	8	1
3	5	1
4	9	1
5	6	3
6	6	2
7	11	5
8	10	6
9	9	4
10	7	9
11	10	7, 8, 10

8. What is the critical path for the included table?

- A. A, C, F, H, K, M
- B. A, D, G, L, M
- C. A, B, E, H, K, M
- D. A, B, E, I, J, M

Task	Duration	Predecessor
A	15	N/A
B	7	A
C	12	A
D	9	A
E	5	B
F	8	C
G	14	D
H	6	F
I	13	E
J	14	I
K	12	H
L	15	G
M	9	J, K, L

9. Using the included table what is the project duration using CPM?

- A. 59
- B. 63
- C. 67
- D. 61

Task	Duration	Predecessor
A	15	N/A
B	7	A
C	12	A
D	9	A
E	5	B
F	8	C
G	14	D
H	6	F
I	13	E
J	14	I
K	12	H
L	15	G
M	9	J, K, L

10. Using CPM to evaluate the project represented by the included table, which of the following tasks are not on the critical path?

- A. A
- B. B
- C. C
- D. J

Task	Duration	Predecessor
A	15	N/A
B	7	A
C	12	A
D	9	A
E	5	B
F	8	C
G	14	D
H	6	F
I	13	E
J	14	I
K	12	H
L	15	G
M	9	J, K, L

11. Using CPM to evaluate the project represented by the included table, which of the following tasks are not on the critical path?

- A. F
- B. E
- C. I
- D. J

Task	Duration	Predecessor
A	15	N/A
B	7	A
C	12	A
D	9	A
E	5	B
F	8	C
G	14	D
H	6	F
I	13	E
J	14	I
K	12	H
L	15	G
M	9	J, K, L

12. Using the included table what is the critical path for the project?

- A. 1, 3, 6, 7, 9, 10
- B. 1, 3, 6, 7, 8, 10
- C. 1, 2, 5, 7, 8, 10
- D. 1, 2, 5, 7, 9, 10

Task	Duration	Predecessor
1	9	N/A
2	13	1
3	8	1
4	7	1
5	5	2
6	6	3, 4
7	18	5, 6
8	7	7
9	9	7
10	11	9

13. Using the included table what is the project duration using CPM?

- A. 66
- B. 51
- C. 48
- D. 62

Task	Duration	Predecessor
1	9	N/A
2	13	1
3	8	1
4	7	1
5	5	2
6	6	3, 4
7	18	5, 6
8	7	7
9	9	7
10	11	9

14. Using CPM to evaluate the project represented by the included table, which of the following tasks are not on the critical path?

- A. 2
- B. 5
- C. 3
- D. 9

Task	Duration	Predecessor
1	9	N/A
2	13	1
3	8	1
4	7	1
5	5	2
6	6	3, 4
7	18	5, 6
8	7	7
9	9	7
10	11	9

15. Using the included table what is the critical path for the project?

- A. A, B, C, F, G, H
- B. A, B, D, F, G, H
- C. A, B, C, D, E, H
- D. A, B, D, E, H

Task	Duration	Predecessor
A	5	N/A
B	8	A
C	4	B
D	6	B
E	12	D
F	5	C
G	7	F
H	7	E, G

16. Using the included table what is the project duration using CPM?

- A. 38
- B. 36
- C. 42
- D. 40

Task	Duration	Predecessor
A	5	N/A
B	8	A
C	4	B
D	6	B
E	12	D
F	5	C
G	7	F
H	7	E, G

17. Using the included table what is the critical path for the project?

- A. 2, 4, 8, 9
- B. 1, 3, 5, 6, 9
- C. 2, 4, 8, 7, 9
- D. 1, 3, 5, 7, 9

Task	Duration	Predecessor
1	12	N/A
2	8	N/A
3	7	1
4	11	2
5	9	3
6	6	5
7	5	5
8	11	4
9	10	6, 7, 8

18. Using the included table what is the project duration using CPM?

- A. 45
- B. 43
- C. 44
- D. 46

Task	Duration	Predecessor
1	12	N/A
2	8	N/A
3	7	1
4	11	2
5	9	3
6	6	5
7	5	5
8	11	4
9	10	6, 7, 8

19. Using the included table what is the critical path for the project?

- A. A, B, D, G, J, L, M
- B. A, C, E, H, I, L, M
- C. A, C, E, G, J, L, M
- D. A, B, F, G, K, L, M

Task	Duration	Predecessor
A	6	N/A
B	5	A
C	8	A
D	7	B
E	9	B, C
F	4	C
G	10	D, E
H	7	E, F
I	9	G
J	6	G, H
K	4	H
L	5	J, K
M	8	I, L

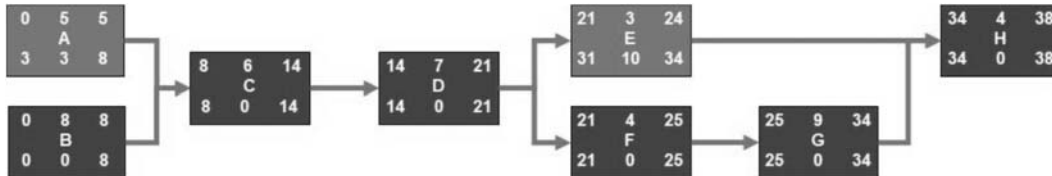
20. Using the included table what is the project duration using CPM?

- A. 52
- B. 49
- C. 50
- D. 54

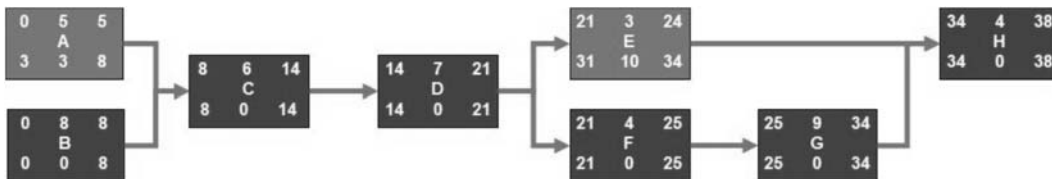
Task	Duration	Predecessor
A	6	N/A
B	5	A
C	8	A
D	7	B
E	9	B, C
F	4	C
G	10	D, E
H	7	E, F
I	9	G
J	6	G, H
K	4	H
L	5	J, K
M	8	I, L

Exercise 9 — Critical Path Method Answers

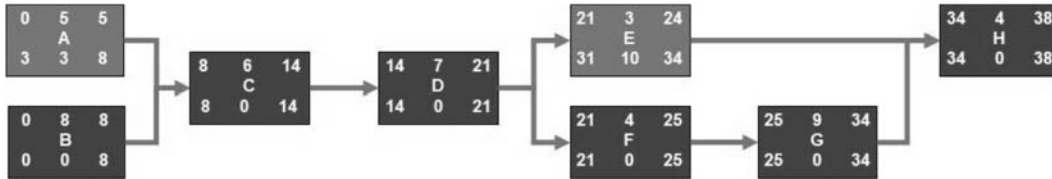
- Answer A.** The critical path is the longest path of dependent tasks with no slack or float. It requires you to first do a forward pass and then a backward pass. Any task where the late start – early start or late finish – early finish equal zero is on the critical path. The Critical Path for this model is B, C, D, F, G, H.



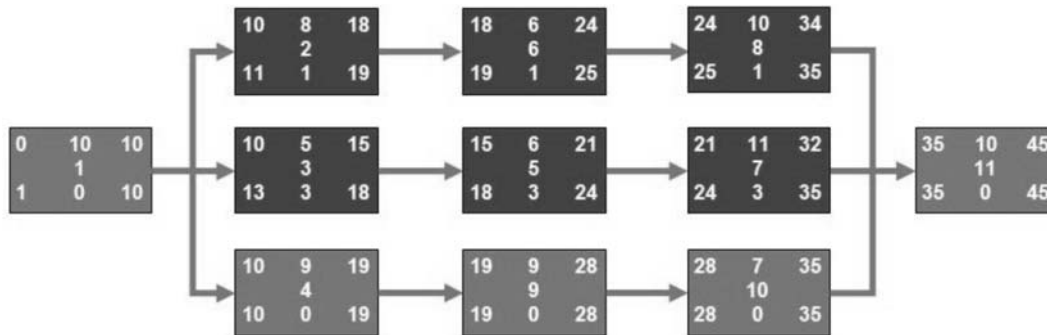
- Answer B.** Calculating the duration of the critical path is done by first building the Precedence Diagram. Once that is done enter the task durations and complete the forward and backward pass by evaluating the differences between the late and early start or the late and early finish. The longest chain of dependent tasks with zero slack or float is the critical path. The project duration for this model is 38.



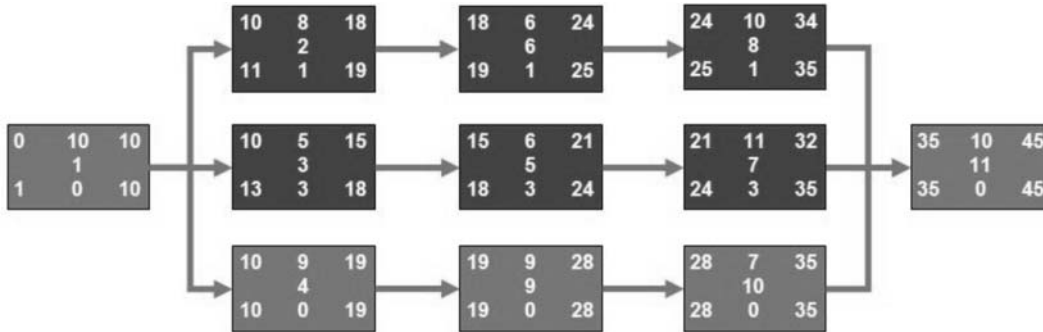
- Answer A.** Task A has slack or float of 3. By definition, any task or deliverable with float greater than zero is not on the critical path.



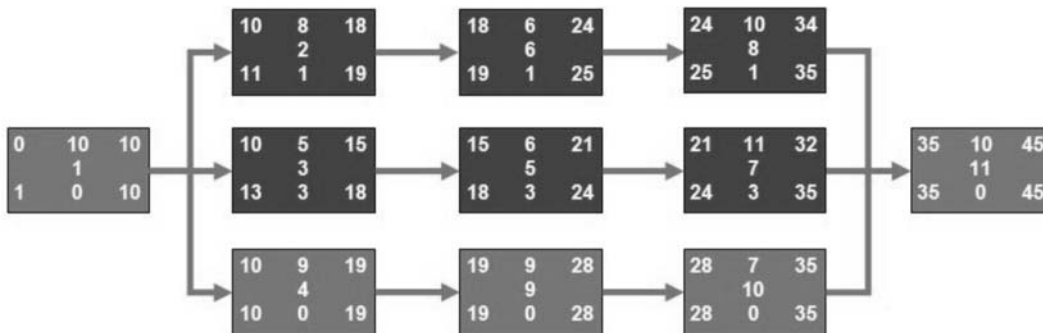
- Answer D.** Calculating the critical path is done by first building the Precedence Diagram. Once that is done enter the task durations and complete the forward and backward pass by evaluating the differences between the late and early start or the late and early finish. The longest chain of dependent tasks with zero slack or float is the critical path. In this case the Critical Path is 1, 4, 9, 10, 11.



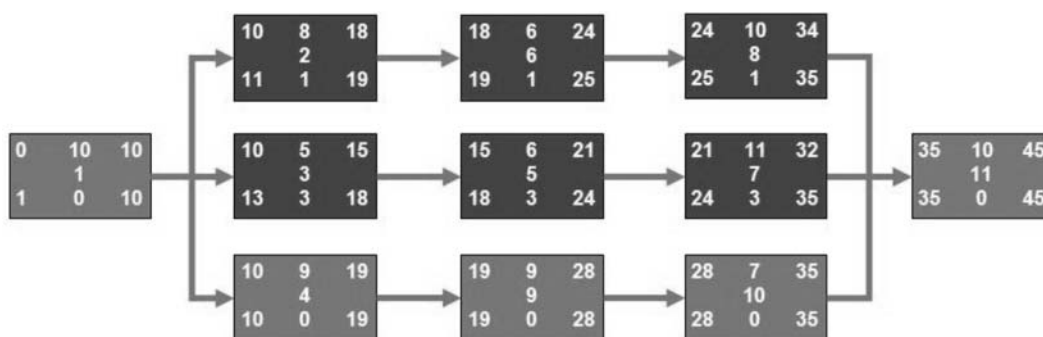
5. **Answer C.** Calculating the duration of the critical path is done by first building the Precedence Diagram. Once that is done, enter the task durations and complete the forward and backward pass by evaluating the differences between the late and early start or the late and early finish. The longest chain of dependent tasks with zero slack or float is the critical path. Summing this time provides the project duration. The correct project duration is 45.



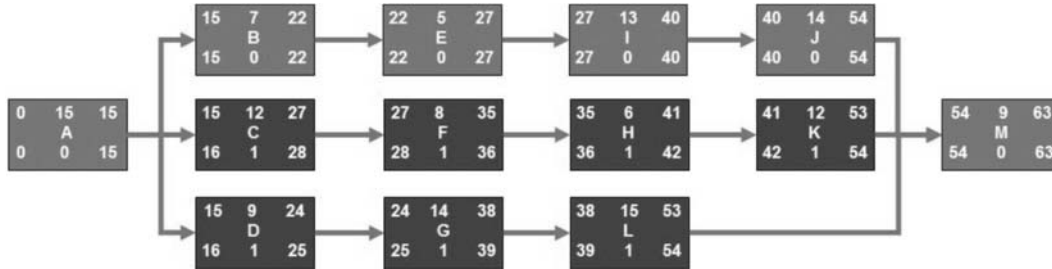
6. **Answer B.** Task 2 has slack or float of 1. By definition, any task or deliverable with float greater than zero is not on the critical path.



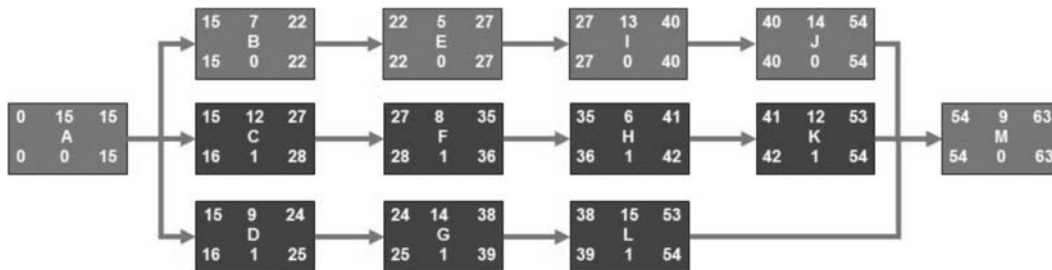
7. **Answer C.** Task 6 has slack or float of 1. By definition, any task or deliverable with float greater than zero is not on the critical path.



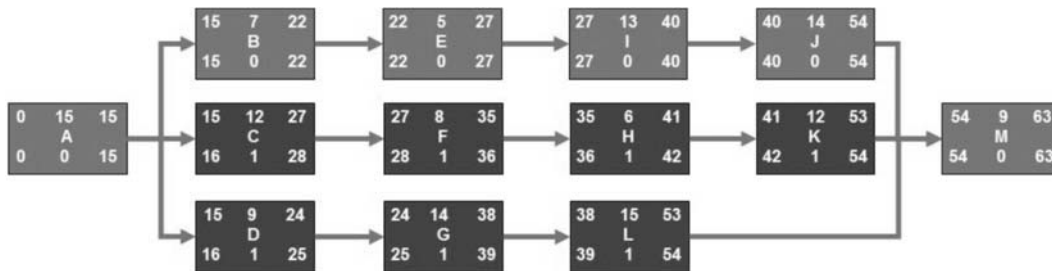
8. **Answer D.** Determining the critical path is done by first building the Precedence Diagram. Once that is done, enter the task durations and complete the forward and backward pass. By evaluating the differences between the late and early start or the late and early finish. The longest chain of dependent tasks with zero slack or float is the critical path. The Critical Path in this case is A, B, E, I, J, M.



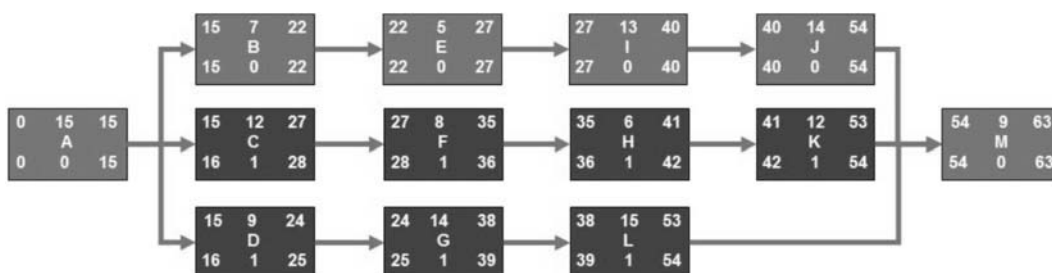
9. **Answer B.** Calculating the duration of the critical path is done by first building the Precedence Diagram. Once that is done, enter the task durations and complete the forward and backward pass by evaluating the differences between the late and early start or the late and early finish. The longest chain of dependent tasks with zero slack or float is the critical path. This project duration is 63.



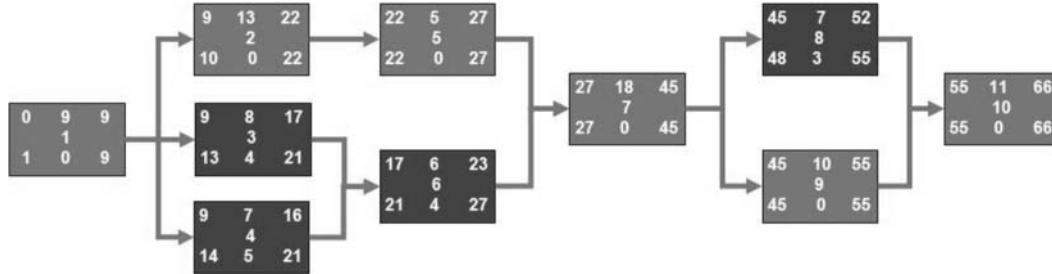
10. **Answer C.** Task C has slack or float of 1. By definition, any task or deliverable with float greater than zero is not on the critical path.



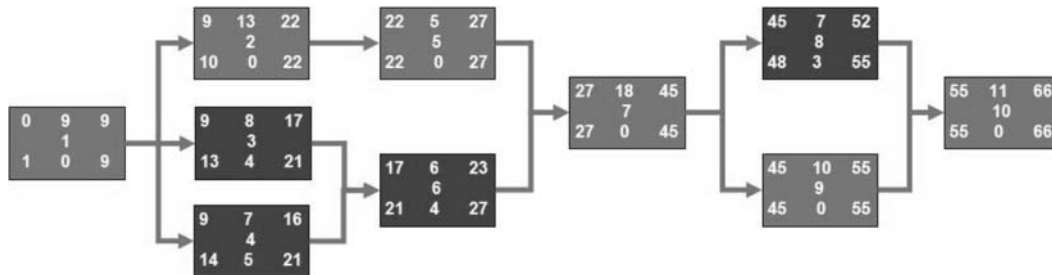
11. **Answer A.** Task F has slack or float of 1. By definition, any task or deliverable with float greater than zero is not on the critical path.



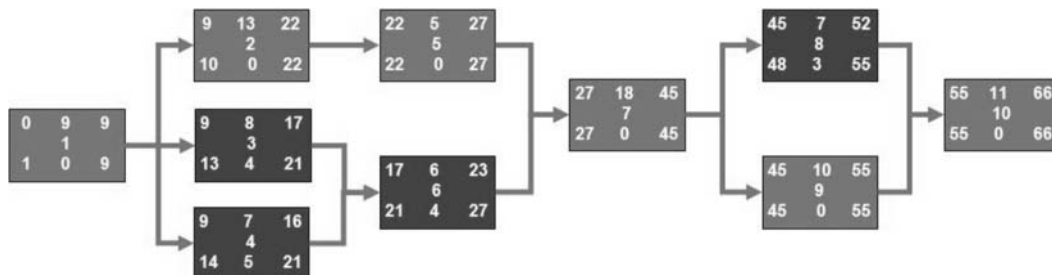
12. **Answer D.** Calculating the critical path is done by first building the Precedence Diagram. Once that is done, enter the task durations and complete the forward and backward pass by evaluating the differences between the late and early start or the late and early finish. The longest chain of dependent tasks with zero slack or float is the critical path. In this case the Critical Path is 1, 2, 5, 7, 9, 10.



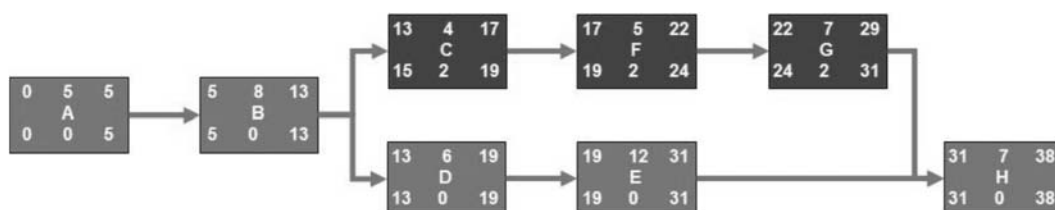
13. **Answer A.** Calculating the duration of the critical path is done by first building the Precedence Diagram. Once that is done, enter the task durations and complete the forward and backward pass by evaluating the differences between the late and early start or the late and early finish. The longest chain of dependent tasks with zero slack or float is the critical path. This project's duration is 66.



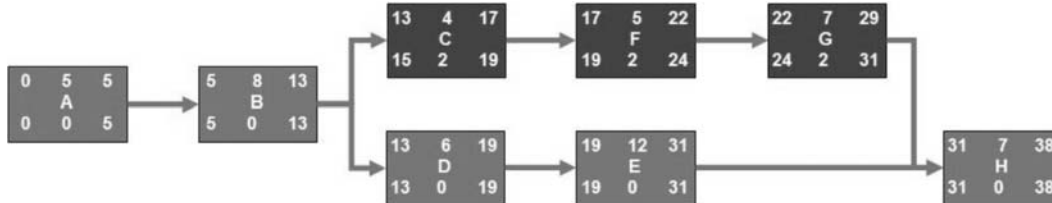
14. **Answer C.** Task 3 has slack or float of 4. By definition, any task or deliverable with float greater than zero is not on the critical path.



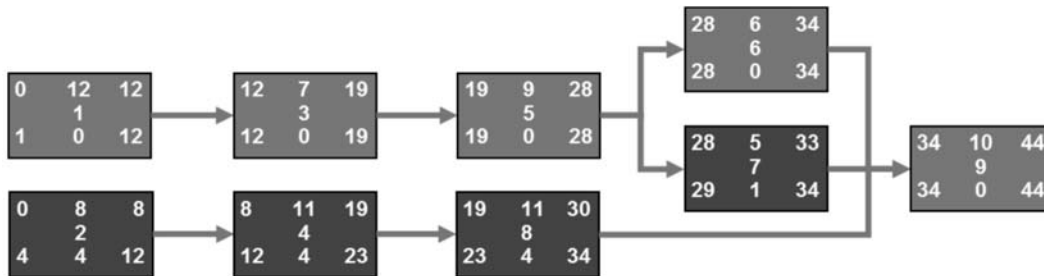
15. **Answer D.** Calculating the critical path is done by first building the Precedence Diagram. Once that is done, enter the task durations and complete the forward and backward pass by evaluating the differences between the late and early start or the late and early finish. The longest chain of dependent tasks with zero slack or float is the critical path. The Critical Path for this project is A, B, D, E, H.



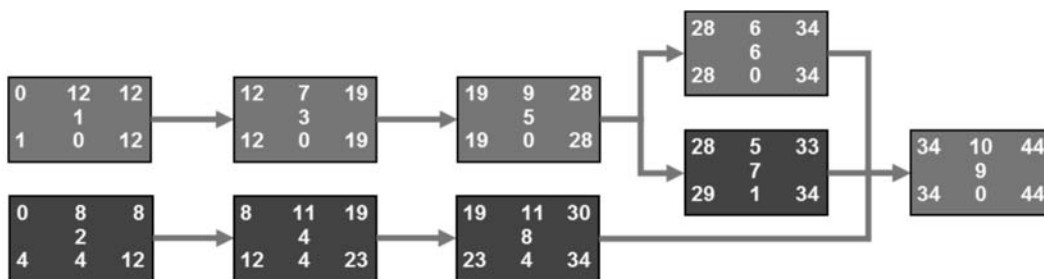
16. **Answer A.** Calculating the duration of the critical path is done by first building the Precedence Diagram. Once that is done, enter the task durations and complete the forward and backward pass by evaluating the differences between the late and early start or the late and early finish. The longest chain of dependent tasks with zero slack or float is the critical path. This project's duration is 38.



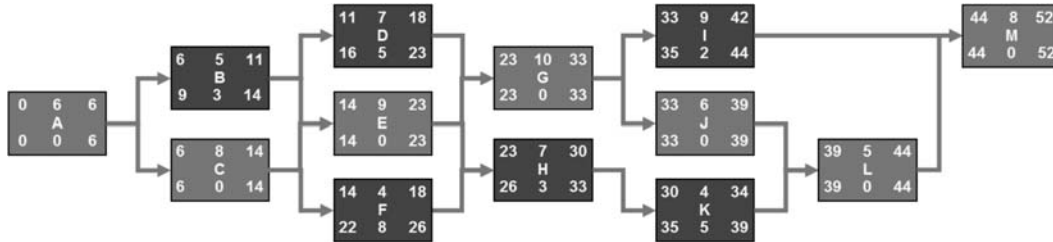
17. **Answer B.** Calculating the critical path is done by first building the Precedence Diagram. Once that is done, enter the task durations and complete the forward and backward pass by evaluating the differences between the late and early start or the late and early finish. The longest chain of dependent tasks with zero slack or float is the critical path. This project's Critical Path is 1, 3, 5, 6, 9.



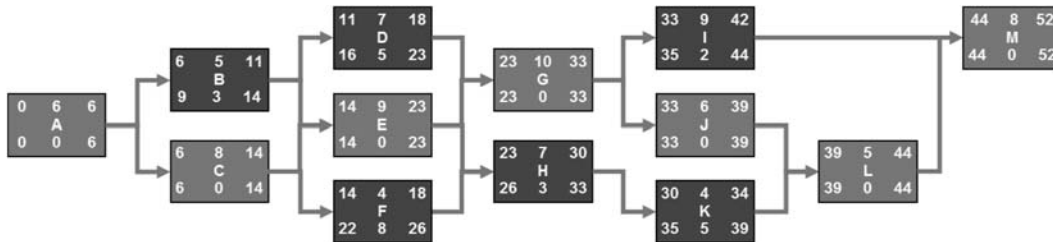
18. **Answer C.** Calculating the duration of the critical path is done by first building the Precedence Diagram. Once that is done, enter the task durations and complete the forward and backward pass by evaluating the differences between the late and early start or the late and early finish. The longest chain of dependent tasks with zero slack or float is the critical path. This project's duration is 44.



19. **Answer C.** Calculating the critical path is done by first building the Precedence Diagram. Once that is done, enter the task durations and complete the forward and backward pass by evaluating the differences between the late and early start or the late and early finish. The longest chain of dependent tasks with zero slack or float is the critical path. The diagram shows the Critical Path for this model is A, C, E, G, J, L, M.



20. **Answer A.** Calculating the duration of the critical path is done by first building the Precedence Diagram. Once that is done, enter the task durations and complete the forward and backward pass by evaluating the differences between the late and early start or the late and early finish. The longest chain of dependent tasks with zero slack or float is the critical path. In this case the project duration is 52.



Resource Leveling and Critical Chain Methodology

Once the critical path has been determined, the network can be laid on a calendar to determine the start and end dates for the project. Before these dates are determined, however, it is important that all resources are leveled. Optimizing resources ensures that no resource is being tasked with accomplishing more work than can be reasonably completed. This happens whenever a resource is tasked with doing more than one task, activity or deliverable at a time. *Image 54* shows this situation for a two week period.

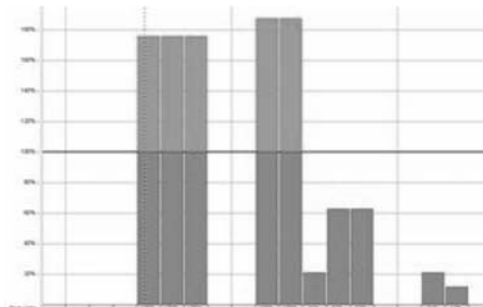


Image 54: An over allocated resource

Each column represents a specific day. The two bar wide gap represents weekend days, and the dark horizontal line that appears halfway up the graph is the maximum efficiency for any day. Where there is a bar above the horizontal line, the resource is over-allocated. Leveling the resource takes the work above the horizontal bar and moves it to days where the resource has capacity. Leveling a project's resources will often extend the schedule, but it is an important step to ensure the success of the project.

In the real world of project management, many project managers do not level their resources as part of the planning process. This is probably OK for minor overages, but it becomes a disaster when there are multiple projects using the same resource pool or when it is for a very large project where each resource might own a number of tasks, activities or deliverables.

In the late 1990's a new scheduling methodology was introduced to address the problem of resource constraints called **critical chain project management or CCPM**. CCPM first appeared in 1997 in the business novel *Critical Chain* by **Eliyahu Goldratt**. In the novel Goldratt applied his **theory of constraints** to the field of project management. The PMBOK® Guide also mentions CCPM, but does not cover the topic in a significant way. The limited coverage of the topic by the PMBOK® Guide has created a great deal of confusion by the authors of many PMP® exam prep books. Many do not understand the topic, so they choose to ignore it. The best advice is to not take such a risk and instead study the topic. Although it is unlikely that you will have to calculate a CCPM network, do not be surprised if you see some questions about critical chain methodology. You must be prepared.

To understand CCPM you need to begin by understanding Goldratt's theory of constraints. Goldratt argues that the business world is divided into two camps: the cost world and the production world. The objective of those who live in the cost world is to reduce costs. The objective of those who live in the production world is to increase production. Unfortunately, these goals have an adverse impact on each other. When you decrease costs you often decrease production. On the other hand, when you increase production you often increase costs. The real goal is to increase production while decreasing costs. To meet this goal,



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Goldratt argues that you must first understand what is preventing success. It is here that Goldratt introduces his Theory of Constraints.

Goldratt contends that in any system there is only one constraint at a time. It is the one thing that acts as a bottleneck. To resolve this bottleneck you must follow a simple process:

- ⇒ Identify the system constraint
- ⇒ Exploit the constraint
- ⇒ Subordinate everything to the constraint
- ⇒ Elevate the systems' constraints
- ⇒ Repeat the process

When this process is applied to project management, the constraining factor (according to Goldratt) is resources—specifically the tendency to have a single resource assigned to multiple tasks, activities or deliverables at the same time. This problem becomes compounded as the resource pool is shared across projects. However, simply leveling the resources on a project largely fails to resolve the issue of resource constraints because there are a number of other issues tied to the problem. These issues include the following:

- ⇒ **Probability and not precision** — Most people assume project estimates are precise, but they are actually exercises in probability and not precision.
- ⇒ **Misplaced safety** — In most cases, 50% of every existing duration estimate is safety—yet we struggle to hit targets. One of the major causes for this is that resources generally use the safety at the beginning of tasks, activities or deliverables, instead of at the end when it might do some good.
- ⇒ **Delays accumulate and advances get wasted** — The intent of project management is to deliver the overall project within the schedule baseline. To accomplish this, most people manage each task, activity or deliverable to its deadline, assuming that perfection in the parts will result in the desired whole. Unfortunately, it doesn't work like that. In the real world, sometimes people are early and sometimes they are late. To achieve success we have to be able to pass safety between tasks, activities or deliverables—and that can't be done easily.

There are several other factors that Goldratt discusses, but what we have discussed so far provides you with a general background to the CCPM. The basic goal is to produce a scheduling system that takes these factors into consideration and puts the project manager—rather than the individual resources—in charge of the safety.

The critical chain is defined as the longest chain of dependent tasks, activities or deliverables with zero slack or float (*sound familiar?*) that takes into consideration the resource constraints. Here are the steps to complete a critical chain model:

- ⇒ Complete the critical path model as discussed in the last section.



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- ⇒ Cut all duration estimates in half, thereby leaving the project finish date as defined in CPM. There will then be a large gap to the left of the project, closer to the beginning.
- ⇒ Level the resources so that no resource is ever doing more than one thing at a time. In selecting which tasks, activities, or deliverables to move, always select the ones which have the smallest impact on the schedule.
- ⇒ Determine the critical chain by following the logical dependencies and by only moving off of the logical path when a single resource is asked to do two or more things in succession.
- ⇒ Add the project buffer to the end of the critical chain using 30%, 25%, or the sum of the squares methods. Allow the project to be pushed to the left towards the start date.
- ⇒ Add up the lengths of the non-critical chains and add feed buffers wherever the non-critical chains feed into the critical chain. As before, allow items to be pushed to the left.
- ⇒ Add resource buffers in front of the first task, activity, or deliverable whenever a single resource is asked to do a series of items in succession.

To measure progress on a project using critical chain project management measure the percent of the project complete versus the burn rate of the project buffer. They should be close to equal. *Image 50* shows a critical chain diagram with all its buffers.

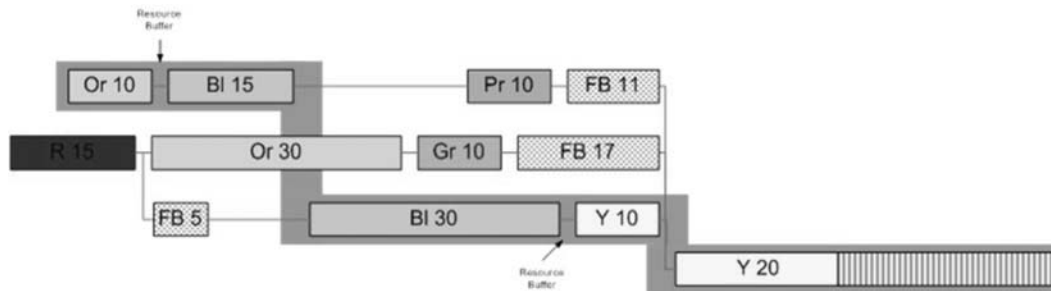


Image 55: A CCPM Diagram

Exercise 10 — Critical Chain Project Management



Exercise 10—CCPM

1. When comparing the Critical Chain to the Critical Path which of the following is true?
 - A. The Critical Path accounts for resource limitations
 - B. The Critical Chain accounts for resource limitations
 - C. The Critical Path uses aggressive estimates
 - D. The Critical Chain uses pessimistic estimates
2. The Critical Chain Methodology schedules each activity to:
 - A. Occur as late as possible
 - B. Occur as soon as possible
 - C. Occur with the middle schedule
 - D. Any of the above
3. The Critical Chain Method focuses on managing what?
 - A. Total project float
 - B. The Critical Path
 - C. Buffers
 - D. Specific network paths
4. What is the major difference between the Critical Path and the Critical Chain?
 - A. The Critical Path takes into account resources
 - B. The Critical Path is always longer
 - C. The Critical Chain is always longer
 - D. The Critical Chain takes into account resources
5. Which of the following statements about the Critical Chain is true?
 - A. Critical Path management does not allow multi-tasking
 - B. Critical Chain management uses bar charts
 - C. Critical Chain management does not allow multi-tasking
 - D. All of the above are true
6. Which of the following statements about Critical Chain Management is true?
 - A. It is a methodology that creates an optimized project schedule that considers resource limitations
 - B. It is a methodology that works best when resources are unlimited but schedule milestones are restricted
 - C. It makes extensive use of PERT
 - D. It is used primarily with Agile Methodologies in information technology projects.

7. Which of the following is not a step in the Theory of Constraints (TOC)?
- Identify the constraint
 - Identify the next systems' constraint
 - Exploit the constraint
 - Subordinate everything to the constraint
8. According to the TOC most current management philosophies focus on what?
- Throughput management
 - Schedule management
 - Cost management
 - Balancing all of the above
9. According to the TOC, what is the only way to achieve good cost performance?
- Achieve good local performance everywhere
 - Manage costs throughout the system
 - Have visibility to all costs
 - Have all project team members know the project costs

10. Using the table below, what is the project's Critical Chain excluding feed buffers and assuming 30% for all other buffers? Assume all estimates have already been halved.

- 1, 3, 5, 7, 10
- 1, 2, 6, 8, 10
- 1, 4, 8, 10
- 1, 2, 5, 7, 10

Task	Predecessor	Duration	Resource
1	N/A	10	AB
2	1	8	OD
3	1	5	GE
4	1	9	MR
5	3	6	OD
6	2	15	AB
7	5	11	GE
8	4	10	AB
9	N/A	7	MR
10	6, 7, 8, 9	9	MR

11. Using the table below, what is the length of the project's critical chain excluding feed buffers and assuming 30% for all other buffers?

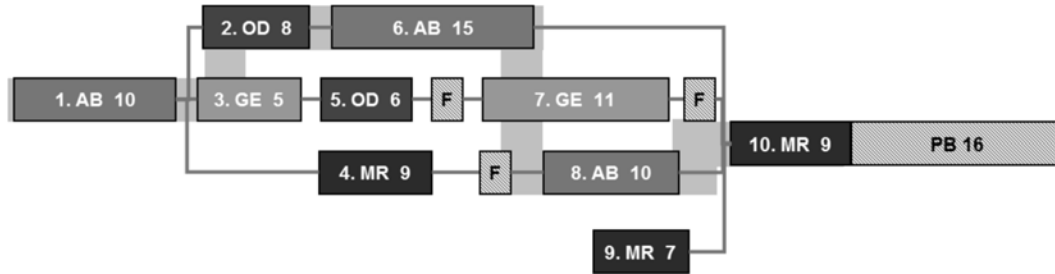
- 73
- 62
- 95
- 52

Task	Predecessor	Duration	Resource
A	N/A	15	1
B	A	7	2
C	A	12	3
D	A	9	2
E	B	5	1
F	C	8	4
G	D	14	4
H	F	6	2
I	E	13	3
J	I	8	2
K	H	12	1
L	G	15	3
M	J, K, L	9	4

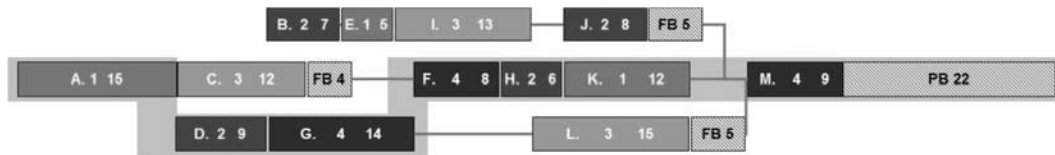
Exercise 10 — Critical Chain Project Management Answers

1. **Answer B.** The Critical Chain is the longest chain of dependent tasks with zero slack or float taking into consideration resource constraints. The difference between the Critical Path and the Critical Chain is the resource considerations. When using the Critical Chain Methodology it is important that you use true, most likely case estimates without safety.
2. **Answer A.** The Critical Chain Method requires the creation of a PDM Diagram and then scheduling from the late finish date for each activity asks the project manager to add in resource, feeder and project buffers.
3. **Answer C.** Critical Chain Management focuses on managing the three different types of project buffers: Project, feeder, and resource.
4. **Answer D.** While in most cases the Critical Chain will be longer, there is no set rule guaranteeing it. However, it is true that the Critical Chain does take into account resource limitations while the Critical Path does not.
5. **Answer C.** Because CCPM focuses on the longest chain of dependent tasks that takes into account resource constraints, it specifically excludes multi-tasking.
6. **Answer A.** The core argument of Critical Chain Management is that most projects fail because they do not consider the limitations of the resources. This means that one resource cannot be doing two tasks at the same time. When this happens, the resource in question becomes the bottleneck and will delay the project.
7. **Answer B.** The Theory of Constraints has five major steps:
 - A. Identify the system constraint
 - B. Exploit the constraint
 - C. Subordinate everything to the constraint
 - D. Elevate the systems' constraints
 - E. Repeat the process
8. **Answer C.** According to the Theory of Constraints, most current management philosophies focus on either cost or throughput management. In reality, most are simply focused on cost management.
9. **Answer A.** According to the Theory of Constraints, the only way to achieve good cost performance is to achieve it at each local or independent stage of the process. This localizing factor becomes a major problem for overall project performance because this can be very different from good overall project cost performance. Sometimes a local step needs to be sacrificed to ensure good overall performance.

10. **Answer B.** 1, 2, 6, 8, 10. The Critical Chain is the longest chain of dependent tasks with zero slack or float, taking into consideration resource constraints. Tasks 2 and 5 as well as 6 and 8 are done by the same resource and must be leveled to create the Critical Chain.



11. **Answer A.** 73. The project's Critical Chain is determined by first determining the project's network using PDM. Then resources and durations are assigned to each task. Tasks are then leveled to account for resource limitations. The longest chain of dependent tasks (taking into consideration resource limitations) is then determined. This path is summed to provide the time of the project's Critical Chain which does not include buffers of any kind.



The Agile world does not typically use either the critical path or critical chain method. Instead, Agilists use tools such as a story map to represent the timing of a project. A story map is a two dimensional graphic. It arranges the project features or user stories first on the horizontal axis to represent the item's rough priority with the highest priority items at the left and lowest on the right. The vertical axis represents increasing sophistication of the implementation. What this creates is a diagram where the first horizontal row represents what is called a "walking skeleton", or a barebones but usable version of the project's product. As the team works through successive rows they add features to the product with additional functionality. Often distinct columns are used in the story map to represent iterations or releases. *Image 56* shows a sample story map.

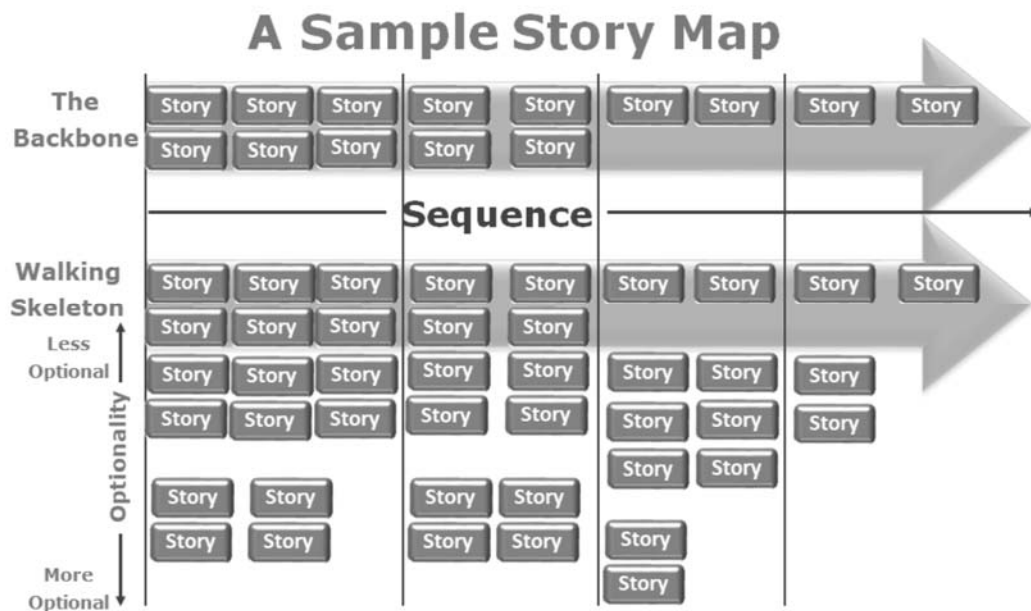


Image 56: A Sample Story Map

We have reviewed most of the tools and techniques used in the develop schedule process, but to ensure that you don't miss anything let's review the entire develop schedule process formally.

The inputs to the develop schedule process include the following:

- ⇒ **.1 Project management plan** — Within the project management plan, the schedule management plan and scope baseline are critical to develop the schedule. This is because these two documents define what has to be scheduled and how the schedule is to be developed and managed.
- ⇒ **.2 Project documents** — The project documents represent a very big list. Within that list, PMI® provides some more specific guidance. The team needs to examine the activity list, and the activity attributes. These items represent the work you are scheduling. You must also examine the assumption log, the duration estimates and the basis of estimates as a big part of this process is summing the estimates in the correct sequence to develop

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the schedule. As you go through this effort you must also learn from previous projects through the lessons learned register and make sure you are aware of any milestones that exist as they can significantly alter the schedule. Knowing the correct sequence of activities comes from the schedule network diagram. Understanding when that work can be completed requires the resource requirements, the team assignments, and the resource calendars. Finally, the team must always look at the risk register to understand any potential risks on the project.

- ⇒ **.3 Agreements** — Any contracts or agreements the organization has that may impact how the work is done require careful examination.
- ⇒ **.4 Organizational process assets** — Any time the project manager has organizational process assets which could make their job easier or faster they should be used.
- ⇒ **.5 Enterprise environmental factors** — Like most of the processes, enterprise environmental factors are at play in scheduling.

The tools and techniques for the develop schedule process include the following:

- ⇒ **.1 Schedule network analysis**— Precedence diagramming is the primary technique used to produce network diagrams. You must be very familiar with PDM. However, you might also see questions requiring you to recognize Conditional Diagramming and GERT. You must examine those diagrams to determine the best way to get the project done.
- ⇒ **.2 Critical path method** — CPM is the primary method used by PMI® to develop project schedules. You must be very good at working through CPM models to pass the exam because there can be several questions that refer back to one CPM model.
- ⇒ **.3 Resource optimization** — Resource optimization is done in order to ensure that no resource is ever assigned to more work than can reasonably be done. There are two aspects of resource optimization: resource leveling and resource smoothing. Be careful as these terms do **NOT** mean the same thing and they are **NOT** interchangeable.

Linear methodologies use one of two types of scheduling, **resource constrained scheduling** or RCS and **time constrained scheduling** or TCS. In resource constrained scheduling the team is limited to a defined set of resources. This means the project is limited by the number of hours those resources can work in a day, and while they can work overtime, research has shown that the more overtime a resource works the less efficient they become. Often the initial project schedule shows the same resource working on multiple activities at the same time even though common sense says this is impossible. The assignment of a resource to more work than they have available time is called **over allocation**. This over allocation can happen because of the total amount of work assigned to a resource or because of a calendar constraint (e.g. the resource is assigned too much work but only for a short period of time).

Resource leveling involves adjusting the start and finish dates of tasks to prevent resources from becoming over allocated. Leveling often causes the project's critical path to change, but the process begins by examining all available float. Work is then moved until no resource has more work assigned than they can handle. This process will often extend the project completion date.

Resource smoothing adjust the project activities so they do not exceed predefined resource limits. This is different from leveling in that smoothing does not allow the project's critical path to change and the project's completion date cannot be delayed. The goal in resource smoothing is to maximize the utilization of all the resources on the team, but not at the expense of the delivery date. Therefore, it is entirely possible that one or more resources cannot be optimized because doing so would cause delays in the project delivery date. The tables below compares and contrasts resource smoothing with leveling.

Similarities	
Resource Leveling	Resource Smoothing
A schedule network analysis technique.	A schedule network analysis technique.
A resource optimization technique.	A resource optimization technique.
Improves resource utilization.	Improves resource utilization.

Image 57: Taken from Satya Narayan Dash Nov.3 2015 MPUG

Differences	
Resource Leveling	Resource Smoothing
Aim is to adjust start and end dates of a project with resource constraints while balancing resource requirements and resource availability	Aim is to achieve optimal resource usage by avoiding peaks and valleys in the resource usage profile. Hence the name smoothing.
Used in resource-constrained scheduling.	Used in time-constrained scheduling.
Critical path of the project will be affected, and usually the length of critical path will increase.	Critical path of the project won't change.
Can be applied to resources on critical path.	Doesn't apply to resources on critical path.
Free and total float (or slack) may be used.	Free and total float (or slack) are used.
Will optimize all the resources and may change the duration of the project.	May not be able to optimize all the resources if sufficient slack (or float) isn't available, but does not change the duration of the project.
Risk: May change the critical path and hence the duration.	Risk: Loss of flexibility due to reduction in slack. Hence chances of increase in number of near-critical activities.

Image 58: Taken from Satya Narayan Dash Nov.3 2015 MPUG



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- ⇒ **.4 Data analysis** — There are a number of data analysis techniques the team can use, but PMI® calls out two specifically: what-if scenario analysis; and simulations.

What-if scenario analysis is much older than you might expect. It is the process of creating a range of unique conditions with definable variables and then evaluating them when changes are made to the specific drivers. It is asking the question, “what is the result if this variable changes?” What-If scenario analysis increases in popularity as the risk of the project rises, and has been greatly impacted by advances in computer technology. This technology allows project teams to quickly set up their basic model and then move individual variables to determine the impact of one driver at a time.

Simulations allow the team to pretend to complete project work without actually doing it or incurring the expense. This is done to evaluate area of uncertainty to gain a better understanding of how specific aspects of the project are impact the whole. The most common simulation technique is a Monte Carlo analysis. **Monte Carlo** analysis is relatively new, and is a result significant advances over the last ten years in computer processing power. Monte Carlo analysis begins with the user establishing a basic equation that describes the situation. This can be as simple as:

$$\text{Activity A Duration} + \text{Activity B Duration} + \text{Activity C Duration} = \text{Total}$$

The user then defines the curve of each variable. This is where the distribution types discussed in the last process come into play. Imagine our scenario with A having a normal distribution, B having a binomial distribution and C having a triangular distribution. With each variable the user also defines what are called the “tails” or the limits of the variable’s potential values. Once that is complete the user initiates the analysis and the program generates 1,000 instances of the model randomly selecting values for each variable using the curve and defined range. Once complete, the user can then determine the probability of achieving any result in seconds. At the simplest level, a Monte Carlo analysis allows the team to determine the likelihood of completing the project by a specific target date and what must change to improve those chances.

- ⇒ **.5 Leads and lags** — Leads and lags are used to allow dependent tasks, activities or deliverables to begin either prior to their predecessor being completed or after a delay, based upon the nature of the work or on other conditions. Both leads and lags can significantly impact a schedule.
- ⇒ **.6 Schedule compression** — Schedule compression is shrinking the schedule to meet a specific target such as a deadline. A major assumption with schedule compression is that the project scope is maintained. When compressing a schedule there are only two choices:



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- ◇ **Fast Tracking** — Fast Tracking is doing dependent items in parallel. It amounts to changing a finish-to-start relationship to a start-to-start or a finish-to-finish relationship. For the exam it is important that you remember that the negative impact of Fast Tracking is the potential for rework.
 - ◇ **Crashing** — Crashing is increasing the number of hours worked. This can be done by adding resources assigned to a task, activity or deliverable or by simply working overtime. The negative impact of Crashing that must be remembered is a likely increase in costs.
- ⇒ **.7 Project management information system** — Throughout this process we have described many situations making use of computer technology. The PMIS is often the tool providing these capabilities and is therefore a critical tool.
- ⇒ **.8 Agile release planning** — In agile development a release is a group of iterations put into production together to gain some advantage. In Scrum, those iterations are called sprints and the team might choose to group three or four sprints together because the organization has set production windows that allow for the introduction of new functionality. The process of release planning involves the team determining the number of small iterations in the project and how they will be combined into sprints. Then the team places this information on a calendar to provide a product roadmap that is typically three to six months in length. This information allows the customer to understand when they will receive the various components of functionality based on the current information.

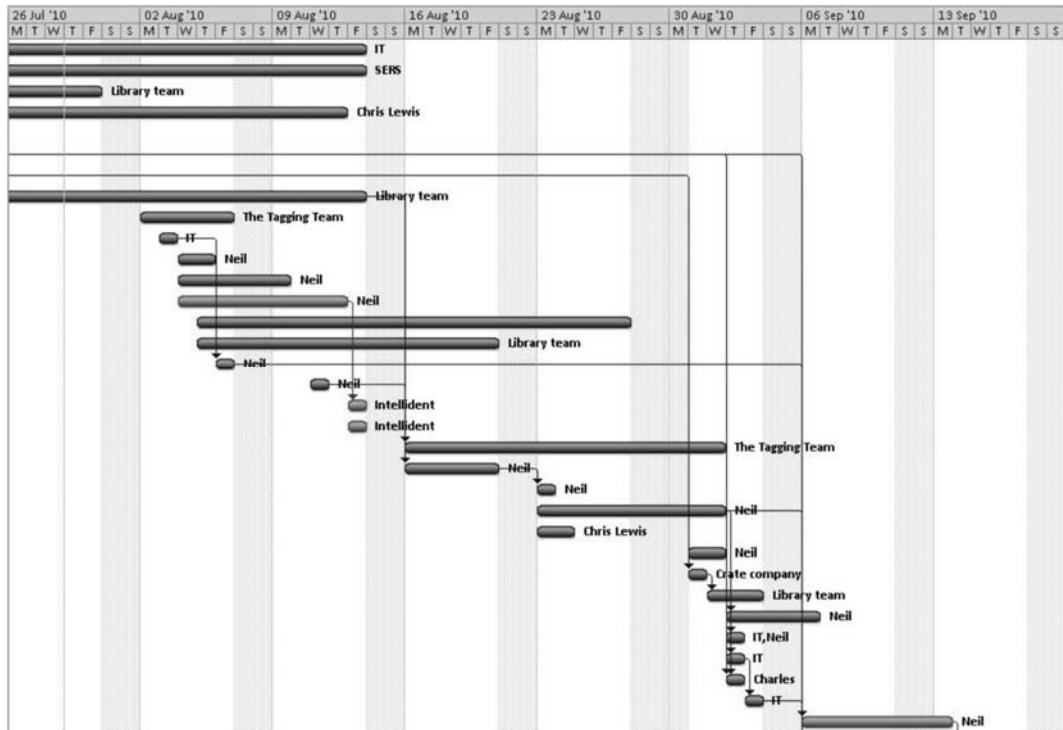
The outputs to the Develop Schedule Process include the following:

- ⇒ **.1 Schedule baseline** — The schedule baseline represents what the project manager and team have committed to the sponsor in terms of when the various project tasks, activities and deliverables will be completed. It is the basis of measuring progress on the project and is required for any time-based variance analysis. For the exam, make sure that you can differentiate between the schedule and the schedule baseline.
- ⇒ **.2 Project schedule** — The project schedule is a living, breathing document. It is constantly being reviewed and changed to reflect reality. It is the document that shows when different project tasks, activities or deliverables are to be completed. At a minimum, the schedule should include the planned start and finish date for each activity although it is slightly different for an agile project. PMI[®] also suggests three visual aids to help with the presentation of the schedule.

A bar chart is perhaps the most common tool used in linear project methodologies. It appears as a **Gantt chart** with the bars representing project work over time represented horizontally. The Gantt chart also has the advantage of showing precedence diagram dependencies, milestones, the critical path, and resourcing which is why it is the most popular project display used today. *Image 59* shows a sample Gantt chart.



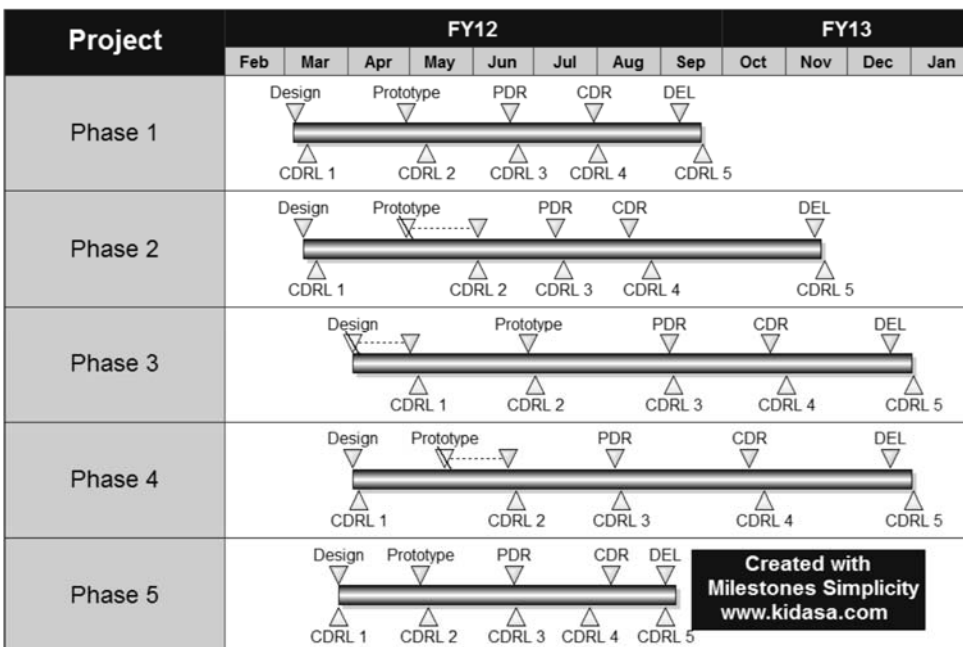
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Image 59: Sample Gantt Chart

Another common information radiator used to display a project schedule is the milestone chart. A **milestone chart** is similar to bar charts but only identifies the start and/or finish of phases or activities and does not make any effort to represent the project work. Image 60 shows a sample milestone chart.



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Image 60: Sample Milestone Chart

In some situations the team may not use any advanced technology to represent their schedule. In these cases the team might simply present the schedule using a schedule network diagram using the activity-on-node format describe earlier in this section.

- ⇒ **.3 Schedule data** — Schedule data includes any information about delayed tasks, activities or deliverables with explanations and/or schedule forecasts.
- ⇒ **.4 Project calendars** — The project calendars show the team and other stakeholders when things are supposed to happen.
- ⇒ **.5 Change requests** — Almost any of the defined process can generate a requested change as the team and organization learn new information about the project. It is always critical that you work to first understand the change and then follow whatever change management process the team has defined.
- ⇒ **.6 Project management plan updates** — Based on the schedule, it might be necessary to update the various project plan with new information.
- ⇒ **.7 Project document updates** — All of this information could have a significant impact on the project's documentation. It is important that you update those documents.

6.6 Control Schedule

The last process in the schedule management knowledge area is the control schedule process. This process moves us out of the planning process group and into the monitoring and controlling process group. The control schedule process is part of the integrated change control process that is defined in the integration management knowledge area. The primary goal of the control schedule process is to determine the current status of the project in terms of the schedule. However, it is also the process that is used to manage changes to the schedule and to make sure that only good changes occur.

The inputs to the control schedule process include the following:

- ⇒ **.1 Project management plan** — The project management plan is a large set of documents and PMI® specifies several components for controlling the schedule including: the schedule management plan, the schedule baseline, the scope baseline, and the performance management baseline. The first three of these defines the work to be completed and how long the team thought it was going to take to complete the work. The last item, the performance measurement baseline is used when the team is implementing earned value analysis to compare forecasts to actuals and determine if a change, corrective action, or preventive action is necessary.



Image 61: Sample Gantt Chart



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- ⇒ **.2 Project documents** — The project documents adds a large list of additional information to that already provided in the project management plan. Within this set, PMI® specifies the lessons learned register, project calendars, project schedule, resource calendars and schedule data. Most of these items are common sense so stop and think to yourself, “What do I need to know to manage a project schedule?” and you will likely have the project documents list.
 - ⇒ **.3 Work performance data** — The work performance data includes information about project progress—such as which tasks, activities or deliverables have started, where they are in terms of progress, and which items have been completed.
 - ⇒ **.4 Organizational process assets** — Many organizations have tools in place to assist in the creation of duration estimates. These tools can be physical or electronic.

The tools and techniques used in the control schedule process include the following:

- ⇒ **.1 Data analysis** — In this case we are looking at the measures and analysis of schedule information. It is essential for the exam that you remember that PMI® views earned value measures as central to this effort. Therefore, you are going to examine the major values found in earned value such as the schedule variance and the schedule performance index. If the project is being managed using an agile methodology the team must look at its iteration burndown chart. You might also need to examine the team’s performance reviews, complete trend analysis, variance analysis and some what-if scenario analysis.
- ⇒ **.2 Critical path method** — Comparing the team’s progress along the critical path can provide critical information about how the team is really doing on the project. Remember, project progress is always measured against delivering the items on the critical path.
- ⇒ **.3 Project management information system** — The standards establish a complex network of ideas and items that must be tracked as the project progresses. The PMIS provides the primary tool to do this.
- ⇒ **.4 Resource optimization** — To get the most out of your people, project leaders must constantly consider the most efficient way of completing work. This means looking a utilization, leveling, availability and other factors.
- ⇒ **.5 Leads and lags** — As the project progresses the team may need to adjust its leads and lags to get activities that are currently behind schedule back on track.
- ⇒ **.6 Schedule compression** — Earlier in this course we defined two techniques for compressing a schedule. They are crashing and fast tracking.

The outputs to the control schedule process include the following:

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- ⇒ **.1 Work performance information** — Work performance measurements represent the calculated SPI and SV values for the deliverables on the project. Specifically, the values for the control accounts are measured.
 - ⇒ **.2 Schedule forecasts** — This tells us when the work is expected to be completed based on the current information.
 - ⇒ **.3 Change requests** — Often schedule adjustments can cause other areas to change. You need to constantly be aware of this and track the change requests.
 - ⇒ **.4 Project Management Plan updates** — Specific updates to the Project Management Plan might include schedule baseline updates, Schedule Management Plan updates, or updates to the cost baseline.
 - ⇒ **.5 Project documents updates** — Specific updates to other project documents might include updates to the schedule data or to the schedule itself.

Time Management Summary

To conclude the Time Management Knowledge Area, focus your studies on these five areas:

- ⇒ **Six processes** — Make sure you understand the six processes which make up the Time Management Knowledge Area. Know their order and their relationships in the planning process group. Take special note of the relationship between the scope processes and time processes.
- ⇒ **PERT, GERT, PDM, CPM, CCPM** — Each of these acronyms represent a key modeling technique or calculation you need to know. The only one that you only need to be able to recognize—and that you do not need to be prepared to calculate—is GERT.
- ⇒ **Crashing, fast tracking** — Make sure that you know these schedule compression techniques and know what the negative impact is from each one.
- ⇒ **Decomposition, baseline, float or slack** — Make sure that you not only know these terms, but that you also know how to effectively use them.
- ⇒ **Schedule development is iterative** — Above all else, remember that the process of building a project schedule is iterative. A schedule must be a living, breathing document to ensure the project's success. Therefore, you must constantly revisit the schedule as new data presents itself.



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Exercise 11 — Schedule Management



Exercise 11—Time Management

1. What is the variance of a project that has a best case estimate of 6, a most likely case estimate of 7, and a worst case estimate of 10?
 - A. 2.08
 - B. 0.44
 - C. 0.67
 - D. 7.33
2. Your project is significantly over budget and behind schedule. It is critical that you determine your projected duration. To gain a better understanding of the project you analyze the sequence of deliverables, activities or tasks to find the ones with the least amount of schedule flexibility. What technique are you using?
 - A. GERT
 - B. CPM
 - C. PERT
 - D. PDM
3. A project manager is discussing her project with her boss. They are concerned that the project might be falling behind schedule and decide they must determine the project's likely completion date and find out where any flexibility exists. Which of the following tools would best provide this information?
 - A. AOA
 - B. PDM
 - C. CPM
 - D. Network Diagramming
4. You are the project manager for a new product. You are in the planning phase of your project and have just been told by one of your senior resources that they require the completed schematics before they can begin to build the product prototype. This is an example of what kind of dependency?
 - A. Mandatory
 - B. Discretionary
 - C. Internal
 - D. External
5. You are the project manager at a major pharmaceuticals company. You are planning the release of a new drug and must wait for regulatory approval before you can begin manufacture of the drug. This is an example of what kind of dependency?
 - A. Discretionary
 - B. External
 - C. Internal
 - D. Mandatory

-
6. Which of the following is a type of bar chart?
 - A. Gaussian distribution
 - B. Scatter plot
 - C. Gantt chart
 - D. Logit model
 7. As a general rule, which of the following is better illustrated by network diagrams than by bar charts?
 - A. Project progress
 - B. Logical relationships between activities
 - C. The project's critical chain
 - D. Resource needs
 8. Which of the following is not correct about PDM?
 - A. The critical path always has dummy tasks
 - B. Every network has at least one critical path
 - C. The network displays all task interdependencies
 - D. Tasks not on the critical path have slack or float
 9. Which of the following terms represents a method of problem solving that relies on inductive reasoning from past experience or expert judgment when there is no relevant mathematical algorithm available?
 - A. A heuristic
 - B. A logit
 - C. GERT
 - D. Analogous estimating
 10. Which of the following best describe the amount of time that one activity can be delayed without impacting the early start of its succeeding task or activity?
 - A. Lead time
 - B. Float
 - C. Lag time
 - D. None of the above
 11. Which of the following terms best represents the amount of time one activity can begin prior to the completion of its preceding dependent task?
 - A. Lag time
 - B. Lead time
 - C. Float
 - D. None of the above

-
12. Which of the following statements is correct?
- A. A network diagram allows you to determine the amount of time the project will take.
 - B. A WBS allows you to determine the longest chain of dependent tasks.
 - C. Changing the end date of the project will cause the network diagram to change.
 - D. The critical path will always contain dummy tasks.
13. Which of the following statements about a milestone is true?
- A. A milestone can have any duration
 - B. A milestone has the same duration as the task, activity or deliverable it represents
 - C. A milestone always has zero duration
 - D. None of the above
14. Which of the following statements best describes the relationship between standard deviation and risk?
- A. Standard deviation provides the level of uncertainty about the estimate
 - B. Standard deviation defines whether or not safety is in the estimate
 - C. Standard deviation defines the accuracy of the estimate
 - D. There is no relationship between risk and standard deviation
15. Your boss asks you to use Monte Carlo analysis to evaluate your project. For what purpose was this request most likely made?
- A. To create an activity's estimated length
 - B. To gain an indication of the risk in the project
 - C. To define the order in which activities occur
 - D. Define project resource requirement
16. On Monday morning your boss comes into your office and asks about the amount of slack you have on a specific activity in your project. This is determined by which of the following:
- A. Performing a PERT analysis.
 - B. Estimating the task or activity length.
 - C. Creating a PDM diagram.
 - D. Determining the total amount of time that a schedule activity may be delayed without impacting the project delivery.
17. Your boss enters your office and is concerned that a particular activity will delay the delivery of the project. What is the best thing to do?
- A. Determine if the activity is on the critical path.
 - B. Explain why your boss should not worry.
 - C. Perform a GERT analysis.
 - D. Examine the activity's risk triggers.

-
18. You and your project team have obtained estimates for your project, assigned resources, and developed a precedence diagram of the project. Several of your resources are very concerned that two of the activities are not being focused on enough and will end up delaying the project because they are critical components of the project's end product. What is the best thing to do?
- A. Sit down with the resources to discuss the project Gantt chart.
 - B. Determine if the activities in question are on the critical path.
 - C. Examine the project's risk register.
 - D. Evaluate alternative project execution paths.
19. Which of the following best describes the impact of multiple critical paths on a project?
- A. The project takes longer to complete.
 - B. The project is more expensive.
 - C. The project takes more resources to manage.
 - D. The project risk increases.
20. You and your project team have just completed the development of your PDM diagram. The current diagram shows there are three critical paths in your project. What is the best thing to do next?
- A. Re-evaluate the network for errors.
 - B. Develop the project schedule.
 - C. Examine the project risk register.
 - D. Discuss alternative networks with your team.
21. In discussing your project with management you determine that the project schedule is the most flexible and the project scope is the least flexible. If the allowable monthly project expenditures are fixed, then what is the best thing to do?
- A. Level the resources.
 - B. Examine the project's critical path.
 - C. Analyze the project's life cycle costs.
 - D. Crash the project.
22. Your manager asks you to produce a report on your project for management. Which of the following would best meet the request?
- A. Bar chart
 - B. PERT chart
 - C. Milestone chart
 - D. Gantt chart

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23. You and your project team have just completed the development of your project schedule. Based on the constraints provided by the project sponsor, the project is scheduled to be completed after the project deadline. Assuming that costs are the least important constraint and scope is the most important constraint, which of the following is the best thing to do?
- A. Fast track the project.
 - B. Crash the project.
 - C. Reassess the critical path.
 - D. Develop a critical chain model for the project.
24. You and your project team have just completed the development of your project schedule. Based on constraints provided by the project sponsor, the project is scheduled to be completed after the project deadline. Assuming that costs are the most important constraint and scope is the least important constraint, which of the following is the best thing to do?
- A. Crash the project.
 - B. Reassess the critical path.
 - C. Develop a new project schedule.
 - D. Fast track the project.
25. Your manager comes to you and demands that you complete your project three weeks early. What is the best thing to do?
- A. Meet with your project team to examine alternatives for crashing and fast tracking.
 - B. Tell your boss the project critical path does not allow for a three week early completion.
 - C. Ask the project to work overtime.
 - D. Ask your manager if you can reduce the scope of the project.
26. When evaluating the impact that crashing will have on your project, which of the following should be included in the evaluation?
- A. The project sponsor's interest.
 - B. Risks associated with the schedule changes.
 - C. The amount of overtime to be worked.
 - D. The impact of a reduction in project scope.
27. Which of the following PM processes requires the project manager to reach an agreement with the activity resources on the calendar date for each activity?
- A. Sequence activities.
 - B. Estimate activity durations.
 - C. Estimate resources.
 - D. Develop schedule.

-
28. It is late Friday afternoon when your project sponsor informs you that the project schedule has been reduced by two weeks. What is the best thing to do?
- A. Meet with your project team to determine options for schedule compression.
 - B. Cut the project scope.
 - C. Crash the project.
 - D. Inform management that the date cannot be met.
29. As the project manager, you estimate the time that is needed for each activity, assign tasks to specific resources and then add the estimates to create the project estimate. You then use this value to establish the project delivery date which you provide to the project sponsor. What is incorrect with this process?
- A. The project manager created the estimates without the team. Additionally, summing the tasks will lead to a significantly longer project duration.
 - B. Project duration estimates should be developed by the project sponsor.
 - C. The project manager created the estimates without the project resources and did not use a network diagram to define the critical path.
 - D. The project completion date should be derived from an evaluation of the triple constraints.
30. You are the project manager for a large construction project. It is early in the project lifecycle and you have completed the activity definition. In analyzing the activities you see a number of activities that are dependent on each other but can start at the same time. Which methodology is the best one to properly evaluate this project?
- A. CPM
 - B. PDM
 - C. AOA
 - D. GERT
31. You are the project manager for a \$250,000 software development project. You are working with your project team and you determine that the project has a number of project tasks that are dependent on each other. However, one of your team members also points out that the tasks can finish at the same time. Which of the following is the best technique to understand this situation?
- A. Critical path method
 - B. Activity on arrow method
 - C. Precedence diagramming method
 - D. Program evaluation and review technique

-
32. You are the project manager for a large consulting company leading a process improvement project for your organization's largest client. The project currently has a CPI of 1.04 and SPI of .98. Your customer has just asked if you can produce a diagram that shows the probabilistic project path. Which of the following tools would be best in this situation?
- A. Graphical evaluation and review technique
 - B. Program evaluation and review technique
 - C. Critical path method
 - D. Precedence diagramming method
33. Which of the following is best suited to define a project network that has potential looping of the activities, deliverables or tasks?
- A. PERT
 - B. CPM
 - C. GERT
 - D. PDM
34. You are the project manager for a software development project with an estimated budget of \$650,000. You have just completed the duration estimates, and activity sequencing for your project. Which of the following do you still need to complete the initial project schedule?
- A. Performance measurement baseline
 - B. Contingency reserves
 - C. Schedule data
 - D. Schedule management plan
35. You are just taking over for a project manager who was forced to take a medical leave of absence. Your project has a CPI of .93 and an SPI of .89. To gain a better understanding of how the previous project manager was managing schedule changes, to which of the following would you turn?
- A. The project plan
 - B. The project schedule
 - C. The schedule management plan
 - D. The project Gantt chart
36. You are taking over for a project manager who was terminated. The previous project manager was using weighted average duration estimates to develop the schedule network. What type of modeling are you using?
- A. Monte Carlo analysis
 - B. Project evaluation and review technique analysis
 - C. Critical chain analysis
 - D. Critical path analysis

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37. You are the project manager for a large mechanical engineering project. You have completed your scope statement, the WBS, the resource estimate, duration estimates, and the network diagram. Which of the following is the thing you should do next?
- A. Create the schedule
 - B. Complete the cost estimates
 - C. Define the project budget
 - D. Solicit purchase
38. You work as a project manager and have completed the scope statement, resource estimates, and the WBS. You've just received the activity duration estimates. Which of the following is your best course of action?
- A. Finalize the schedule
 - B. Compress the schedule
 - C. Complete the risk register
 - D. Develop RFPs
39. One of your resources comes into your office to discuss their task. The project has a CPI of .89 and an SPI of .92. The resource's task has an early start of week 14 and a late start of week 17. What do you know about this activity?
- A. It is ahead of schedule
 - B. It is behind schedule
 - C. It is on the critical path
 - D. It is not on the critical path
40. You have an activity that has an ES of 12 weeks, an LS of 15 weeks, an EF of 21 weeks, and an LF of 24 weeks. What do you know about this activity?
- A. It is not on the critical path
 - B. It is ahead of schedule
 - C. It is behind schedule
 - D. It is on the critical path
41. You are leading a project that you have just learned is 3 weeks behind schedule. The dependencies are discretionary. The project has an SPI of .81 and a CPI of .83. Due to cost overruns you cannot add more resources. What is the best thing to do?
- A. Move resources from tasks with discretionary dependencies
 - B. Complete activities in parallel where possible
 - C. Reduce resources
 - D. Reduce project scope

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42. You've been brought into the organization because senior management is struggling to get a strong understanding of the state of their projects. You only have a week to prepare a 30 minute presentation on the status of all the projects. Which of the following would best help senior management understand the current portfolio status?
- A. Project management plan executive summaries
 - B. Detailed cost and schedule analysis
 - C. Milestone charts
 - D. Gantt charts
43. Sally is a brand new project manager within a company that manufactures household products. She's just taken over a project that is seriously over budget and behind schedule. Originally, the project was slated to have spent \$135,000 and they have already spent \$170,000. It appears that most of the overage is because of flawed original estimates. This project is critical to the organization's success. Who has primary responsibility to solve these issues?
- A. The project sponsor
 - B. The project manager
 - C. The project team
 - D. Senior management
44. You are the project manager for a project that you have just learned is 30 days behind schedule. You do not have any additional resources that may be engaged. The project has a CPI of .84 and an SPI of .79. The BCR is 1.45 and only a few of the project tasks have mandatory dependencies. What is the best thing to do?
- A. Meet with the project sponsor to inform them of the delay.
 - B. Reduce the project scope to meet the deadline.
 - C. Crash the project.
 - D. Make more activities concurrent.
45. Rearranging dependent tasks or activities so they are done in parallel is called what?
- A. Fast tracking
 - B. Leveling
 - C. Paralleling
 - D. Crashing
46. Rearranging resources and resource workloads so that the amount of work done in each month or specified time period is constant is called what?
- A. Fast tracking
 - B. Paralleling
 - C. Leveling
 - D. Crashing

-
47. Adding additional resources to reduce the schedule time of a task or activity is called what?
- A. Fast tracking
 - B. Crashing
 - C. Paralleling
 - D. Leveling
48. Which of the following is a benefit of a three point project estimate?
- A. It shows a better understanding of the task.
 - B. It allows the project manager to better manage stakeholder expectations.
 - C. It helps determine if the project will meet the schedule.
 - D. It provides a probabilistic estimate.
49. Which of the following is a benefit of analogous project estimates?
- A. It helps to raise questions about expectations.
 - B. The estimates will more accurately reflect actuals.
 - C. It helps the project resources understand their obligations.
 - D. It helps senior management feel better about the estimates.
50. Which of the following is an advantage of parametric estimating?
- A. It accounts for estimating uncertainty.
 - B. It provides for improved communication.
 - C. It provides a quantifiable deterministic estimate.
 - D. It provides estimates at the lowest possible level.
51. You are the project manager for a very large and important project within your organization. Your project has been progressing very well until the last couple of weeks when you began to experience a large number of scope changes. Your current CPI is 1.02 and your SPI is .98. As the project manager, what should you do?
- A. Maintain the baseline and make approved changes.
 - B. Maintain the baseline and resist all changes.
 - C. Make only the changes approved by the project sponsor.
 - D. Initiate a discussion with management about the level of changes.
52. Your boss asks you to change a presentation slide showing a network diagram to one showing a bar chart. Which of the following best explain this request?
- A. Bar charts show logical relationships more effectively than network diagrams.
 - B. Bar charts better display resource trade-offs than network diagrams.
 - C. Bar charts better show the critical path than network diagrams.
 - D. Bar charts better display progress or status.

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53. You are leading a large project for your organization. Early in the project the sponsor informs you that neither time nor costs are as important as the number of resources used each month. Which of the following is the best thing for you to do?
- A. Level the project resources
 - B. Crash the project
 - C. Fast track the project
 - D. Apply a heuristic
54. Upon presenting your plan to your sponsor you are informed that the schedule exceeds the target completion date the sponsor desired. If the project network diagram cannot change, but the sponsor offers extra resources what is the best thing to do?
- A. Crash the project
 - B. Fast track the project
 - C. Level the resources
 - D. Perform a Monte Carlo analysis
55. You've determined that crashing your project is the best option for reducing your project schedule. The best approach to crashing would also include looking at the:
- A. Sponsor's opinion of which activities to crash.
 - B. Risk impacts of crashing each activity.
 - C. Customer or end user's opinion of which activities to crash.
 - D. When in the project timeline the activities occur.
56. You are assigned as the project manager for a manufacturing project within your organization. During the planning phase of the project, you estimate the time needed for each activity and then add the estimates to create the project estimate. You then commit to delivering the project by the defined date. What is wrong with this scenario?
- A. The team did not create the estimate, and compilation was not used.
 - B. The estimate is too short and should be created by management.
 - C. The team did not create the estimate and a network diagram was not used.
 - D. The estimate should be matched to the customer's required completion date.

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57. You have a project with the following activities: Activity A takes 40 hours and is the first task. Activity B takes 25 hours and should happen after the project starts. Activity C must happen after activity A and takes 35 hours. Activity D must happen after activities B and C and takes 30 hours. Activity E must take place after activity C and takes 10 hours. Activity F takes place after activity E and takes 22 hours. Activities F and D are the last activities of the project. Which of the following is true if activity B actually takes 37 hours?
- A. The critical path is 67 hours.
 - B. The critical path changes to Start, B, D, End.
 - C. The critical path is Start, A, C, E, F, End.
 - D. The critical path increases by 12 hours.
58. The WBS, activity duration estimates, and the precedence diagram are completed. Which of the following should you do next?
- A. Validate project scope.
 - B. Identify project risks.
 - C. Sequence the activities.
 - D. Create a preliminary schedule and get the team's approval.
59. You are leading an engineering project for your organization and have developed a six level WBS that has been sequenced using PDM. The activity duration estimates have been received. What should you do next?
- A. Create an activity list.
 - B. Begin the work breakdown structure.
 - C. Finalize the schedule.
 - D. Compress the schedule.
60. You are the project manager for an information technology project within your organization. A five-level work breakdown structure has been developed for the project. The network diagram and duration estimates have been created and the schedule has been developed and compressed. Which of the following time management activities should you do next?
- A. Gain approval.
 - B. Estimate activity resources.
 - C. Use parametric estimating.
 - D. Control the schedule.
61. The project is calculated to be completed two weeks after your sponsor's deadline. You have been told there are no additional resources. The project is low risk, the benefit cost ratio is expected to be 1.71, and the project dependencies are preferential. What is the best thing to do?
- A. Remove non-critical activities from the project.
 - B. Make more activities concurrent.
 - C. Cut resources from non-critical activities.
 - D. Move resources from preferential dependencies to external dependencies.

Exercise 11—Time Management Answers

1. **Answer B.** PMBOK® Guide p. 201. The correct answer is 0.44. The PERT variance is calculated by first calculating the PERT standard deviation for the case using the formula of (pessimistic – optimistic) / 6. Once you have the PERT standard deviation you must square that result to obtain the PERT variance.
2. **Answer B.** Each of these methods provides an evaluation of the project in some way. However, only the critical path method or CPM, focuses in on the amount of slack or float contained by a task.
3. **Answer C.** Each of these methods provides an evaluation of the project in some way. However, only the critical path method or CPM, focuses in on the amount of slack or float contained by a task.
4. **Answer B.** PMBOK® Guide p. 191. Internal dependencies are not a type defined by PMI®. This is an example of a discretionary dependency because the question clearly states that the schematics are required to go the next step.
5. **Answer D.** PMBOK® Guide p. 191. Internal dependencies are not a type defined by PMI®. This is an example of a mandatory dependency. Neither the manufacturing nor the project management processes require the regulatory approval. However, governmental approval is required in order to sell the completed product.
6. **Answer C.** PMBOK® Guide p. 217. A Gantt chart is a type of bar chart laid on its side that also shows a project calendar. The lengths of the bars reflect the length of time the task, deliverable, or activity take.
7. **Answer B.** PMBOK® Guide p. 209-212. Network diagrams are modeling methods that display the relationships between task, deliverable and activities. Since the bars in a bar chart are independent of each other, they cannot provide this information.
8. **Answer A.** PMBOK® Guide p. 189-190. PDM or the precedence diagramming method is a method of network diagram designed to display task dependencies and relationships. One of its most valuable outputs is the critical path which is the longest chain of dependent tasks where there is no slack or float.
9. **Answer A.** A **heuristic** – is a method of problem solving that relies on inductive reasoning from past (expert) judgment when there is no relevant mathematical algorithm. It is also sometimes referred to as a “rule of thumb”.
10. **Answer C.** PMBOK® Guide p. 193. Lag time represents the amount of time a task or activity can be delayed without impacting the early start of the next task or activity. Often lag is added to a chain to produce a gap between tasks or activities.

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11. **Answer B.** PMBOK® Guide p. 192. Lead time represents the amount of time one activity can begin prior to the completion of its preceding dependent task. Lead time is used to compress a schedule and can run the risk of rework.
 12. **Answer A.** PMBOK® Guide p. 189-190. The network diagram is specifically designed to allow you to determine all the potential project paths and the longest time the project can take. A work breakdown structure is used to show the project deliverables. Changing the end date of a project does not necessarily change a network diagram and the critical path never contains dummy tasks.
 13. **Answer C.** PMBOK® Guide p.157. A milestone is a marker representing the completion of a task, activity or deliverable. It never has duration of any length.
 14. **Answer A.** Standard deviation allows you to determine the amount of dispersion from the mean that your estimates have. The more dispersed the estimates, the more variance exists between the estimates — and therefore the greater the risk is.
 15. **Answer B.** PMBOK® Guide p. 213. Several of these answers are close, but the correct answer is to gain an indication of the risk in the project. Monte Carlo simulations will not tell you about specific risk. They reveal the probabilistic nature of risk. A Monte Carlo simulation enables the user to determine the probability that a result will occur within a given range. The wider the range, the greater the uncertainty or risk.
 16. **Answer D.** PMBOK® Guide p.210. Slack or float represents the amount of time a specified activity may be delayed without impacting the project's critical path. Only items not on the Critical Path have slack or float. It is the difference between the early finish and late finish or the early and late start.
 17. **Answer A.** PMBOK® Guide p.210. Slack or float represents the amount of time a specified activity may be delayed without impacting the project's Critical Path. Only items not on the Critical Path have slack or float. It is the difference between the early finish and late finish or the early and late start. In this case the best answer is to first determine if the task is on the Critical Path and find out how much slack or float it has.
 18. **Answer B.** PMBOK® Guide p.210. Slack or float represents the amount of time a specified activity may be delayed without impacting the project's Critical Path. Only items not on the critical path have slack or float. It is the difference between the early finish and late finish or the early and late start. In this case the best answer is to first determine if the tasks are on the Critical Path and find out how much slack or float it has.

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19. **Answer D.** PMBOK® Guide p.210. Multiple critical paths are not unusual in the real world. This simply means that if any of the activities on any of the Critical Paths are delayed, the entire project will be delayed. This sometimes causes an increase in project resources or cost and it might cause the project to take longer. However, it is a guarantee that the project has an increase in risk because the project now has more chance for an activity delay to impact the delivery of the project.
 20. **Answer B.** PMBOK® Guide p.210. Multiple critical paths are not unusual in the real world. This simply means that if any of the activities on any of the critical paths are delayed the entire project will be delayed. Therefore, the existence of multiple critical paths does not represent an error in your process. The development of the PDM Diagram is part of activity sequencing. The next step in the process is developing the project schedule.
 21. **Answer A.** PMBOK® Guide p.211. This is a triple constraints question. If the project schedule is the most flexible, this means the project could continue for several months past the original forecast. This is especially true because the project has an inflexible scope. Because the project cost is fixed on a monthly basis — but not on a total basis — the best thing to do is level the resources to ensure the monthly project costs do not exceed the allowable amount.
 22. **Answer C.** PMBOK® Guide p.218. The best tool for reporting to management is a milestone chart. This provides the correct level of information for management.
 23. **Answer B.** PMBOK® Guide p.215. The best thing to do in this case is crash the project. This usually entails adding resources to the project to get project work done more quickly. This will cause a likely increase in project costs. Fast tracking is doing tasks in parallel which decreases the schedule, but this often causes rework which in this case is unacceptable.
 24. **Answer D.** PMBOK® Guide p.215. The best thing to do in this case is fast track the project. This is because you do not have the ability to increase the cost by adding resources (crashing). Reassessing the critical path and developing a new schedule are not preferred alternatives.
 25. **Answer A.** PMBOK® Guide p.215. Whenever your due date is reduced, the first thing to do evaluate the two alternatives you have. You can either crash or fast track the project.
 26. **Answer B.** PMBOK® Guide p.213. Whenever doing any type of evaluation of a project it is always critical that you analyze the risks associated.
 27. **Answer D.** PMBOK® Guide p. 205. Develop schedule is the process where the basic schedule is applied to a calendar.
 28. **Answer A.** This is a PMIism. The best option is always to determine alternatives before you do anything else.

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29. **Answer A.** PMBOK® Guide p. 195-204, 210. Project estimates should always be developed by the project team and not just the project manager. Additionally, the project duration is never generated by simply summing the activity estimates as many activities are completed concurrently. Simply summing these values will cause an inflation of the estimate.
 30. **Answer B.** PMBOK® Guide p. 189-190. Only the precedence diagramming method or PDM allows for relationships other than finish to start. In this case a start to start relationship is indicated by the fact that the tasks can begin at the same time. Therefore PDM is the correct answer.
 31. **Answer C.** PMBOK® Guide p. 189-190. Only the precedence diagramming method or PDM allows for relationships other than finish to start. In this case a finish to finish relationship is indicated by the fact that the tasks can begin at the same time. Therefore PDM is the correct answer.
 32. **Answer A.** GERT or graphical evaluation and review technique allows for looping, alternative flows and probabilistic networks and is the only diagramming technique that does so.
 33. **Answer C.** GERT or graphical evaluation and review technique allows for looping, alternative flows and probabilistic networks and is the only diagramming technique that does so.
 34. **Answer B.** PMBOK® Guide p. 222. To complete the project schedule you also need to include your safety or contingency reserves. All the other alternatives are used in schedule control as inputs or are not applicable.
 35. **Answer C.** PMBOK® Guide p. 181-182. To understand how a project is managing schedule change you first look at the schedule management plan. PMI® is consistent on this point. You always examine the topic area's management plan first.
 36. **Answer B.** PMBOK® Guide p. 201. A weighted average is created when PERT or project evaluation and review technique is used.
 37. **Answer A.** PMBOK® Guide p. 189-190. Once you have completed the network diagram you need to create a schedule and get it approved by your team.
 38. **Answer B.** PMBOK® Guide p. 215. The only two answers that are close include: compress the schedule and finalize the schedule. Compressing the schedule is done before the schedule is finalized.
 39. **Answer D.** PMBOK® Guide p. 210. The information concerning earned value has nothing to do with this question. The only thing you can tell for sure is that there are three weeks of slack or float because the early and late start times are not the same. This means the task must not be on the Critical Path.
 40. **Answer A.** PMBOK® Guide p. 210. The only thing you can tell for sure is that there are three weeks of slack or float because the early and late start

times are not the same. This means the task must not be on the critical path. In addition, this question tests whether or not you know that ES stands for early start, LS stands for late start, EF stands for early finish and LF stands for late finish.

41. **Answer B.** PMBOK® Guide p. 191-192; 215. Two pieces of knowledge are important to this question. First, you must understand the different types of dependencies (mandatory, discretionary, internal and external). Secondly, you must know that whenever a schedule needs to be shortened you can either crash the schedule or fast track it. Fast tracking is the correct answer because you cannot add resources.
42. **Answer C.** PMBOK® Guide p. 218. Whenever it is a question about the type of reporting for senior management the answer is always Milestone Reports. You may provide a lot of other information, but the Milestone Report always comes first.
43. **Answer B.** PMBOK® Guide p. 175. Hopefully, this was an easy one. The project manager is always the first line. Although they can get help from their project team, they are ultimately responsible.
44. **Answer D.** PMBOK® Guide p. 215. Making more activities concurrent is another way of saying fast track the project. It is one of only two ways to reduce a project schedule without reducing project scope. The other is crashing — which is adding resources to the project. Crashing is not an option in this case. Reducing the scope is not an option until you have first tried the other alternatives.
45. **Answer A.** PMBOK® Guide p. 215. Fast tracking is the technique where you change the scheduling of dependent tasks so they are done in parallel.
46. **Answer C.** PMBOK® Guide p. 211. The process of changing work assignments or resourcing so that the amount of work done in each month or specified time period is called resource leveling.
47. **Answer B.** PMBOK® Guide p. 215. Crashing is the schedule compression technique that reduces the amount of time that specific activities take by adding resources to those tasks. It runs the risk of increasing project costs.
48. **Answer D.** PMBOK® Guide p. 201. A three point estimate forces a normal distribution when used with the PERT analysis technique. This is a probabilistic technique. When using a PERT Standard Deviation you get the probability that the real duration comes within a range.
49. **Answer A.** PMBOK® Guide p. 200. Analogous estimating is an inexact estimating technique because it is a top down technique. It is best used early in the project when inexact estimates are expected to raise concerns or questions about expectations.
50. **Answer C.** PMBOK® Guide p. 200. Parametric estimating provides project estimates based upon some form of mathematical model. It is quantitative and deterministic.

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51. **Answer A.** PMBOK® Guide p. 189-190. Changes are a fact of life for a project manager. The key is that you use your change control process, only implement those changes approved by management, and always maintain the project baseline. If you do not maintain the baseline you have nothing with which to compare.
52. **Answer D.** PMBOK® Guide p. 209-210. Progress or status is not effectively displayed with a network diagram. Network diagrams are very good at displaying logical relationships and the critical path. Bar charts can be used to display progress.
53. **Answer A.** PMBOK® Guide p. 215. Both fast tracking and crashing will get the project done faster, but neither control the number of resources used in a month. In fact, crashing will increase the number of hours worked. The only answer that manages the hours worked by a resource is leveling.
54. **Answer A.** PMBOK® Guide p. 215. The definition of crashing is increasing the number of hours worked. This is done by working overtime or by adding people to the project.
55. **Answer B.** PMBOK® Guide p. 215. Project risks must always be considered. It is said that risk management is simply project management for adults. None of the other alternatives are common requirements for proper crashing.
56. **Answer C.** PMBOK® Guide p. 189-190. In terms of process, this question highlights the concept of compilation and summing. Just adding all the totals together is summing. To correctly compile the schedule, a network diagram must be built first.
57. **Answer C.** PMBOK® Guide p. 210-211. To correctly answer this question you must weed through the long wording and build a precedence diagram. The described network has three possible paths. If the duration of activity B changes from 25 to 37, the activity will take 12 additional hours which changes the duration of that path from 55 to 67 hours. Since the critical path has a duration of 107 hours the delay of activity B has no impact on the critical path.
58. **Answer D.** PMBOK® Guide p. 187-190; 205-221. Sequencing the activities is the same as creating a network diagram, so that has already been done. The verify scope process is done during the monitoring and controlling process group and not during the planning process. Since a schedule is a critical input to risk management you cannot do that yet. This leaves creating the preliminary schedule and getting the team's approval.
59. **Answer D.** PMBOK® Guide p. 195-204. If you read carefully, you will notice that this question is really asking what you should do after the activity duration estimating process. The WBS and activity list are created before the estimate activity durations. The schedule is not finalized until after schedule compression. Therefore compressing the schedule is done next.

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60. **Answer A.** PMBOK® Guide p. 205. This question is a bit tricky for two reasons. First, it looks like the question above, and control the schedule is the next step in the process. However, you have not yet completed the develop schedule process because you still need to gain approval from the stakeholders before proceeding.
61. **Answer B.** PMBOK® Guide p. 215. In this question you are being asked for the best way to deliver the project when you are exceeding the deadline. The first choice is to always maintain the scope and either fast track or crash the project. Making more activities concurrent is a fancy way of saying fast track and it is the only viable option.

Cost Management

Overview

The sister process to schedule management is found in chapter seven of the PMBOK® Guide. It is the cost management knowledge area. Cost management shares many of the same tools and techniques with time management. Cost management includes all the processes involved in planning, estimating, budgeting and controlling costs so the project is completed within the approved budget. *Image 61* shows the processes involved in cost management. These processes are primarily concerned with the cost of resources, although there are several other factors which must be examined:

⇒ **Life-cycle costing** — Life-cycle costing is the process by which the product or service of the project is examined to determine not only the cost of the project which will produce it, but also the costs associated with operating and disposing of the product, service or result when its useful life has ended. The project manager has responsibility to determine the overall costs of both the product and the project.

⇒ **Opportunity cost** — The opportunity cost is the determined by the value of the next highest alternative. Imagine there are three potential projects (A, B, and C). You can only choose to do one project and the criteria is selecting the project with the highest payout. Project A has a payout of 100. Project B has a payout of 75, and Project C has a payout of 50. Project A would be the choice with the highest payout, but its opportunity cost would be 75, as the next highest value is Project B. The concept here is based upon the understanding of mutually exclusive options, meaning you cannot simultaneously choose to do Projects A and B. Selecting A means you are consciously choosing not to do Project B.

⇒ **Sunk costs** — Sunk costs are monies that have already been spent. They cannot be refunded or returned. It is important that a project manager never makes future project decisions based on money that has already been spent. A good project leader must always look to the future and use forecasts for decisions.

⇒ **Value Analysis** — Sometimes referred to as **value engineering**. Its goal is to find a less costly way to do the same work. The required project functions are systematically identified, and values are then assigned to those functions and work to provide each function at the lowest possible cost.

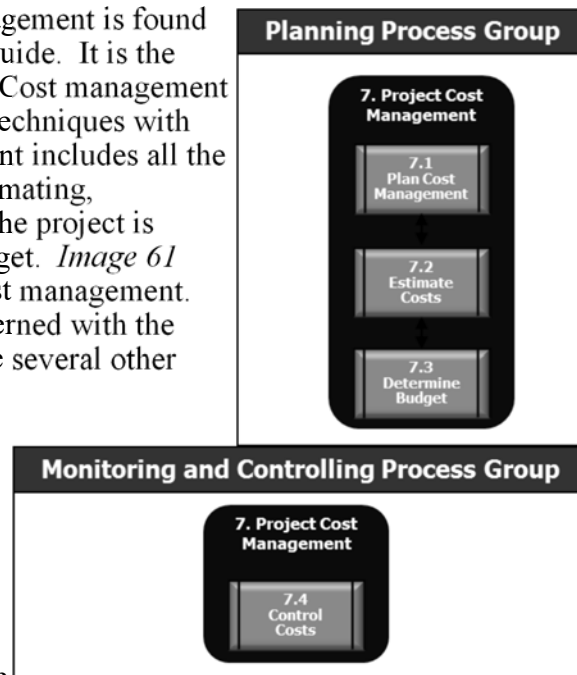


Image 61: The Cost Management Processes



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⇒ **Cost Risk** — Cost risk is exactly what the name implies. It addresses the question, “What are the cost-related risks?”

7.1 Plan Cost Management

The PMBOK Guide® is now very consistent. Every one of the knowledge areas begins with a process to develop a management plan to direct that area. For cost management, that process is called plan cost management. Just like all the other “plan” processes, this one has the goal of producing the “X” management plan. In this case cost.

The inputs to the plan cost management process are as follows:

- ⇒ **.1 Project charter** — This is used to provide the limits of authority, business need, justification, constraints and assumptions.
- ⇒ **.2 Project management plan** — The scope baseline and other information such as cost, risk, and communication information.
- ⇒ **.3 Enterprise environmental factors** — Items such as organizational culture and structure, resource availability and skills, as well as commercial information all might be included.
- ⇒ **.4 Organizational process assets** — This is a standard input to all processes that can be fairly assumed.

There are three tools and techniques used the plan cost management process. These include the following:

- ⇒ **.1 Expert judgment** — As has been previously repeatedly stated, PMI prefers expert judgment over any other technique. As a project manager, your first inclination should always be to trust your subject-matter experts.
- ⇒ **.2 Data analysis** — There are many different ways to analyze the costs of a project to determine which techniques are best. You might choose a statistical model, an examination of previous similar projects, or an Excel spreadsheet.
- ⇒ **.3 Meetings** — Communication is key to good project management. That means getting your team together and talking about various issues.

The only output of the plan cost management process is the cost management plan. The plan defines the rules and processes the project will use to manage project costs. With cost there are several specific things the team must provide. These include the units of measure, level of precision and level of accuracy. Each of these is important in providing information about how the team is supposed to report out and track project costs.

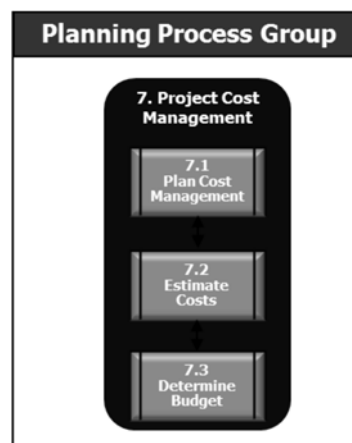


Image 62: 7.1 Plan Cost Management



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7.2 Estimate Costs

The second process in the cost management knowledge area is estimate costs. This process focuses on determining the estimated costs at the most detailed level of the WBS, referred to as the terminating node. It is an inquiry into how much it will cost to have the specified resources complete the desired tasks or activities necessary to produce the specified work packages. Most exam candidates find this concept relatively simple, but be careful: a simple way to trick candidates is to ask questions that use the term price instead of cost. They are not the same thing! Remember, price is equal to the cost plus profit.

The inputs to the estimate costs process include the following:

- ⇒ **.1 Project management plan** — Within the project management plan the team needs to examine the cost management plan, the quality management plan, and the scope baseline
- ⇒ **.2 Project documents** — Have figured out the trend yet? With most processes PMI® calls out the project management plan and the project documents and the highlights those items of particular importance for the specific process. To estimate project costs the team needs to examine the lessons learned register for information about previous projects, the project schedule, resource requirements as resources are the most expensive component of any project, and the risk register to understand the project's risks.
- ⇒ **.3 Enterprise environmental factors** — The specific enterprise environmental factors at play here include market conditions and published commercial information, but these are not all that is possible.
- ⇒ **.4 Organizational process assets** — As always: any policies, procedures, and/or templates you might have that would aid in the costing of the project should be used.

The tools and techniques used in the estimate costs process are very similar to those used to create duration estimates. This makes it much easier to learn as you can learn two sections at the same time. The tools and techniques used in the estimate costs process include the following:

- ⇒ **.1 Expert judgment** — As previously stated, this is a consistently emphasized resource. It is much easier to memorize the few processes where expert judgment is not used rather than trying to memorize all the processes where it does appear.

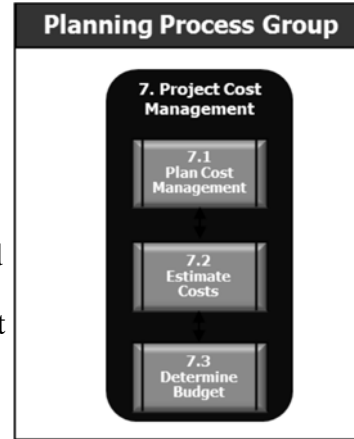


Image 63: 7.2 Estimate Costs



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- ⇒ **.2 Analogous estimating** — Analogous estimating is sometime referred to as top-down estimating. It is the processes of determining a project's costs by assuming its costs will be similar to another project that it closely resembles. Analogous estimating is often used in the initial phases of a project when there is very little information and accuracy is less important. This occurs because analogous estimating is only accurate if the two projects are actually alike. If the details of the two projects are not alike, then the estimates will not be accurate.
 - ⇒ **.3 Parametric estimating** — Parametric estimating is a form of mathematical modeling. The major variables are used to develop an equation to calculate the project cost estimate. Parametric estimating works well so long as the major project variables have been captured in the equation. A simple example of parametric estimate is the cost per square foot of a house, or the cost per lane mile of a highway.
 - ⇒ **.4 Bottom-up estimating** — Bottom-up estimating is the PMBOK® Guide's preferred estimating technique when used in combination with expert judgment. In bottom-up estimating, cost estimates are created at the terminating nodes of the WBS.
 - ⇒ **.5 Three-point estimating** — The most common type of three point estimating is PERT Analysis. The calculations are the same as the PERT Analysis calculations found in the last chapter (Time Management).
 - ⇒ **.6 Data analysis** — The specific kinds of analysis done to estimate project costs include analyzing the alternatives, reserve analysis and the cost of quality.

Reserve analysis is the process of analyzing the project's required contingency reserves. Management reserves are not analyzed at this point because management reserves are generated only after the project budget is created.

The cost of quality or COQ assumptions about the cost of quality are analyzed to determine their accuracy. We will discuss this idea more in the quality chapter of our course.

- ⇒ **.7 Project management information system** — Project management software can be a powerful tool in the process of determining project costs. This is especially true because of the compilation process which occurs in adding the project work packages.
- ⇒ **.8 Decision making** — How does your team make decisions? There are lots of options, spanning from consensus to directive decision-making. These will be talked about in greater detail in the Human Resources Management chapter.

The tools and techniques for the estimate costs process are used to generate three outputs. The outputs for the estimating costs process are as follows:

- ⇒ **.1 Cost estimates** — The cost estimates are the detail cost estimates for the individual project work packages.
- ⇒ **.2 Basis of estimates** — The basis of estimates is the explanation and details for how the estimates were generated. It also includes any constraints and assumptions that were used to create the estimates. It is similar to the WBS dictionary or activity attributes.
- ⇒ **.3 Project documents updates** — The detailed costs estimates require many project documents to be updated with the newly determined information. Make sure to specifically examine the assumption log, the lessons learned register and the risk register.

As the project team goes through the process of estimating costs, it is important to remember there are two different types of project estimates that may be done.

- ⇒ **Rough Order of Magnitude** — There is some disagreement in PMI's resources concerning a ROM estimate. Earlier editions of the PMBOK® Guide and many other resources suggest a ROM estimate is plus or minus 50% of the likely actual project costs. While the 6th edition of the PMBOK® Guide says it is -25% to +75% [PMBOK® Guide 6th ed. p. 241]. A ROM estimate is often used in the early stages of a project when the details are very vague. A ROM estimate is often used to test the resolve and risk-tolerance of the project sponsors.
- ⇒ **Budget Estimate** — The budget estimate, or project budget, is the detailed project budget. The budget estimate has a variance of +10% to -5% [PMBOK® Guide 6th ed. p. 241].

7.3 Determine Budget

The next process in the cost management knowledge area is the determine budget process. Notice the process is not called the estimate budget process. This is because estimating has already been completed. Once the estimates are created the process continues to determine what the estimates mean. Determine budget is the process of aggregating the cost estimates into a single project budget, and then spreading it over time to generate the cost baseline. The **cost baseline** is the basis of cost comparison for the rest of the project. When graphically represented, the cost baseline is often represented as an S-curve like what is usually seen as the result of a logistic regression equation. The curve represents the total or cumulative project costs to-date on one axis and time on the other. *Image 65* on the next page shows a sample **cost curve**. In addition to understanding the cost curve, there are a number of accounting terms you need to understand and be able to compare and contrast for the exam. It is often easier to understand these terms if you imagine working at the Acme widget factory where you are mass producing widgets, having to deal with inventory, components, and paying rent.

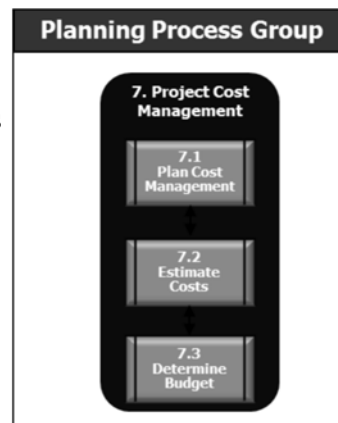


Image 64: 7.3 Determine Budget



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⇒ **Working capital** — Working capital represents the amount of money the organization has to invest in projects and operations. It is calculated by taking the current assets minus the current liabilities. Assets include the liquid money, properties, shares and any other financial vehicle the organization can use. Liabilities represent the actual debts of the company, and can include leases or rental fees, payments to suppliers and contractors, and/or salaries.

⇒ **Accounts receivable** — Accounts receivable or AR represents money that is owed to the organization, but not yet paid.

⇒ **Business intelligence** — BI is the trends, insights and analysis obtained by examining large amounts of data and achieving a wide range of reports with a focus on understanding the underlying causes of business performance which helps leaders make more informed decisions.

⇒ **Fixed consumption** — Fixed consumption represents the assets the organization exhausts during the course of a project or time period.

⇒ **Gross profit** — The gross profit equals the total revenue coming in minus the labor and expenses used to obtain that revenue.

⇒ **Gross profit margin** — The gross profit margin is the gross profit expressed as a percentage of total revenue. The gross profit margin is often simply referred to as the margin. It is calculated using the following formula:

$$\frac{\text{Total Revenue} - \text{Total Costs}}{\text{Total Revenue}}$$

⇒ **Utilization rate** — The utilization rate measures the amount of time an employee spends on productive activities. There are two types of utilization: total and billable. Total utilization measures the percent of time employees spend on productive work, but this measure includes non-billable work such as business development (BD) and proposal-writing. Billable utilization is the percentage of time that can be billed to the client. Most consulting and project-based organizations have what is called the target utilization.

⇒ **Variable vs. fixed** — A variable expense is an expense that could be higher or lower based on another activity. An example of a variable expense is the material costs in our widget factory. If you choose to not make any widgets you have no variable material costs, but if you make lots of widgets you have a lot of variable material costs. A fixed expense would be the monthly rent payment you must make, regardless of how many widgets you make.

⇒ **Direct vs. indirect** — A direct expense is one that is specifically caused by an action of the organization. Returning to the widget factory example, a

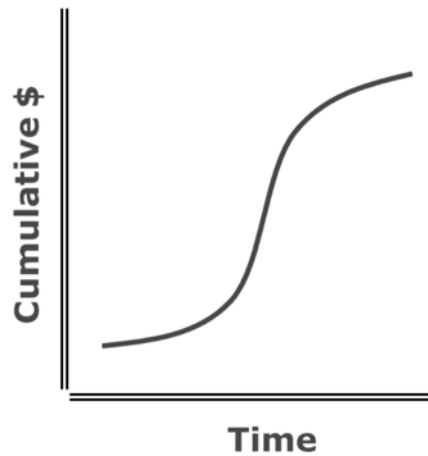


Image 65: A Cost Curve



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direct expense would be the material cost of production. An indirect expense is an expense which cannot be attributed to a specific action. In the widget factory, the lease expense is an indirect expense of producing widgets. It does not matter whether or not you choose to make widgets, you still have to pay your rent.

- ⇒ **Recurring vs. non-recurring** — A recurring expense is one that happens multiple times, often at a specified interval. A non-recurring expense is one that only happens once. Be careful to not say “reoccurring,” as this is both a redundant and a non-existent term.
- ⇒ **Capital vs. expense** — Capital and expense represent the two basic sides of any business. Although not exactly the same, other closely linked terms include assets and liabilities. Capital is an inflow to the business. It adds positive value to the organization. Capital is one asset class. Expenses are outflows of value from the organization. Expenses are a primary form of liability to the business.

With the basic financial terms in hand we can turn our attention to the inputs for the determine budget process which include the following:

- ⇒ **.1 Project management plan** — The project management plan is almost always the first input into the process. Its components define the project. To determine the project budget the team needs to look specifically at the cost management plan, the resource management plan and the scope baseline as these three documents define how the team plans to manage the project costs, the work that has been defined and who is to do the work.
- ⇒ **.2 Project documents** — The documents found in the project management plan are not enough to successfully determine the project budget. The team also needs to look at several additional documents including the cost estimates and the basis of estimates, the project schedule and finally, the risk register. The cost estimates provide the costing for each individual activity on the project and the basis of estimates tells the team how those estimates were derived. A big part of the determine budget process is about correctly combining those numbers until there is a single number representing the total estimated cost to execute the project. It then takes that number and uses the project schedule to understand when the money is needed.
- ⇒ **.3 Business documents** — The business case and the benefits management plan are what is called out from the business documents. The business case defines why the project is needed and provides the critical success factors the needs to meet to achieve overall project success. The benefits management plan describes the benefits the team hopes to deliver to the organization by executing the project. Although these are also usually in the business case, the benefits management plan also describes when the team plans to realize the benefits and any metrics associated with them.



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- ⇒ **.4 Agreements** — Any contracts or other agreements that exist for the purpose of executing the project must also be examined to ensure the team include their defined costs in the development of the overall project budget. These agreements often also include payment schedules and/or other cost implications that must be taken into consideration.
 - ⇒ **.5 Enterprise environmental factors** — What is going on around the project team can greatly impact overall project success and therefore must be considered for almost every process.
 - ⇒ **.6 Organizational process assets** — As always, organizational process assets are in play. Templates, policies and procedures can often add value to the budgeting process.

The determine budget process tools and techniques include the following:

- ⇒ **.1 Expert judgment** — PMI's preferred tool is always expert judgment. In almost every case your subject matter experts are your best resource to determine the output for a process
- ⇒ **.2 Cost aggregation** — Cost aggregation is the process of adding the costs from the individual activities together to develop the overall single number for the project. This is a process of compilation and not summing. To understand this statement, imagine you had a spreadsheet with each row representing a different work package from the WBS, and you also had a column for the cost for each work package, task and/or activity. Simply adding every value found in the cost column together to produce a single result would be summing. However, this would cause double counting. Imagine a single deliverable has five tasks required to produce it within the structure. The cost for that deliverable would be the sum of the five tasks. However, if you counted both the costs of the five tasks and the summed cost of the deliverable towards the project budget, the costs just doubled. Compilation addresses this issue by taking into consideration the project structure in the budgeting process.
- ⇒ **.3 Data analysis** — The most important type of data analysis for determining the project budget is reserve analysis. Reserve analysis is applicable with costs just as with time. The project manager and team must determine the required monies to be set aside for related response strategies. A difference from time, however, is the fact that you have now reached a stage in the planning process where management reserves—as well as contingency reserves—may be planned.
- ⇒ **.4 Historical information review** — In cases where parametric or analogous estimates are used to produce mathematical models it can be important to understand the various relationships that exist within the model, in order to more clearly define the budget. Therefore, the team needs to examine any past projects to considered similar factors that may impact costs.

- ⇒ **.5 Funding limit reconciliation** — It is important to examine any limits that are placed on the use of project funds. It is expected that the project manager will have to work within those limitations. These limits might cause project work to be rescheduled or redefined.
- ⇒ **.6 Financing** — Sometimes the organization lacks the internal financial resources to execute the project. In these cases, completing the project may require seeking outside financial resources. This process is called financing. Borrowing money or selling shares of the organization represent the two most common forms of financing and both add additional agreements to the project sphere.

The outputs for the determine budget process include the following:

- ⇒ **.1 Cost baseline** — The cost baseline is an authorized time-phased budget At completion (**BAC**). It is used to measure, monitor, and control overall project cost performance. A key earned value term often used to refer to this baseline is the **performance measurement baseline (PMB)**.
- ⇒ **.2 Project funding requirements** — How much money does the project need to be successfully completed, and when is the money required? These are the key questions answered by the project funding requirements. *Image 66* shows an example of a cost baseline (the top dark line). The lower and lighter line shows the actual costs for the project. In many real-world projects, the funding does not constantly flow in like water from a faucet. Instead, money is distributed in normal intervals to set limits. These distributions are represented by the dotted line and are the funding requirements.

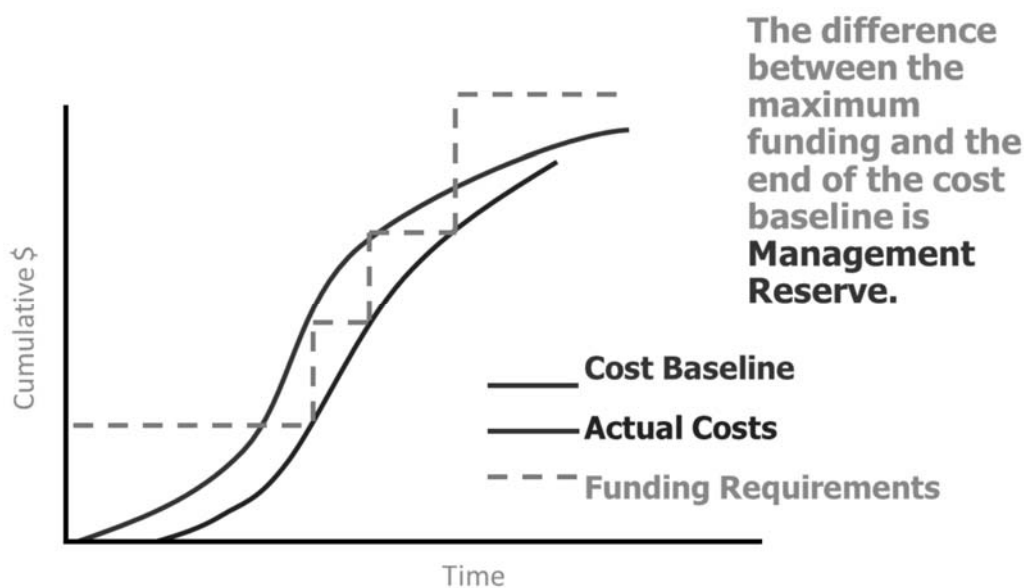


Image 66: Project funding requirements



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- ⇒ **.3 Project document updates** — PMI® specifically calls out the updating of the cost estimates, project schedule and risk register as all three can be significantly altered by the process of generating a project budget.

Depreciation

The next topic to review for the test is depreciation. Depreciation provides a series of financial calculations to account for the wearing out of equipment within the organization. This is important to an organization because of an earlier topic: assets and liabilities. Two key elements are relevant to understand this concept. First, you must consider yourself the project leader for an American organization. Secondly, go back to the scenario of being a project manager at the widget factory. Imagine purchasing a \$100,000 widget stamping machine. From the federal government's perspective you still have a \$100,000 worth of assets in the organization. However, as soon as you start using that widget stamping machine, is anyone going to pay you the full \$100,000 to take that machine off your hands? The answer is, of course, "No!" The machine is now used and worth less. So why should your company continue to pay taxes on the asset as if it were brand new? It shouldn't, and depreciation provides the method to reduce this burden. As you can imagine, most organizations want to reduce this burden as quickly as possible. The speed at which you can depreciate an asset is defined by its depreciation schedule. For the PMP® exam, it is not expected that you are a subject matter expert on depreciation. It is enough for you to know the basic calculations, the differences between the types, and that it is governed by the **Generally accepted accounting principles (GAAP)**. Remember, you always can rely on your team's expert judgment.

Before discussing the specifics surrounding depreciation, there are a few terms you need to know. These terms include the following:

- ⇒ **Useful life** — The useful life represents how long it is until the asset cannot be used for tax purposes. Most assets have supposed useful lives of five years or less so this value has little to do with how long the asset is really used.
- ⇒ **Residual value** — Also referred to as the scrap or salvage value. The residual value refers to the supposed value of an asset after its useful life has been expended. It answers the question how much would the junk dealer pay for the machine when all they were going to do is melt it down for the metal. Again, this is a value obtained from your subject matter experts.
- ⇒ **Cost** — An asset's cost is how much was paid to obtain the asset.

Depreciation is largely broken into two groups, standard and accelerated. The difference between these two is that accelerated depreciation makes the asset worth less, more quickly. For the exam there are four types of depreciation you must be able to solve. Two methods are standard and two methods are accelerated.

Straight Line Depreciation

The first depreciation method is the oldest and easiest. It is called straight line depreciation (**SLD**) and it is the first standard depreciation method. SLD is defined using the formula:

$$\text{Current Asset Value} = \frac{\text{cost} - \text{residual value}}{\text{useful life}}$$

Let's go back to our widget factory to get a better understanding. Imagine your team purchased a widget stamping machine that cost \$100,000. Your accounting expert tells you the allowed depreciation schedule is five years, and your machine expert says when the machine is all worn out you can sell it to the scrap dealer for \$25,000. The straight line depreciation formula would be as follows:

$$\begin{aligned} \Rightarrow \text{Year 1} &= \$100,000 - ((\$100,000 - \$25,000) / 5) = \mathbf{\$85,000} \\ \Rightarrow \text{Year 2} &= \$85,000 - ((\$100,000 - \$25,000) / 5) = \mathbf{\$70,000} \\ \Rightarrow \text{Year 3} &= \$70,000 - ((\$100,000 - \$25,000) / 5) = \mathbf{\$55,000} \\ \Rightarrow \text{Year 4} &= \$55,000 - ((\$100,000 - \$25,000) / 5) = \mathbf{\$40,000} \\ \Rightarrow \text{Year 5} &= \$40,000 - ((\$100,000 - \$25,000) / 5) = \mathbf{\$25,000} \end{aligned}$$

There are three points with regard to this calculation and its results. First, notice that each annual calculation is run at the end of its year. Second, notice that the final result at the end of the useful life or schedule period is exactly equal to the salvage value. This will be the case in all instances except when using the double declining balance or the units of production method of calculating depreciation. The final point is that you need to be careful in answering any depreciation question, as they are unlikely to ask what the value of the asset would be at the end of the useful life, as that will almost always be the salvage value. More than likely you will be asked to solve for one of the interim periods. Imagine being asked—in the case above—what the asset value would be at the end of year three. The answer would be \$55,000.

Production Method of Depreciation

The second standard depreciation method is the **units of production** (UOP) method of depreciation. This method is commonly used in manufacturing environments where the life expectancy of a piece of equipment is best defined by the number of units it can produce. The formula to calculate the production method of depreciation is as follows:

$$\text{Current Asset Value} = \left(\text{Units Produced} * \left(\frac{\text{cost} - \text{residual value}}{\text{estimated units of useful life (production)}} \right) \right)$$

In the units of production method of depreciation, our subject matter experts must provide two additional pieces of information before we can complete the calculation. To successfully complete the calculation, we need to know how many units the widget stamping machine can produce before wearing out, and how many units have been produced. In this case, imagine our subject matter expert informs us that the stamping machine can produce 10,000,000 widgets before wearing out and it has produced 750,000 units. With this new piece of data our calculation now is as follows:



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**Straight Line
Depreciation
Formula**

**Units of
Production
Formula**

- ⇒ Cost — Residual = \$100,000 - \$25,000 = **\$75,0000**
- ⇒ Depreciation per Unit Produced = \$75,000 / 10,000,000 = **0.0075**
- ⇒ Depreciation for 750,000 Units = 750,000 * 0.0075 = **\$5,625**
- ⇒ Depreciated Value = \$100,000 — \$5625 = **\$94,375**

Common questions using the production method would ask about what the depreciated value was after X units are produced, without regard for the number of time periods.

Accelerated Depreciation

Accelerated depreciation methods make an asset's value decline at a faster rate, sometimes significantly faster than standard depreciation allows. Remember, the idea is that the organization must pay taxes on the assessed value, so the faster it loses value, the less tax the organization pays. Don't fret about knowing when to use a standard versus accelerated method. You are only responsible for knowing the basic calculations. You subject matter experts will define which method is appropriate for your situation. There are potentially two accelerated depreciation methods on the exam. These methods are: Double Declining Balances and Sum of the Year Digits.

Double Declining Balances

Double declining balances or DDB is the fastest method for depreciating an asset. It requires the project manager to take 100% and divide it by the term of the depreciation schedule. This result is doubled and the asset value is then reduced by the doubled result until the value becomes equal to or less than the salvage value. Here is an absolutely critical point, as an asset can **NEVER** be worth less than its salvage value. Once that result is reached, you are done calculating regardless of the term. Let's go back to our widget factory and machine example. Using the same \$100,000 machine with a \$25,000 salvage value and a five year term the calculation would be:

- ⇒ 100% / 5 = 20%
- ⇒ 20% doubled = 40%
- ⇒ Year 1 = \$100,000 — 40% = \$60,000
- ⇒ Year 2 = \$60,000 — 40% = \$36,000
- ⇒ Year 3 = \$36,000 — 40% = \$21,600

At the end of year three you would stop calculating because the result (\$21,600) is less than the salvage value of \$25,000. At the end of year three, the salvage value is then \$25,000 because it can never be worth less than the salvage value.

Sum of the Year Digits

The last depreciation method is often the most difficult for exam candidates to learn. It is the **sum of the year digits method** of depreciation or **SYD**. SYD begins by adding all the values in the term. For example, if the term was three years, you would add 1 + 2 + 3 = 6. Next, count the term backwards and divide the value by the sum just created (6), and multiply the result by the purchase



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price minus the salvage value. Third, subtract this new result from the value. Let's look at an example to better understand SYD. Returning to our widget factory machine with a purchase price of \$100,000, a salvage value of \$25,000 and a term of five years, the process would be as follows:

$$\begin{aligned} \Rightarrow 1 + 2 + 3 + 4 + 5 &= 15 \text{ (the sum of the five year term)} \\ \Rightarrow \$100,000 - \$25,000 &= \$75,000 \text{ (the purchase price—residual value)} \\ \Rightarrow \text{Year 1} &= \$100,000 - (5/15 * \$75,000) = \$75,000 \\ \Rightarrow \text{Year 2} &= \$75,000 - (4/15 * \$75,000) = \$55,000 \\ \Rightarrow \text{Year 3} &= \$55,000 - (3/15 * \$75,000) = \$40,000 \\ \Rightarrow \text{Year 4} &= \$40,000 - (2/15 * \$75,000) = \$30,000 \\ \Rightarrow \text{Year 5} &= \$30,000 - (1/15 * \$75,000) = \$25,000 \end{aligned}$$

Notice that the SYD method will always conclude at the end of the term exactly at the salvage value. This is a good test to ensure you have not made a mistake on the exam.

Take a few moments to complete the depreciation exercise on the following page before continuing on to the next topic.



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Exercise 12—Depreciation

1. You are a project manager and have been asked to assess the value of an asset on your project at the end of year four using straight line depreciation. Assuming the asset costs \$100,000 to purchase, has a residual value of \$25,000, and is depreciated based on a five year schedule what is the assessed value?
 - A. \$25,000
 - B. \$40,000
 - C. \$65,000
 - D. \$85,000
2. You are a project manager and have been asked to assess the value of an asset on your project at the end of year three using straight line depreciation. Assuming the asset costs \$225,000 to purchase, has a residual value of \$35,000, and is depreciated based on a five year schedule what is the assessed value?
 - A. \$187,000
 - B. \$149,000
 - C. \$111,000
 - D. \$73,000
3. You are a project manager and have been asked to assess the value of an asset on your project at the end of year one using straight line depreciation. Assuming the asset costs \$75,000 to purchase, has a residual value of \$12,500, and is depreciated based on a three year schedule what is the assessed value?
 - A. \$75,000
 - B. \$12,500
 - C. \$33,333
 - D. \$54,167
4. You are a project manager and have been asked to assess the value of an asset on your project at the end of year three (3) using straight line depreciation. Assuming the asset costs \$50,000 to purchase, has a residual value of \$10,000, and is depreciated based on a three (3) year schedule what is the assessed value?
 - A. \$10,000
 - B. \$13,333
 - C. \$23,333
 - D. \$36,667



Exercise 12— Depreciation

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5. You are a project manager and have been asked to assess the value of an asset on your project at the end of year three using straight line depreciation. Assuming the asset costs \$250,000 to purchase, has a residual value of \$50,000, and is depreciated based on a five year schedule what is the assessed value?
- A. \$210,000
 - B. \$175,000
 - C. \$130,000
 - D. \$110,000
6. You are a project manager for a manufacturing company. You are asked to determine the depreciated value for a piece of equipment using the UOP method. If the piece of equipment initially cost \$1,000,000, has a residual value of \$25,000, has a useful life of 10,000,000 units produced, and has already produced 1,000,000 units what is its current value?
- A. \$900,000
 - B. \$902,500
 - C. \$875,000
 - D. \$800,000
7. You are a project manager for a manufacturing company. You are asked to determine the depreciated value for a piece of equipment using the UOP method. If the piece of equipment initially cost \$750,000, has a residual value of \$40,000, has a useful life of 8,000,000 units produced, and has already produced 2,500,000 units what is its current value?
- A. \$375,500
 - B. \$768,250
 - C. \$625,500
 - D. \$528,125
8. You are a project manager for a manufacturing company. You are asked to determine the depreciated value for a piece of equipment using the UOP method. If the piece of equipment initially cost \$500,000, has a residual value of \$65,000, has a useful life of 7,500,000 units produced, and has already produced 310,000 units what is its current value?
- A. \$365,500
 - B. \$532,250
 - C. \$482,020
 - D. \$525,010

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9. You are a project manager for a manufacturing company. You are asked to determine the depreciated value for a piece of equipment using the UOP method. If the piece of equipment initially cost \$250,000, has a residual value of \$15,000, has a useful life of 5,500,000 units produced, and has already produced 4,100,000 units what is its current value?
- A. \$72,652
 - B. \$74,818
 - C. \$76,534
 - D. \$81,225
10. You are a project manager for a manufacturing company. You are asked to determine the depreciated value for a piece of equipment using the UOP method. If the piece of equipment initially cost \$2,000,000, has a residual value of \$68,000, has a useful life of 15,000,000 units produced, and has already produced 7,200,000 units what is its current value?
- A. \$1,072,640
 - B. \$1,528,860
 - C. \$925,310
 - D. \$875,687
11. You are a project manager and have been asked to assess the value of an asset on your project at the end of year two using DDB. Assuming the asset costs \$100,000 to purchase, has a residual value of \$25,000, and is depreciated based on a five year schedule what is the assessed value?
- A. \$60,000
 - B. \$36,000
 - C. \$25,000
 - D. \$21,400
12. You are a project manager and have been asked to assess the value of an asset on your project at the end of year three using DDB. Assuming the asset costs \$250,000 to purchase, has a residual value of \$35,000, and is depreciated based on a five year schedule what is the assessed value?
- A. \$54,000
 - B. \$64,000
 - C. \$90,000
 - D. \$150,000
13. You are a project manager and have been asked to assess the value of an asset on your project at the end of year four using DDB. Assuming the asset costs \$650,000 to purchase, has a residual value of \$52,000, and is depreciated based on a five year schedule what is the assessed value?
- A. \$390,000
 - B. \$234,512
 - C. \$140,375
 - D. \$84,240

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14. You are a project manager and have been asked to assess the value of an asset on your project at the end of year two using DDB. Assuming the asset costs \$79,800 to purchase, has a residual value of \$12,000, and is depreciated based on a three year schedule what is the assessed value?
- A. \$26,600
 - B. \$12,000
 - C. \$6,500
 - D. \$18,460
15. You are a project manager and have been asked to assess the value of an asset on your project at the end of year two using DDB. Assuming the asset costs \$150,000 to purchase, has a residual value of \$10,000, and is depreciated based on a three year schedule what is the assessed value?
- A. \$50,000
 - B. \$36,450
 - C. \$16,667
 - D. \$10,000
16. You are a project manager and have been asked to assess the value of an asset on your project at the end of year three using SYD. Assuming the asset costs \$100,000 to purchase, has a residual value of \$25,000, and is depreciated based on a five year schedule what is the assessed value?
- A. \$55,000
 - B. \$45,000
 - C. \$40,000
 - D. \$35,000
17. You are a project manager and have been asked to assess the value of an asset on your project at the end of year two using SYD. Assuming the asset costs \$250,000 to purchase, has a residual value of \$29,000, and is depreciated based on a three year schedule what is the assessed value?
- A. \$65,833
 - B. \$59,561
 - C. \$55,610
 - D. \$49,900
18. You are a project manager and have been asked to assess the value of an asset on your project at the end of year three using SYD. Assuming the asset costs \$350,000 to purchase, has a residual value of \$33,000, and is depreciated based on a four year schedule what is the assessed value?
- A. \$48,750
 - B. \$55,800
 - C. \$61,900
 - D. \$64,700

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19. You are a project manager and have been asked to assess the value of an asset on your project at the end of year two using SYD. Assuming the asset costs \$450,000 to purchase, has a residual value of \$41,000, and is depreciated based on a four year schedule what is the assessed value?
- A. \$159,900
 - B. \$163,700
 - C. \$165,500
 - D. \$169,200
20. You are a project manager and have been asked to assess the value of an asset on your project at the end of year three using SYD. Assuming the asset costs \$550,000 to purchase, has a residual value of \$62,500, and is depreciated based on a four year schedule what is the assessed value?
- A. \$111,250
 - B. \$118,500
 - C. \$125,200
 - D. \$130,500

Exercise 12—Depreciation Answers

1. **Answer B.** This question requires you to calculate the depreciation using the formula below then subtracting that result from the purchase price four times.

$$\text{Current Asset Value} — \frac{\text{cost} - \text{residual value}}{\text{useful life}}$$

2. **Answer C.** This question requires you to calculate the depreciation using the formula below then subtracting that result from the purchase price three times.

$$\text{Current Asset Value} — \frac{\text{cost} - \text{residual value}}{\text{useful life}}$$

3. **Answer D.** This question requires you to calculate the depreciation using the formula below then subtracting that result from the purchase price one time.

$$\text{Current Asset Value} — \frac{\text{cost} - \text{residual value}}{\text{useful life}}$$

4. **Answer A.** This question requires you to calculate the depreciation using the formula below then subtracting that result from the purchase price three times.

$$\text{Current Asset Value} — \frac{\text{cost} - \text{residual value}}{\text{useful life}}$$

5. **Answer C.** This question requires you to calculate the depreciation using the formula below then subtracting that result from the purchase price three times.

$$\text{Current Asset Value} — \frac{\text{cost} - \text{residual value}}{\text{useful life}}$$

6. **Answer B.** The Unit of Production Method, or UOP is defined by first calculating the amount of value the asset loses with each unit produced. This is done with the formula below. This result is then multiplied by the number of units produced giving you the lost value. By subtracting this number from the original purchase price you obtain the result.

$$\text{Current Asset Value} — \left(\text{Units Produced} * \left(\frac{\text{cost} - \text{residual value}}{\text{estimated units of useful life (production)}} \right) \right)$$

7. **Answer D.** The Unit of Production Method, or UOP is defined by first calculating the amount of value the asset loses with each unit produced. This is done with the formula below. This result is then multiplied by the number of units produced giving you the lost value. By subtracting this number from the original purchase price you obtain the result.

$$\text{Current Asset Value} — \left(\text{Units Produced} * \left(\frac{\text{cost} - \text{residual value}}{\text{estimated units of useful life (production)}} \right) \right)$$

8. **Answer C.** The Unit of Production Method, or UOP is defined by first calculating the amount of value the asset loses with each unit produced. This is done with the formula below. This result is the multiplied by the number of units produced giving you the lost value. By subtracting this number from the original purchase price you obtain the result.

$$\text{Current Asset Value} - \left(\text{Units Produced} * \left(\frac{\text{cost} - \text{residual value}}{\text{estimated units of useful life (production)}} \right) \right)$$

9. **A:** The Unit of Production Method, or UOP is defined by first calculating the amount of value the asset loses with each unit produced. This is done with the formula below. This result is the multiplied by the number of units produced giving you the lost value. By subtracting this number from the original purchase price you obtain the result.

$$\text{Current Asset Value} - \left(\text{Units Produced} * \left(\frac{\text{cost} - \text{residual value}}{\text{estimated units of useful life (production)}} \right) \right)$$

10. **A:** The Unit of Production Method, or UOP is defined by first calculating the amount of value the asset loses with each unit produced. This is done with the formula below. This result is the multiplied by the number of units produced giving you the lost value. By subtracting this number from the original purchase price you obtain the current value.

$$\text{Current Asset Value} - \left(\text{Units Produced} * \left(\frac{\text{cost} - \text{residual value}}{\text{estimated units of useful life (production)}} \right) \right)$$

11. **Answer B.** Double Declining Balances or DDB is an accelerated depreciation method. Begin by calculating depreciation as if using the straight line method. Then determine the total percentage of the asset that is depreciated the first year and double it. Each subsequent year, that same percentage is multiplied by the remaining balance to be depreciated.
12. **Answer A.** Double Declining Balances or DDB is an accelerated depreciation method. Begin by calculating depreciation as if using the straight line method. Then determine the total percentage of the asset that is depreciated the first year and double it. Each subsequent year, that same percentage is multiplied by the remaining balance to be depreciated.
13. **Answer D.** Double Declining Balances or DDB is an accelerated depreciation method. Begin by calculating depreciation as if using the straight line method. Then determine the total percentage of the asset that is depreciated the first year and double it. Each subsequent year, that same percentage is multiplied by the remaining balance to be depreciated.
14. **Answer B.** Double Declining Balances or DDB is an accelerated depreciation method. Begin by calculating depreciation as if using the straight line method. Then determine the total percentage of the asset that is depreciated the first year and double it. Each subsequent year, that same percentage is multiplied by the remaining balance to be depreciated.

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15. **Answer C.** Double Declining Balances or DDB is an accelerated depreciation method. Begin by calculating depreciation as if using the straight line method. Then determine the total percentage of the asset that is depreciated the first year and double it. Each subsequent year, that same percentage is multiplied by the remaining balance to be depreciated.
 16. **Answer C.** SYD or Sum of the Year Digits is an accelerated depreciation method. Begin by adding the number of years in the schedule. For example, for a five year schedule add $1+2+3+4+5 = 15$. Next, take the asset value minus the residual value and divide it by this result (15). This creates the amount you will use at the end of each year to reduce the value of the asset.
 17. **Answer A.** SYD or Sum of the Year Digits is an accelerated depreciation method. Begin by adding the number of years in the schedule. For example, for a five year schedule add $1+2+3+4+5 = 15$. Next, take the asset value minus the residual value and divide it by this result (15). This creates the amount you will use at the end of each year to reduce the value of the asset.
 18. **Answer D.** SYD or Sum of the Year Digits is an accelerated depreciation method. Begin by adding the number of years in the schedule. For example, for a five year schedule add $1+2+3+4+5 = 15$. Next, take the asset value minus the residual value and divide it by this result (15). This creates the amount you will use at the end of each year to reduce the value of the asset.
 19. **Answer B.** SYD or Sum of the Year Digits is an accelerated depreciation method. Begin by adding the number of years in the schedule. For example, for a five year schedule add $1+2+3+4+5 = 15$. Next, take the asset value minus the residual value and divide it by this result (15). This creates the amount you will use at the end of each year to reduce the value of the asset.
 20. **Answer A.** SYD or Sum of the Year Digits is an accelerated depreciation method. Begin by adding the number of years in the schedule. For example, for a five year schedule add $1+2+3+4+5 = 15$. Next, take the asset value minus the residual value and divide it by this result (15). This creates the amount you will use at the end of each year to reduce the value of the asset.

7.4 Control Costs

The third and final process found in the cost management knowledge area is the control costs process. It is one of the most important processes to study for the PMP® exam because it provides the primary focus on the **earned value technique (EVT)** otherwise known as the **earned value management system (EVMS)**. There are a number of calculations and graphing skills that must be mastered to successfully understand this process.

The control costs process is concerned with influencing the factors that create changes to the cost baseline, ensuring requested changes are agreed upon, managing the actual changes as they occur, and assuring that potential cost-overruns do not exceed the authorized funding, periodically and in total for the project. As with any of the processes which have the word “control” in them, control costs is part of integrated change control.

Most of this section will focus on EVT, but let’s begin with the inputs, tools and techniques, and outputs of the control costs process. The inputs to the control costs process include:

- ⇒ **.1 Project management plan** — Within the project management plan there are three components which are critical to controlling project costs. The first is the cost management plan which describes how the project costs are managed and controlled, and the second is the cost baseline, which provides the primary point of comparison for the actual result. The third and final component is the performance measurement baseline.
- ⇒ **.2 Project documents** — Although you might need to examine a lot of different project documents as you go through the process of controlling costs, the one PMI® specifically calls out is the lessons learned register because the team uses it to see where other projects have had trouble controlling costs and how they solved specific cost problems.
- ⇒ **.3 Project funding requirements** — The funding requirements define how much money is needed to complete the project, and when the money is required.
- ⇒ **.4 Work performance data** — The work performance information explains which deliverables have started, their progress, and which deliverables have finished. It also includes information about incurred actual costs, authorized costs, and estimates for both schedule and cost completion.
- ⇒ **.5 Organizational process assets** — Many organizations have processes, policies and templates that deal with project cost control. All of these should be included if they are available.

The tools and techniques used in the control costs process include the following:

- ⇒ **.1 Expert judgment** — To accurately control project costs, the team needs to have real world experience. It is that expert judgment that PMI® calls on to ensure the team has success.



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- ⇒ **Data analysis** — There are a number of data analysis techniques the team might use to control costs, but PMI® specifically calls out four that are critical. For the exam it is absolutely critical that you know these cold. They include:
- ◇ **Earned value management** — EVT or EVMS is PMI's preferred method for measuring progress on a project because of its quantitative nature and focus on future predictability.
 - ◇ **Variance analysis** — Variance analysis is largely tied to earned value. It is the process of comparing your actual results to what you promised and then understanding the difference.
 - ◇ **Trend analysis** — Trend analysis involves understanding the collective movement of the project costs, where they have been and where they are going. A big part of this is forecasting the future project costs.
 - ◇ **Reserve analysis** — If you recall from earlier in our course, reserves come in two forms: contingency and management reserves. Here we are specifically looking to ensure we have set aside enough money to complete the project should the unexpected occur.
- ⇒ **.3 To-complete performance index** — The TCPI is the calculated projection of cost performance that must be achieved on the remaining work to meet a specified goal. The TCPI is an earned value calculation.
- ⇒ **.4 Project management information system** — Because of the number of calculated fields, often project management software makes the process of controlling costs much easier.

The outputs to the control costs process include the following:

- ⇒ **.1 Work performance information** — The primary work performance measurements are all earned value measures such as CV, SV, CPI, and SPI done at the control account level within the WBS.
- ⇒ **.2 Cost forecasts** — The budget forecast is also an earned value calculation using the EAC value.
- ⇒ **.3 Change requests** — The ongoing analysis of project performance often causes stakeholders to request changes in one or more aspect.
- ⇒ **Organizational process assets updates** — Specific updates might include causes of variances, corrective actions taken with explanations, or other types of lessons learned.
- ⇒ **.4 Project management plan updates** — Your measurements might cause updates to the cost baseline, the cost management plan, and the performance measurement baseline.

⇒ **.5 Project document updates** — Those same measurements might cause updates to a number of other documents found outside the project management plan but still important. Examples include: the assumption log, the cost estimates and the basis of those estimates, the lessons learned register, and the risk register.

Earned Value Management (EVM)

As was previously stated, the primary focus of the control costs process is Earned value management (EVM). For many PMP® candidates, understanding Earned value is the singularly most difficult concept to master. You must know all the equations and the reasoning behind when and where to use the calculations to pass the exam. To better understand EVM let's begin by taking a step back.

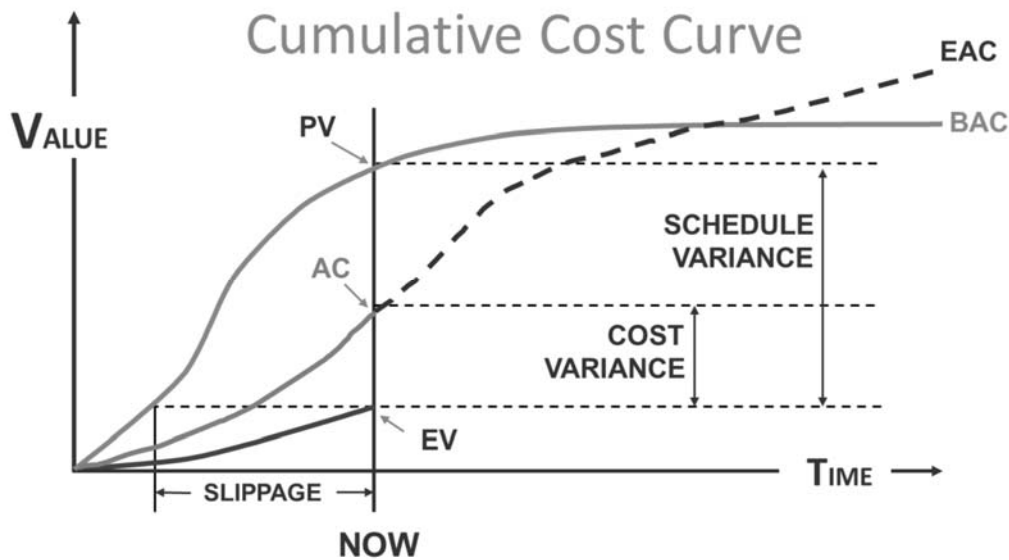
Many basic project management courses teach the importance of the triple constraints in project management. These constraints are time, costs, and scope/quality. It is often said that project management is largely about managing the trade-offs between these three. However, the concept of a series of trade-offs creates a significant problem. How does a project manager evaluate the trade-offs between time and costs, or time and scope, or scope and costs? If you are like many project managers the answer is easy, you simply ask your stakeholders right? Wrong!

If you ask your stakeholders to provide the analysis of the trade-offs you are trapped using highly subjective measures and will fail every time. A key goal of successful project management is finding quantifiable, objective measures of success and progress. Do you see the trap yet? Let's take a look at a simple example to make it more clear.

What is the most common measure of time? Hours, days, weeks or months right? What is the most common measure of cost? Dollars or whatever is your national currency. Finally, how do you measure scope/quality? Be careful as this question often tricks people who go too quickly. The primary measure of scope/quality is deliverables or features.

Now bring these three together. How would you evaluate the trade-off between two weeks, five features and \$10,000? Remember, the correct answer is not ask your stakeholders. The correct answer is you can't! Each person you ask would likely give you a different answer. This simple example brings us to Earned Value Management.

At its heart, earned value management is all about providing a quantitative, objective method to measure the performance of variables which are naturally disparate so the trade-offs can be easily understood. Earned value has become increasingly popular because it focuses on using this information to provide future predictability and can be very accurate, even early in a project. Successfully learning Earned value management requires you to focus on those three variables from the triangle: time, cost and scope/quality. EVM translates these three variables so do not get confused. Remember to stay focused on what



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Image 67: A Cumulative Cost Curve

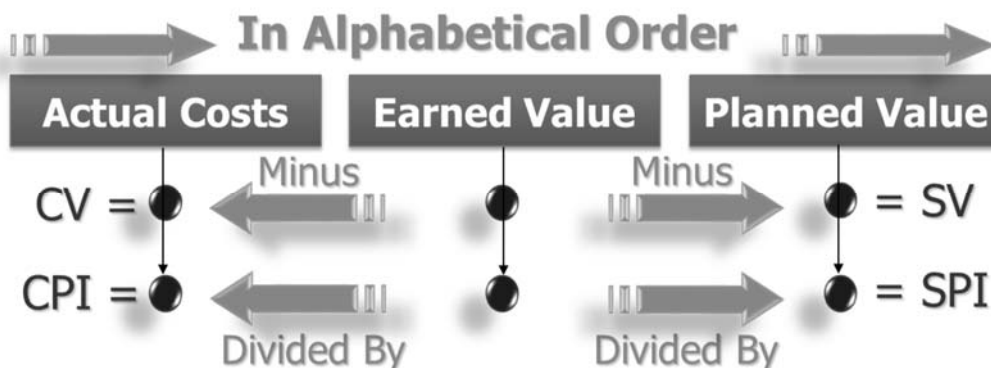
the variables really are. To explain, earned value and its calculations more fully we will use a chart and table. We begin with a slightly more sophisticated version of the cost baseline examined previously in this chapter. *Image 67* shows the cumulative cost curve. The first thing you likely notice is the large number of acronyms. Do not worry, with a little practice these will become second nature. The horizontal axis of the chart represents time as a continuum. The vertical axis represents the cumulative dollars for the project. Notice there is also a vertical bar showing where the project is currently. Below the other acronyms are defined.

- ⇒ **BAC** — The budget at completion. This is the total budget for the project. It is the single number used to answer the question how much money was this project supposed to cost in total?
- ⇒ **Remaining work** — This is exactly what it sounds like it is. It represents the work that is still left to be accomplished. It is calculated with the formula $BAC - EV$.
- ⇒ **ETC** — The estimate to complete. This is the number that answers the question how much **MORE** money do we think the project is really going to cost. There are several different calculations which may be used to calculate ETC.
- ⇒ **Critical ratio** — The critical ratio is the $CPI * SPI$. It provides a quick, single number review of project performance.
- ⇒ **PV** — The planned value is the first of three major variables representing the legs of the triangle in the triple constraints. The PV represents the time leg of the triangle. The transition from days to dollars is made through the budget. A key aspect of any budget is when the money is spent. We can therefore argue that the \$1,000 that was planned to be spent in a given week

is equal to that week. This allows us to now go through the analysis using the \$1,000 instead of always referring back to the one week. The planned value provides the baseline against which all comparisons are made. In a perfectly run project, both the AC and EV lines appear exactly on top of the PV line. Also notice that the BAC is at the end of the PV line at a point where it has flattened out. This flattening occurs because the project reached its total budget without being completed so time continues but the PV line remains flat. The PV is another way of saying the cost baseline or budget. It also can be used to represent the amount of work to be completed in any period.

- ⇒ **AC** — The actual costs is the easiest of the earned value variables. It represent the actual money spent on the project.
- ⇒ **EV** — The earned value is often the most difficult variable for exam candidates to learn. However, it is also the most important of the three major variables (AC, EV and PV) because all the major calculations begin with the earned value. The earned value represents the scope leg of the triple constraints. It is the amount of work product that has been produced by the project. The trick is converting work into dollars. The major requirement to accomplish this feat has already been achieved. The key element to reporting progress using earned value is progress must be reported at the work package level of the WBS. Once the initial budget for a work package is established so is its value because they are the same thing. If you planned on spending \$1,000 in total on a work package then the work package is worth \$1,000. If you are 50% done with the work package you have earned \$500 in value. Finally, a work package can **NEVER** be worth more than you planned on it costing to produce.
- ⇒ **EAC** — The estimate at completion is one of three forecasts that is calculated using the three base variables (AC, EV and PV). It answers the question how much in **TOTAL** are we now expecting the project to cost. It includes an estimate of the remaining work costs (ETC) and the already accrued actual costs.

The discipline of earned value is rooted in four calculations which are found in *Image 68*. This image is the best way of memorizing the basic earned value



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Image 68: The Earned Value Exam Guide

calculations. Begin by noticing the three major earned value variables discussed above (AC, EV and PV) appear at the top of the graphic in alphabetical order. All of the calculations begin in the middle with the Earned Value (the name of the technique) and work outward. On the far left are two variables that begin with the letter C. These variables measure cost performance. On the far right side are two variables which begin with the letter S. These measure schedule performance. The two letter calculations (CV and SV) are variances which show the actual over or under performance in currency terms. The three letter calculations (CPI and SPI) are performance indexes which measure the variances as a percentage. As you will see, the performance indexes are usually more valuable than the variances. The four basic earned value equations defined by *Image 68* are:

- ⇒ $CV = EV - AC$
- ⇒ $CPI = EV / AC$
- ⇒ $SV = EV - PV$
- ⇒ $SPI = EV / PV$

To read these calculations an exam candidate only needs to remember a few simple rules. These rules are:

- ⇒ If it is a two letter abbreviation the target is zero.
 - ◇ CV or $SV > 0$ is under budget
 - ◇ CV or $SV = 0$ is right on budget
 - ◇ CV or $SV < 0$ is over budget
- ⇒ If it is a three letter abbreviation the target is one.
 - ◇ CPI or $SPI > 1$ is under budget
 - ◇ CPI or $SPI = 1$ is right on budget
 - ◇ CPI or $SPI < 1$ is over budget

Let's take a more detailed look at these rules to better understand how they work. If the project has a cost variance of $-\$12,345$, this is bad as it is less than zero and tells the project manager they are over budget. A CV of zero means the project is right on budget, and a CV of greater than zero means the project is under budget by the value of the CV. Replace the cost variance with the schedule variance (SV) and the statements still hold true. A schedule variance less than zero means the project is behind schedule, a value of exactly zero means the project is on schedule, and a schedule variance greater than zero means the project is ahead of schedule.

The CPI and SPI are usually more valuable to the project manager, and are read using a target value of one, as any number divided by itself equals one. The CPI, or cost performance index is calculated by taking the earned value and dividing it by the actual costs. If a value of one is the result, the project is exactly on budget. If the value is greater than one the project is under budget, and if the result is less than one, the project is over budget. In the case of both indexes, the proximity to one has great significance because the one is synonymous with 100%. Hence, a CPI of .91 means the project is 9% over budget ($100\% - 91\% =$

9%), and a CPI of 1.06 means the project is 6% under budget. The same logic works for the schedule performance index. An SPI of .88 means the project is 12% behind schedule and an SPI of 1.04 means the project is 4% ahead of schedule. Both of these statistics are incredibly useful in telling the project manager where the project is right now. However, neither tells the PM how the project is going to end. To provide that information the PM must turn to the earned value forecasting measures.

Earned Value Forecasting

There are three primary forecast values which a project manager might need to calculate on any project, and with each value there are multiple methods to obtain an answer. For the certification exam it is very important that you understand each of these methods and when they should be used.

ETC — Estimate to complete answers the question how much **MORE** money is the project going to take to complete. There are four methods which may be used to calculate ETC. Each method is based upon a different assumption. These include the following:

- ⇒ **ETC based on new estimate** — There is no formula if the Estimate to Complete is being based upon an entirely new estimate. The project manager and the team simply develop a new estimate. This method is used whenever the original estimate is believed to be flawed beyond recovery. This method is not often found on the exam beyond the term and explanation because it is impossible to develop a mathematical question when the new estimate is developed by an external process.
- ⇒ **ETC based on atypical variances** — Atypical variances means the variances are not commonly occurring. For the project manager, it means whatever caused the variances is not expected to continue, and future forecasts can be based on whatever the original budget was. The formula for an ETC with atypical variances is $ETC = BAC - EV$. If you examine the definitions provided a few pages earlier, you will notice this is the same equation to define the remaining work. It is a fancy way of saying you will produce the remaining work for exactly what you said it would cost. This equation might be on the exam, but it is not the most likely. Watch for the phrase “atypical variances” on the exam to clue you in.
- ⇒ **ETC based on typical variances** — An estimate to complete based upon typical variances is the most common ETC seen on the exam. It assumes that whatever has been the rate of progress will continue in the future. In most cases it means whatever has been causing you problems will keep causing you problems. The formula to calculate the ETC using typical variances is $ETC = (BAC - EV) / CPI$. Notice this equation also makes use of the mathematical expression for remaining work (BAC - EV), but it has been factored by the actual performance rate.
- ⇒ **ETC based on both the CPI and SPI** — The final method for calculating the estimate to complete makes use of both the cost performance index and



Estimate to Complete Formulas



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the schedule performance index. This method assumes both a negative cost performance to-date and requirement to hit a specific target date. This method is most commonly used when the project schedule is a driving force impacting the ETC. The formula to calculate the ETC using both the CPI and SPI is $ETC = (BAC - EV) / (CPI * SPI)$. This formula makes use of the mathematical expression for remaining work (BAC-EV) and the Critical Ratio (CPI*SPI).

The next set of calculations used the underlying assumptions of the same four ETC calculations, and simply adds the actual costs to date to them. This creates the **Estimate At completion or EAC**. The EAC answers the question, “How much in TOTAL will the project cost?”. The calculations for EAC are as follows:

- ⇒ **EAC using a new estimate** — As with the ETC, this calculation is unlikely to be on the exam past a definitional question because it is impossible to develop a mathematical question when the formula is based outside the question parameters. The formula for the EAC when an entirely new ETC is developed is $EAC = AC + ETC$.
- ⇒ **EAC assuming atypical variances** — The second possible calculation for Estimate at completion takes the remaining current budget and adds it to the actual costs to-date. It assumes that whatever has been causing problems on the project will not continue to do so in the future. As with the ETC, this method is assuming atypical variances. The formula for the atypical variance EAC is $EAC = AC + (BAC - EV)$.
- ⇒ **EAC Assuming typical variances** — The EAC method that assumes typical variances makes use of the cost performance index (CPI) to factor the remaining work based on actual project cost performance and then adds the costs to date. It assumes the rate of cost performance achieved to date will remain consistent in the future. The formula for EAC assuming typical variances is $EAC = AC + ((BAC - EV) / CPI)$.
- ⇒ **EAC using both CPI & SPI** — The EAC using the critical ratio (CPI*SPI) makes the same assumption as the ETC using the critical ratio, that it is critical to hit a specific schedule target previously defined. The formula for the EAC using the critical ratio is $EAC = AC + ((BAC - EV) / (CPI * SPI))$.

The final cost forecast calculation you must learn for the PMP® exam is the **to-complete performance index** or **TCPI**. The TCPI is a calculated projection of the cost performance, which must be achieved on the remaining work to hit a desired target. In the simplest terms, the TCPI is the remaining work divided by the remaining funds. Typically, the EAC target is either the BAC or a new EAC. The TCPI is often used when the original budget is recognized as unrealistic and a new EAC is developed. The formula for the TCPI — when the goal is to hit the original budget—is as follows:

$$TCPI = (BAC - EV) / (BAC - AC)$$



Estimate at Completion Formulas



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To-Complete Performance Index Formulas



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If the goal is to achieve a new target based upon a specified EAC, the formula for TCPI is as follows:

$$\text{TCPI} = (\text{BAC} - \text{EV}) / (\text{EAC} - \text{AC})$$

In addition to the earned value management calculations specified which target project costs, earned value provides calculations that address forecasting the project schedule. In the PMBOK® Guide these calculations are discussed in the schedule management knowledge area, but we list them here to consolidate all the earned value discussion to a single location. The two equations used to forecast schedule in earned value management are as follows:

- ⇒ **Schedule Est. = Original Project Duration / SPI** (This is often used as a minimum schedule estimate)
- ⇒ **Schedule Est. = Original Project Duration / (CPI * SPI)** (This is often used as the maximum schedule estimate to allow for a range)

The next calculation and definition you must know for the exam is variance at completion or VAC. VAC is defined as how much over or under budget the project will be at the end. The formula used to calculate VAC is as follows:

$$\text{BAC} - \text{EAC}$$

With the 6th edition of the PMBOK® Guide introduces the concept of earned schedule to earned value. The earned schedule replaces the schedule variance used in earned value. The team still looks for zero as the break between being behind and ahead of schedule. Earned schedule theory also provides formulas for forecasting the project completion date, using the earned schedule, actual time and estimated duration. However, it also introduces a number of new variables. It is important that you understand these new variables.

- ⇒ **Schedule at completion or SAC** — This is the original planned completion duration of the project.
- ⇒ **Earned schedule or ES** — The earned schedule is the duration from the beginning of the project to the date on which the planned value is supposed to equal to the budget at completion.
- ⇒ **Actual time or AT** — This is the duration from the beginning of the project to status date.
- ⇒ **Time variance or TV** — The TV is a measure of schedule performance in time units rather than cost units and is defined by the formula:

$$\text{TV} = \text{ES} - \text{AT}$$

The time variance uses zero as its measurement mark. If this value is negative the project is behind schedule, and if it is positive it is ahead of schedule. This is exactly the same as the schedule variance time. However, it is technically not the same as the schedule variance.

- ⇒ **Time estimate at completion or TEAC** — The TEAC represents the forecast of time at completion and is similar to EAC. It uses the same basic



**Variance at
Completion
Formula**



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210**



**Time
Variance
Formula**

formulas as EAC but replaces cost with schedule.

- ⇒ **Time variance at completion or TVAC** — The TVAC shows the estimated amount of time either ahead or behind schedule the project is. It uses the following formula:

$$\text{TVAC} = \text{SAC} - \text{TEAC}$$

The TVAC uses zero as its target for perfectly on schedule with a value greater representing being ahead of schedule and a negative value representing being behind schedule.

Cost Management Summary

Although the cost management knowledge Area only contains three processes, it is critical that you do well in this section to ensure success on the exam. Make sure you are comfortable with the following:

- ⇒ **The four processes** — The four processes found in the cost management knowledge area include: plan cost management, estimate costs, determine budget, and control costs. make sure you know them and their inputs, tools and techniques, and outputs.
- ⇒ **Earned value management concepts and calculations** — EVM makes up the largest portion of the cost management knowledge area. You cannot spend too much time studying EVM!
- ⇒ **Life cycle costing** — It is a professional responsibility of every project manager to make sure the organization understands the costs of both executing the project, and owning the resultant product or service. A project manager should never develop a product or service the organization cannot afford to own.
- ⇒ **Cost baseline** — The cost baseline usually appears as an S-curve and represents the budget over time for the project. It is important because it provides the target or comparison point as the project progresses.
- ⇒ **Estimating vs. budgeting** — Estimating is the process of developing expected costs at the lowest level of delivery. Budgeting is the process of rolling those estimates up to obtain the overall project costs and then determining when that money is expected to be spent.
- ⇒ **Types of estimates and estimating** — The types of estimates include the ROM and detailed or budget estimate. Types of estimating include analogous, parametric, bottom-up and three point estimating.
- ⇒ **Contingency and management reserve** — Make sure you understand the differences between these two. Remember, contingency reserve is used to respond to known unknowns, and is controlled by the project manager. Management reserves are used to respond to unknown unknowns, and controlled by senior management.



**Time
Variance at
Completion
Formula**



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Exercise 13 — Earned Value Management



Exercise 13 — EVMS

- Which of the following variables represents the budgeted cost for the work scheduled to be completed up to a given point?
 - Actual cost
 - Planned value
 - Earned value
 - Estimate at completion
- Which of the following variables represents the budgeted amount for the work completed on the schedule activity up to a given point?
 - Planned value
 - Actual costs
 - Estimate to completion
 - Earned value
- Which of the following variables represents the total cost incurred in accomplishing work on the scheduled activity during a specific time period?
 - Actual costs
 - Summary costs
 - Earned value
 - Planned value
- Which of the following variables represents the amount of additional money that needs to be spent to complete the project?
 - EAC
 - ETC
 - CPI
 - SPI
- Which of the following variables represents the total amount of money that is estimated to be spent when the project is completed?
 - ETC
 - CPI
 - EAC
 - SPI
- Which of the following variables represents the formula: Earned Value minus Actual Costs?
 - CV
 - CPI
 - SV
 - SPI

-
7. Which of the following variables represents the formula: Earned Value minus Planned Value?
- A. SPI
 - B. CV
 - C. CPI
 - D. SV
8. Your boss enters your office and asks for the cost variance on your project that has an AC of \$290, a PV of \$300, and an EV of \$270. What value do you provide them?
- A. -30
 - B. 0.95
 - C. 0.92
 - D. -20
9. Your boss enters your office and asks for the cost variance on your project that has an AC of \$400, a PV of \$405, and an EV of \$391. What value do you provide them?
- A. -5
 - B. 1.30
 - C. 1.08
 - D. -9
10. You are preparing your monthly status report for your project. Your project had an original budget of \$150,000 and an original schedule of 18 months. You currently have spent \$65,000 and had budgeted to spend \$60,000. You have produced \$55,000 worth of product. Your Vice President is very eager to review your report as your project is important to the company's success. What is the Cost Variance for the project?
- A. -10,000
 - B. -5,000
 - C. 0.85
 - D. 0.92
11. You are preparing your monthly status report for your project. Your project had an original budget of \$950,000 and an original schedule of 11 months. You currently have spent \$400,000 and had budgeted to spend \$405,000. You have produced \$391,000 worth of product. Your Vice President is very eager to review your report as your project is important to the company's success. What is the Schedule Variance for the project?
- A. -9,000
 - B. 0.98
 - C. 14
 - D. -14,000

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12. You are leading a project that is a low profile project for the organization. The project was originally scheduled to take 10 months at a total cost of \$70,000. Your title is that of a project coordinator, and you often have to struggle to get the resources you need. You have already spent \$40,000 even though you were only scheduled to spend \$37,500. If you have already produced \$37,500 worth of work what is your current SPI?
- A. -2.50
 - B. 0
 - C. 1.00
 - D. It cannot be determined
13. You are the program manager for a large software development company. You are currently leading a project that has an original budget of \$35,000 and an original schedule of seven months. Currently the project has delivered on \$27,500 of the project. It has also spent \$29,000. If the project was forecast to spend \$30,000 to date, what is the project's SPI?
- A. 0.95
 - B. 0.92
 - C. 0.87
 - D. -1.5
14. What is the Critical Ratio for a project that had an original budget of \$25,000, an original schedule of ten months, actual costs of \$10,000, has produced \$9,000 worth of work, and was scheduled to have spent \$10,000?
- A. 0.90
 - B. -1
 - C. 0.81
 - D. It cannot be determined
15. What is the Critical Ratio for a project that had an original budget of \$75,000, an original schedule of twelve months, actual costs of \$45,000, and has produced \$50,000 worth of work?
- A. 1.11
 - B. 1.25
 - C. 1.39
 - D. It cannot be determined
16. What is the Critical Ratio for a project that had an original budget of \$950,000, an original schedule of eleven months, actual costs of \$400,000, has produced \$391,000 worth of work, and was scheduled to have spent \$405,000?
- A. 0.94
 - B. 0.98
 - C. 0.97
 - D. It cannot be determined

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17. You are a project manager working on a project that had an original budget of \$30,000 and was forecast to take eight months. The project currently has delivered on \$18,000 worth of the project and has spent \$22,500. If the variances to date are believed to be atypical and the project had planned to spend \$20,000 what is the estimate at completion?
- A. \$34,500
 - B. \$37,500
 - C. \$42,670
 - D. It cannot be determined
18. You are a project manager working on a project that had an original budget of \$250,000 and was forecast to take 54 weeks. The project currently has delivered on \$90,000 worth of the project and has spent \$100,000. If the variances to date are believed to be atypical and the project had planned to spend \$80,000 what is the estimate at completion?
- A. \$277,780
 - B. \$260,000
 - C. \$246,910
 - D. It cannot be determined
19. You are a project manager working on a project that had an original budget of \$300,000 and was forecast to take seventy-two weeks. The project currently has delivered on \$65,000 worth of the project and has spent \$100,000. If the variances to date are believed to be atypical and the project had planned to spend \$75,000 what is the estimate at completion?
- A. \$461,540
 - B. \$532,540
 - C. \$335,000
 - D. \$235,000
20. You are a project manager working on a project that had an original budget of \$300,000 and was forecast to take seventy-two weeks. The project currently has delivered on \$65,000 worth of the project and has spent \$100,000. If the variances to date are believed to be typical and the project had planned to spend \$75,000 what is the estimate at completion?
- A. \$335,000
 - B. \$532,540
 - C. \$235,000
 - D. \$461,540

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21. You are a project manager working on a project that had an original budget of \$500,000 and was forecast to take eight months. The project currently has delivered on \$35,000 worth of the project and has spent \$50,000. If the variances to date are believed to be typical and the project had planned to spend \$40,000 what is the estimate at completion?
- A. \$515,000
 - B. \$816,330
 - C. \$465,000
 - D. \$714,290
22. You are a project manager working on a project that had an original budget of \$150,000 and was forecast to take eighteen weeks. The project currently has delivered on \$53,000 worth of the project and has spent \$61,000. If the variances to date are believed to be typical and the project had planned to spend \$57,250 what is the estimate at completion?
- A. \$172,640
 - B. \$158,000
 - C. \$186,490
 - D. \$150,000
23. You are working on a project that had an original budget of \$200,000 and was originally forecast to take sixty weeks. As the project coordinator, you have been somewhat frustrated with your project's performance. To date you have delivered on \$79,000 of the project's deliverables while you had budgeted \$93,000 and actually spent \$98,000. The project has been progressing consistently and you expect the trends the project has shown to continue. Based upon this information, what do you expect the project's estimate at completion to be?
- A. \$219,000
 - B. \$248,000
 - C. \$292,000
 - D. \$256,000
24. You are currently leading a project that had an original budget of \$300,000 and an original schedule of twenty-seven weeks. You currently have spent \$100,000 and are currently over budget by \$15,000. Your boss comes into your office and wants to discuss your project. Specifically, she wants to know how much more money it is going to take to complete the project. Assuming you have completed \$ 78,000 of the deliverables and you expect the performance trends to not continue what do you tell her?
- A. \$222,000
 - B. \$285,000
 - C. \$419,000
 - D. \$322,000

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25. You are preparing your monthly status report for your project. Assuming the variances to date are typical, what would the ETC be assuming your project was budgeted to cost \$125,000 and take twelve months and if you have actually spent \$42,000, have produced \$37,500 worth of product and were scheduled to have spent \$39,000?
- A. \$87,500
 - B. \$129,500
 - C. \$140,000
 - D. \$98,000
26. You are preparing your monthly status report for your project. Assuming the variances to date are typical, what would the estimate to complete the project be assuming your project was budgeted to cost \$90,000 and take thirty-six weeks if you have actually spent \$50,000, have produced \$65,000 worth of product and were scheduled to have spent \$60,000?
- A. \$25,000
 - B. \$64,000
 - C. \$69,000
 - D. \$19,000
27. Which of the following is the calculated projection of cost performance that must be achieved on the remaining work to meet a specified management goal?
- A. CPI
 - B. TCPI
 - C. EAC
 - D. ETC
28. You are asked to produce an estimate of the performance rate that must be achieved to meet the targeted budget at completion. If the project currently has an EV of 18, a PV of 20 and an AC of 22.5. If your original budget was 30 and you are using the EAC method, what estimate do you provide?
- A. 0.80
 - B. 6.40
 - C. 0.81
 - D. 0.78
29. You are asked to produce an estimate of the performance rate that must be achieved to meet the targeted budget at completion. The project currently has an EV of 27.5, a PV of 30 and an AC of 29. If your original budget was 35 and you are using the EAC method, what estimate do you provide?
- A. 0.21
 - B. 0.91
 - C. 0.95
 - D. 0.72

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30. You are asked to produce an estimate of the performance rate that must be achieved to meet the targeted budget at completion. The project currently has an EV of 18, a PV of 17.5 and an AC of 20. If your original budget was 55 and you are using the EAC method, what estimate do you provide?
- A. 0.90
 - B. 1.03
 - C. 0.93
 - D. 1.50

Exercise 13 — Earned Value Management Answers

1. **Answer B.** PMBOK® Guide p. 261-267 – The Planned Value is the budgeted cost for the work scheduled to be completed on an activity or WBS component up to a given point. This is sometimes referred to as the BCWS.
2. **Answer D.** PMBOK® Guide p. 261-267 – The Earned Value is the budgeted amount for the work actually completed on the scheduled activity during a specified time period. This is sometimes referred to as the BCWP.
3. **Answer A.** PMBOK® Guide p. 261-267 – The Actual Costs are the total costs incurred in accomplishing work on the schedule activity during a specified time period. The actual costs are sometimes referred to as ACWP or actual costs of work performed.
4. **Answer B.** PMBOK® Guide p. 261-267 – The Estimate to Complete provides a metric showing how much more money than has already been spent is needed to complete the project. This is in addition to the money that has already been spent. The ETC is correct.
5. **Answer C.** PMBOK® Guide p. 261-267 – As a project continues it is important that you are constantly revising your estimates of how much money you are going to have to spend. This total number is represented by the Estimate At Completion or EAC.
6. **Answer A.** PMBOK® Guide p. 261-267 – The Cost Variance or CV, represents an indicator of how far away from the original cost baseline the project actually is. To calculate it, take the Earned Value (EV) and subtract the Actual Costs. A project is on target if the CV is equal to 0.
7. **Answer D.** PMBOK® Guide p. 261-267 – The Schedule Variance or SV, represents an indicator of how far off of the original schedule baseline the project actually is. To calculate the SV take the Earned Value and subtract the Planned Value. A project is on schedule if the SV is equal to 0.
8. **Answer D.** PMBOK® Guide p. 261-267 – The Cost Variance or CV, represents an indicator of how far away from the original cost baseline the project actually is. To calculate it take the Earned Value (EV) and subtract the actual costs. A project is on target if the CV is equal to 0.
9. **Answer D.** PMBOK® Guide p. 261-267 – The Cost Variance or CV, represents an indicator of how far away from the original cost baseline the project actually is. To calculate it take the Earned Value (EV) and subtract the actual costs. A project is on target if the CV is equal to 0.
10. **Answer A.** PMBOK® Guide p. 261-267 – The Cost Variance or CV, represents an indicator of how far away from the original cost baseline the project actually is. To calculate it take the Earned Value (EV) and subtract the actual costs. A project is on target if the CV is equal to 0.

11. **Answer D.** PMBOK® Guide p. 261-267 – The Schedule Variance or SV, represents an indicator of how far away from the original schedule baseline the project actually is. To calculate it take the Earned Value (EV) and subtract the Planned Value (PV). A project is on target if the SV is equal to 0.
12. **Answer C.** PMBOK® Guide p. 261-267 – The Schedule Performance Index, or SPI, is calculated by taking the Earned Value (EV or amount of work produced) and dividing it by the Planned Value (PV, budget or planned spending). A project is on schedule if the result is 1.
13. **Answer B.** PMBOK® Guide p. 261-267 – The Schedule Performance Index, or SPI, is calculated by taking the Earned Value (EV or amount of work produced) and dividing it by the Planned Value (PV, budget or planned spending). A project is on schedule if the result is 1.
14. **Answer C.** PMBOK® Guide p. 261-267 - The critical ratio is calculated by first determining both the Cost Performance Index, or CPI (EV / AC) and the Schedule Performance Index or SPI (EV / PV). The Critical Ratio is then equal to the CPI * SPI.
15. **Answer D.** PMBOK® Guide p. 261-267 - The critical ratio is calculated by first determining both the Cost Performance Index, or CPI (EV / AC) and the Schedule Performance Index or SPI (EV / PV). The Critical Ratio is then equal to the CPI * SPI. In this case you are missing the planned value so the critical ratio cannot be determined.
16. **Answer A.** PMBOK® Guide p. 261-267 - The critical ratio is calculated by first determining both the Cost Performance Index, or CPI (EV / AC) and the Schedule Performance Index or SPI (EV / PV). The Critical Ratio is then equal to the CPI * SPI.
17. **Answer A.** PMBOK® Guide p. 261-267 – The key to this question is the fact that the variances are believed to be atypical. With this piece of information, you know the formula should be $EAC = AC + BAC - EV$.
18. **Answer B.** PMBOK® Guide p. 261-267 – The key to this question is the fact that the variances are believed to be atypical. With this piece of information, you know the formula should be $EAC = AC + BAC - EV$.
19. **Answer C.** PMBOK® Guide p. 261-267 – The key to this question is the fact that the variances are believed to be atypical. With this piece of information, you know the formula should be $EAC = AC + BAC - EV$.
20. **Answer D.** PMBOK® Guide p. 261-267 – The key to this question is the fact that the variances are believed to be typical. This means whatever is happening will continue to happen at approximately the same rate. With this piece of information you should have known to use the following formula: $EAC = AC + ((BAC - EV)/CPI)$.

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21. **Answer D.** PMBOK® Guide p. 261-267 – The key to this question is the fact that the variances are believed to be typical. This means whatever is happening will continue to happen at approximately the same rate. With this piece of information you should have known to use the following formula:
 $EAC = AC + ((BAC - EV)/CPI)$.
22. **Answer A.** PMBOK® Guide p. 261-267 - The key to this question is the fact that the variances are believed to be typical. This means whatever is happening will continue to happen at approximately the same rate. With this piece of information you should have known to use the following formula:
 $EAC = AC + ((BAC - EV)/CPI)$.
23. **Answer B.** PMBOK® Guide p. 261-267 - The key to this question is the fact that the variances are believed to be typical. This means whatever is happening will continue to happen at approximately the same rate. With this piece of information you should have known to use the following formula:
 $EAC = AC + ((BAC - EV)/CPI)$.
24. **Answer A.** PMBOK® Guide p. 261-267 - To correctly answer this question you must first determine exactly what is being asked. In this question you are being asked for an estimate to complete the project (ETC). In this case you are told that the variances that have been seen to date are not typical. Therefore, your correct formula is $ETC = BAC - EV$.
25. **Answer D.** PMBOK® Guide p. 261-267 - To correctly answer this question you must first determine exactly what is being asked. In this question you are being asked for an estimate to complete the project (ETC). In this case you are told that the variances that have been seen to date are typical. Therefore, your correct formula is $ETC = (BAC - EV) / CPI$.
26. **Answer D.** PMBOK® Guide p. 261-267 - To correctly answer this question you must first determine exactly what is being asked. In this question you are being asked for an estimate to complete the project (ETC). In this case you are told that the variances that have been seen to date are typical. Therefore, your correct formula is $ETC = (BAC - EV) / CPI$.
27. **Answer B.** PMBOK® Guide p. 261-267 – The To-Complete Performance Index is the calculated projection of cost performance that must be achieved on the remaining work to meet a specified management goal, such as the BAC or the EAC.
28. **Answer A.** PMBOK® Guide p. 261-267 – This question requires you to calculate the TCPI or the To-Complete Performance Index using the EAC formula. This formula is: $(BAC - EV) / (EAC - AC)$. The EAC is calculated using the CPI method.
29. **Answer C.** PMBOK® Guide p. 261-267 – This question requires you to calculate the TCPI or the To-Complete Performance Index using the EAC formula. This formula is: $(BAC - EV) / (EAC - AC)$. The EAC is calculated using the CPI method.

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30. **Answer A.** PMBOK® Guide p. 261-267 – This question requires you to calculate the TCPI or the To-Complete Performance Index using the EAC formula. This formula is: $(BAC - EV) / (EAC - AC)$. The EAC is calculated using the CPI method.

Exercise 14 — Cost Management

1. One way to compute EAC is to take the cumulative actual costs and:
 - A. Add the BAC.
 - B. Add the cumulative earned value.
 - C. Add the BAC – cumulative earned value.
 - D. Divide by the CPI.
2. Your boss comes into your office and asks how much more money it is going to take to complete your project. What do you provide her?
 - A. The most current EAC.
 - B. The project budget plus a variance.
 - C. The most current ETC.
 - D. The worst case scenario value.
3. You are six months into a year-long project when your boss comes into your office and asks how much money in total your project is going to cost at completion. What do you provide him?
 - A. The most current ETC.
 - B. The most current EAC.
 - C. The project budget / CPI.
 - D. The project budget plus the latest variance estimate.
4. One way to compute ETC is to:
 - A. Create an entirely new estimate.
 - B. Take the BAC and add the cumulative EV.
 - C. Take the BAC / CPI.
 - D. Take the BAC and add an entirely new estimate.
5. Which of the following is primarily concerned with examining the value of the next highest alternative?
 - A. Sunk costs
 - B. Life cycle costs
 - C. Opportunity cost
 - D. Operational costs
6. At lunch one of your fellow project managers laments about the high sunk costs on their project that is impacting key decisions. What are they likely saying?
 - A. Money budgeted to be spent is impacting the project.
 - B. The unseen costs of the project are impacting decisions.
 - C. Their project should be cancelled.
 - D. Money already spent on the project is impacting the decisions.



Exercise 14 — Cost Management

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7. Which of the following falls under a project manager's ethical responsibility?
 - A. Opportunity costing
 - B. Life cycle costing
 - C. Sunk costing
 - D. Project costing
 8. Which of the following is not typically part of the cost management plan?
 - A. Cost paradigms
 - B. Control thresholds
 - C. Earned value rules
 - D. Reporting formats
 9. Considering the effect project decisions have on the cost of using, maintaining, and supporting the product of the project is more commonly referred to as what?
 - A. Project costing
 - B. Ethical cost management
 - C. Life cycle costing
 - D. Professional cost responsibility
 10. Life cycle costing is often combined with what to improve decision making, reduce cost and execution time, and to improve the quality of the project?
 - A. Earned value management
 - B. Opportunity costing
 - C. Professional project management
 - D. Value engineering
 11. In which of the following processes is the project cost management plan developed?
 - A. The develop project management plan process
 - B. The estimate costs process
 - C. The determine budget process
 - D. The control costs process
 12. Which of the following describes the difference between costing and pricing?
 - A. Costing includes profit and pricing does not
 - B. Pricing includes profit and costing does not
 - C. Pricing always includes a factor of cost
 - D. Cost is always a multiplier of price

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13. Which of the following best represents a ROM estimate?
- A. +100% to –100%
 - B. +75% to –25%
 - C. +50% to 100%
 - D. +10% to –5%
14. Which of the following ranges best represents a definitive estimate?
- A. +100% to –100%
 - B. +75% to –25%
 - C. +50% to 100%
 - D. +10% to –5%
15. A coworker comes into your office and asks about your project that is currently in the execution phase. They specifically want to know what the budget for your project is. If your team estimated the project at \$275,000 what do you tell your coworker?
- A. Approximately \$302,500
 - B. \$247,500 to \$316,250
 - C. \$261,250 to \$302,500
 - D. Approximately \$316,250
16. Your manager comes into your office and asks about your project that is currently in the initiating phase. They specifically want to know what the budget for your project is. If your team estimated the project at \$500,000 what do you tell your boss?
- A. Approximately \$1,000,000
 - B. \$500,000 to \$1,000,000
 - C. \$750,000 to \$250,000
 - D. \$875,000 to \$375,000
17. Your manager comes into your office and asks about your project that is currently in the execution phase. They specifically want to know what the budget for your project is. If your team estimated the project at \$250,000 what do you tell your boss?
- A. \$225,000 to \$275,000
 - B. \$237,500 to \$275,000
 - C. \$125,000 to \$500,000
 - D. Approximately \$275,000
18. Which of the following is a formally recognized enterprise environmental factor that is an input to the cost estimating process?
- A. Cost estimation policies
 - B. Historical information
 - C. Lessons learned
 - D. Published commercial information

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19. Which of the following is a formally recognized organizational process asset used in the Cost Estimating Process?
- A. Cost estimating policies
 - B. Commercial databases
 - C. Marketplace conditions
 - D. Project team knowledge
20. Which of the following cost estimating techniques involves using the actual costs from previous, similar projects as its basis?
- A. Bottom-up estimating
 - B. Parametric estimating
 - C. Analogous estimating
 - D. Monte Carlo estimating
21. Which of the following cost estimating techniques involves calculating the costs of individual tasks or activities and then summarizing the costs?
- A. Analogous estimating
 - B. Bottom-up estimating
 - C. Parametric estimating
 - D. Monte Carlo estimating
22. Which of the following cost estimating techniques involves calculating the costs of individual tasks or activities or work packages by determining the relationship between them, historical data and other variables?
- A. Parametric estimating
 - B. Bottom-up estimating
 - C. Analogous estimating
 - D. Monte Carlo estimating
23. Reserve analysis is the process of looking at the estimated costs to deal with what?
- A. Unknown unknowns
 - B. Certain events
 - C. None of the above
 - D. Known unknowns
24. If your original estimate was 38 weeks and you provided your sponsor with an estimate of 36 to 42 weeks what kind of estimate did you provide?
- A. Rough order of magnitude estimate
 - B. Final estimate
 - C. Budget estimate
 - D. Definitive estimate

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25. If you have a burn rate of .92 which of the following is true?
- A. The AC is 110 and the EV is 120
 - B. The AC is 120 and the EV is 110
 - C. The AC is 120 and the PV is 110
 - D. The EV is 110 and the PV is 120
26. If you have a burn rate of 1.21 which of the following is true?
- A. The AC is \$84,000 and the EV is \$102,000
 - B. The AC is \$102,000 and the EV is \$84,000
 - C. The AC is \$84,000 and the PV is \$102,000
 - D. The EV is \$102,000 and the PV is \$84,000
27. Your manager comes into your office to discuss a project you are leading. In your latest status report you indicated a burn rate of 0.86. If you have spent \$192,000 what else do you know to be true?
- A. You had budgeted to spend \$165,000
 - B. Your SPI is 0.86
 - C. You have produced \$165,000 of work
 - D. Your cost variance is less than your schedule variance
28. You have been assigned a project to deploy new desktop computers throughout your organization. Your assignment to the project has occurred after the project estimates have been completed and baselines have been established. You are concerned that the cost estimates are unrealistic based upon your previous experience. Which of the following is the best thing to do?
- A. Determine if the contingency budget will cover the additional costs
 - B. Bring your project team together to determine the best solution
 - C. Meet with the project sponsor to examine possible solutions
 - D. Meet with the people who generated the cost estimate
29. In preparing your monthly status report you determine that your project is behind schedule. You believe the variances are typical and using Earned Value Analysis you determine the project is 16% behind schedule. Your boss has offered to provide access to an additional six resources, but you are concerned about the impacts of Brooke's Law and also not providing appropriate reward for the cost of the additional resources. Your concerns are best expressed by which of the following?
- A. Crashing
 - B. Parkinson's law
 - C. Pareto principle
 - D. Law of diminishing returns

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30. You have been asked to take over a project that senior management feels is critical to the organization, but has also determined to be failing. Originally, the project had a budget of \$550,000. The project has only produced 2/3 of the required deliverables and has already spent \$500,000. The \$500,000 expenditure represents which of the following?
- A. Capital expenditure
 - B. Sunk cost
 - C. Indirect expenditure
 - D. Direct cost
31. In which of the following steps would a project manager allocate overall cost estimates to the individual activities, tasks, deliverables or work packages to establish a performance measurement baseline?
- A. Estimate costs
 - B. Determine budget
 - C. Cost baselining
 - D. Cost control
32. You are part of a project management office within a large organization. All of the organization's resources are currently allocated to projects. A new project has just been brought to the PMO by senior management that must be given priority. To complete this new project you will have to take resources from the other projects which will cause them to be delayed. From which of the following projects should you take the resources?
- A. Project A with 17 resources, a NPV of \$225,000, and no change management plan.
 - B. Project B with nine resources, an IRR of 19%, BCR of 1.4, and no project cost control plan.
 - C. Project C with seven resources, a benefit cost ratio of 1.2, and no project charter.
 - D. Project D with 11 resources, capital expenses of US \$195,000, a burn rate of 1.25 and no schedule management plan.
33. Which of the following is not a tool or technique used in the control costs process?
- A. Forecasting
 - B. Variance analysis
 - C. Project management software
 - D. Reserve analysis
34. Which of the following is a tool or technique used in the control costs process?
- A. Forecasting
 - B. Funding limit reconciliation
 - C. Reserve analysis
 - D. Parametric analysis

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35. Which of the following is not an output of the Control Costs Process?
- A. Work performance measurements
 - B. Budget forecasts
 - C. Approved changes
 - D. Change requests
36. Parametric estimating:
- A. Uses project characteristics in a mathematical model
 - B. Uses an algorithm to calculate project costs
 - C. Uses top-down estimating
 - D. Represent the most common estimating technique
37. Analogous estimating:
- A. Works best when done from the bottom up
 - B. Uses actual costs from previous projects
 - C. Can be done at any time in the project
 - D. Is frequently used in the late planning phase of a project
38. An executive is evaluating project A with BCR of 1.2 and project B with an NPV of \$380,000. The two projects are mutually exclusive. The cost of choosing one of these projects and not obtaining the benefits of the other is called:
- A. Sunk cost
 - B. Lost cost
 - C. Opportunity cost
 - D. Portfolio cost
39. Jim and Sally are two project managers working for a large manufacturing organization who are discussing Jim's latest project. Sally comments that it is important that Jim consider both the operational and maintenance costs of the product being created in his project decisions. To what is Sally referring?
- A. Jim's professional responsibility
 - B. Total project costing
 - C. Parametric estimating
 - D. Life cycle costing
40. You are in the process of establishing the cost performance measurement system you will be using for a software development project. Which of the following methods would be best?
- A. Ask each resource for a percent of the deliverables that are complete and forecast future performance.
 - B. Use the physical percent complete of the work product to calculate earned value and then forecast future performance.
 - C. Use a 0% / 100% rule of reporting deliverable completeness and forecast future performance.
 - D. Focus on the amount of money budgeted and actually spent in each period and then forecast future performance.

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41. You are the project manager on a project that has a CPI of 0.92. What do you know?
- A. The project is currently 8% behind schedule.
 - B. When the project is delivering 92% of the work product.
 - C. The project will end up being 92% over budget.
 - D. The project is currently 8% over budget.
42. You are the project manager on a project that has a cost performance index of 0.79. What does this mean?
- A. The project is only producing 79 cents of value for every dollar invested.
 - B. The project is 21% behind schedule.
 - C. The project is 79% over budget.
 - D. The project is likely to cost 79% more than planned.
43. Your project has a CPI of 0.87. What does this mean?
- A. You are behind schedule.
 - B. You are 13% under budget.
 - C. It is costing you more to produce each deliverable than forecasted.
 - D. You are 87% over budget.
44. Your project has a SPI of 0.91 what does this tell you?
- A. You will likely deliver the project 9% behind schedule.
 - B. You are currently 9% behind schedule.
 - C. Your project has achieved 91% of its objectives.
 - D. You are 9% over budget.
45. You are the project manager on a large road project that has a current CV of \$176,000. What does this mean?
- A. The project is \$176,000 over budget.
 - B. The project is \$176,000 ahead of schedule.
 - C. The project is \$176,000 behind schedule.
 - D. The project is \$176,000 under budget.
46. You are leading a project that is using resources in four different locations. Management has mandated that you use Earned Value Analysis. If the project is a software development project which of the following would not be necessary to determine the initial cost baseline?
- A. WBS
 - B. Network diagram
 - C. Scope change management plan
 - D. Risk register

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47. You are the project manager for a major road project. You have been asked to estimate the cost for your project using the formula of number of miles of road multiplied by the number of lanes multiplied by the cost per lane mile of road. What kind of estimate is this?
- A. Parametric estimate
 - B. Analogous estimate
 - C. Rough order of magnitude estimate
 - D. Bottom up estimate
48. In which of the project management process groups would you make a ROM estimate?
- A. The planning process group
 - B. The executing process group
 - C. The monitoring and controlling process group
 - D. The initiating process group
49. You have been asked to choose between two different projects that your organization might undertake. Which of the following would not be grounds for comparison?
- A. BCR
 - B. Marginal analysis
 - C. IRR
 - D. NPV
50. Which of the following is a tool for determining when investing any additional money will not produce an equivalent return?
- A. Marginal analysis
 - B. Benefit cost ratio analysis
 - C. Cost benefit ratio analysis
 - D. Internal rate of return analysis
51. You have been asked to choose one of three projects. Project A has an NPV of \$75,000. Project B has an NPV of \$81,000. Project C has an NPV of \$62,500. What is the opportunity cost of selecting Project B?
- A. \$81,000
 - B. \$62,500
 - C. \$75,000
 - D. \$6,000

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52. You are placed in charge of a software development project. As part of your team building you determine that your resources do not have all the necessary skills. To improve their skills you decide to send them to an external class to obtain the required skills. Which of the following would best categorize this expense?
- A. Indirect cost
 - B. External cost
 - C. Fixed cost
 - D. Direct cost
53. You are meeting with the project sponsor. They voice concern about the setup costs of the project escalating. You assure them that this is not an issue. Why?
- A. Because good project management will ensure the costs do not escalate.
 - B. Because project setup represents an opportunity cost.
 - C. Because project setup represents an overhead cost.
 - D. Because project setup represents a fixed cost.
54. You have been asked to determine a less costly way to complete the same work. Which of the following tools would you use?
- A. Value analysis
 - B. Six sigma analysis
 - C. Marginal analysis
 - D. Benefit cost analysis
55. When working with earned value management which primary term represents the actual output or work product?
- A. Planned value
 - B. Earned value
 - C. Actual cost
 - D. CPI
56. You have been asked to select one of three projects for your organization using NPV. Project A has an NPV of \$23,000 and will take two years to produce. Project B has an NPV of \$41,000 and will take three years to produce, and Project C has an NPV of \$35,000 and will take three years to produce. Which project would you select?
- A. Project A
 - B. Project B
 - C. Project C
 - D. It cannot be determined

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57. You are leading a project for an external customer. The client representative asks that you provide a written cost estimate that is 25% higher than your estimate of the project's cost. They justify the request by telling you their company budgeting process requires managers to estimate pessimistically to ensure enough money is allocated for projects. What is the best way to handle this?
- A. Add the 25% as a lump sum contingency to handle project risks.
 - B. Add the 25% to the cost estimate by spreading it evenly across all project activities.
 - C. Create one cost baseline for budget allocation and a second one for the actual project management plan.
 - D. Ask for information on risks that would cause your estimate to be too low.
58. What type of cost is team development?
- A. Direct
 - B. Indirect
 - C. Required
 - D. Fixed
59. Value analysis is performed to get:
- A. The team to buy into the project.
 - B. More value from the cost analysis.
 - C. A less costly way of doing the same work.
 - D. Management to buy into the project.
60. You have been assigned as the project manager for a medium-sized information technology project. Upon receiving your charter, the project sponsor asks if the project can be completed within the target budget. Which of the following is the best way to handle this?
- A. Build an estimate in the form of a range of possible results.
 - B. Ask the team members to help estimate the cost based on the project charter.
 - C. Based on the information you have, calculate a parametric estimate.
 - D. Provide an analogous estimate based on past history.
61. Early in the life of your project, you are having a discussion with the sponsor about which estimating techniques should be used. You want a form of expert judgment, but the sponsor argues for analogous estimating. It would be best to:
- A. Agree to analogous estimating, as it is a form of expert judgment.
 - B. Suggest life cycle costing as a compromise.
 - C. Determine why the sponsor wants such an accurate estimate.
 - D. Try to convince the sponsor to allow expert judgment because it is typically more accurate.

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62. You have just completed the initiating processes of a small project and are moving into project planning when a project stakeholder asks you for the project's budget and cost baseline. What should you tell her?
- A. The project budget can be found in the project charter, which has just been completed.
 - B. The project budget and baseline will not be finalized and accepted until planning processes are completed.
 - C. The project management plan will not contain the project's budget and baseline; this is a small project.
 - D. It is impossible to complete an estimate before the project management plan is created.

Exercise 14—Cost Management Answers

1. **Answer C.** PMBOK® Guide p. 264-265. There are several ways to calculate the Estimate At Completion or EAC. The most common of these include:
 - ⇒ Creating an entirely new estimate
 - ⇒ Cumulative actual costs + (Original Total Budget – Cumulative Earned Value)
 - ⇒ Cumulative Actual Costs + ((Original Total Budget - Cumulative Earned Value) / Cumulative CPI)
 - ⇒ Cumulative Actual Costs + ((Original Total Budget - Cumulative Earned Value) / (Cumulative CPI * SPI))
2. **Answer C.** PMBOK® Guide p. 264-265. This question is asking how much more money is required. This is money in addition to the money already spent. This is the definition of the Estimate to Complete or ETC.
3. **Answer B.** PMBOK® Guide p. 264-265. This question is asking how much money will you have spent when the project has been completed. This is the Estimate at Completion or EAC.
4. **Answer A.** PMBOK® Guide p. 264-265. There are three ways to calculate ETC or Estimate to Complete. They include:
 - ⇒ Create an entirely new estimate
 - ⇒ Assume the variances are atypical (BAC- Cumulative EV)
 - ⇒ Assume the variances are typical (BAC – cumulative EV) / (CPI* SPI)
 - ⇒ Using the critical ratio (BAC – cumulative EV) / CPI
5. **Answer C.** PMBOK® Guide p. 712. Opportunity costs measure the value of the next highest alternative. This provides a way of measuring what you chose not to do.
6. **Answer D.** PMBOK® Guide p. 238. Sunk costs represent money that has already been spent on the project. Often these costs become so great that projects are forcibly continued to save face or for other reasons when they should be cancelled.
7. **Answer B.** Although project costing is a responsibility of the project manager, life cycle costing is an ethical responsibility. The project manager has the responsibility to ensure the product of the project is within the operating budget of the organization.
8. **Answer A.** Control thresholds, earned value rules and reporting formats are all typically part of the cost management plan. “Cost paradigms” is a non-existent term for the purposes of project management.
9. **Answer C.** Project cost management should consider the effect of project decisions on the cost of using, maintaining, and supporting the project’s product or service, more commonly referred to as life cycle costing.

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10. **Answer D.** Life cycle costing is often combined with value engineering to improve decision making, reduce costs and execution time, and to improve the quality of the project.
 11. **Answer A.** PMBOK® Guide p. 235 – Although it is not formally called out in the cost management processes, the PMBOK® Guide specifies that the cost management plan is initially produced as part of the development of the project management plan.
 12. **Answer B.** Price is made up of the cost of the item plus the desired profit. Cost simply represents what the item took to produce in monetary terms.
 13. **Answer B.** PMBOK® Guide p. 241. Early in a project's life cycle you are not likely to have a lot of detailed information. Therefore, you need to provide a wide ranging estimate. The Rough Order of Magnitude estimate does just that. It is a range of +75% to –25% of the original estimate.
 14. **Answer D.** PMBOK® Guide p. 241. The definitive estimate is the final project estimate given to all management and resources. It is never a single number and always represented by a range. The correct range for a definitive estimate is +10% to –5%.
 15. **Answer C.** PMBOK® Guide p. 241. Remember, according to PMI®, you never give a single number. You always provide a range. In this case that fact excludes two of the answers. Since you are in the execution phase of the project you are using the definitive estimate which is +10% to –5%. That provides a range of 261,250 to \$302,500.
 16. **Answer D.** PMBOK® Guide p. 241. Remember, according to PMI®, you never give a single number. You always provide a range. In this case that fact excludes two of the answers. Since you are in the initiation phase of the project you are using the ROM estimate which is +75% to –25%. That provides a range of 375,000 to \$875,000.
 17. **Answer B.** PMBOK® Guide p. 241. Remember, according to PMI®, you never give a single number. You always provide a range. In this case that fact excludes one of the answers. Since you are in the planning phase of the project you are using the definitive estimate which is +10% to –5%. That provides a range of \$237,500 to \$275,000.
 18. **Answer D.** PMBOK® Guide p. 171 – Enterprise environmental factors are factors or conditions that exist within the area that the project resides. When discussing the factors for the estimate cost process, PMI® specifically calls out two:
 - ⇒ Market conditions
 - ⇒ Published commercial information
 - ⇒ Exchange rates and inflation

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19. **Answer B.** PMBOK® Guide p. 171 – Organizational process assets represent templates and information that help the project team complete the project. When it comes to the cost estimating process these assets formally include:
- ⇒ Cost estimating policies
 - ⇒ Cost estimating templates
 - ⇒ Historical information
20. **Answer C.** PMBOK® Guide p. 244 – Analogous estimating represents a technique used usually early in a project to develop cost and schedule estimates. It makes use of comparative analysis and argues that if two projects are similar their costs should be similar as well. This method runs a significant accuracy risk because often the details of the projects are not that similar.
21. **Answer B.** PMBOK® Guide p. 244. Bottom-up estimating involves completing the estimates at the lowest possible level, the task or activity, and then summing the work packages as you go higher up the WBS. PMI® considers this the most accurate and detailed form of estimating.
22. **Answer A.** PMBOK® Guide p. 244. Relationships between historical data and other variables to calculate a cost estimate represent parametric estimating.
23. **Answer D.** PMBOK® Guide p. 245 – Reserve analysis is the technique of looking for areas where there are known, potential risks, called known unknowns because you know they are possible, but you do not know when they are going to happen.
24. **Answer D.** PMBOK® Guide p. 241. The definitive estimate is the final estimate provided in the project. It is the estimate used for baselines and represents a range of +10% to –5%.
25. **Answer B.** PMBOK® Guide p. 263. The “Burn Rate” measures the rate you are “burning” or spending your money versus how much work product you are obtaining. It is another way to say CPI. It is expressed as a numerical value with a target of one. It is defined by the formula of Earned Value / Actual Costs.
26. **Answer A.** PMBOK® Guide p. 263. The “Burn Rate” measures the rate you are “burning” or spending your money versus how much work product you are obtaining. It is another way to say CPI. It is expressed as a numerical value with a target of one. It is defined by the formula of Earned Value / Actual Costs.
27. **Answer C.** PMBOK® Guide p. 263. The “burn rate” measures the rate you are “burning” or spending your money versus how much work product you are obtaining. It is another way to say CPI. It is expressed as a numerical value with a target of one. It is defined by the formula of earned value / actual costs.

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28. **Answer B.** Your best answer is to always work with your project team first to determine alternatives. Remember, the PMI® standards are all about examining alternatives and presenting recommendations. You would not want to meet with anyone else until you have met with your team.
29. **Answer D.** The law of diminishing returns argues that in every scenario there is a point where spending money will not get an equal amount of value in return. The rest of the question is simply subterfuge and should be ignored.
30. **Answer B.** Sunk costs represent monies that have already been spent. They cannot be recovered. They are important to project managers because many organizations make project decisions based upon the money that has already been spent. This often leads to good money following bad.
31. **Answer B.** PMBOK® Guide p. 248-256 – Determine budget involves aggregating the various estimated costs for all the tasks, activities, deliverables, and/or work packages to establish a total cost baseline for the project.
32. **Answer C.** Each of these projects is in trouble, but only one of them should have never been started. That is project C. Project C does not have a project charter and should have never been started. Therefore, it should be the first place you go for resources. Remember, you never do a project without a charter no matter what the numbers say.
33. **Answer D.** PMBOK® Guide p. 257 – The tools and techniques used in the control costs process include:
- ⇒ Expert judgment
 - ⇒ Data analysis
 - ⇒ To-complete performance index (TCPI)
 - ⇒ Project management information system
34. **Answer A.** PMBOK® Guide p. 167 – The tools and techniques used in the control costs process include:
- ⇒ Expert judgment
 - ⇒ Data analysis
 - ⇒ To-complete performance index (TCPI)
 - ⇒ Project management information system
35. **Answer C.** PMBOK® Guide p. 167 – The outputs from the cost control process include:
- ⇒ Work performance measurements
 - ⇒ Cost forecasts
 - ⇒ Change requests
 - ⇒ Project management plan updates
 - ⇒ Project document updates

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36. **Answer A.** PMBOK® Guide p. 244 – Parametric estimating involves using project characteristics in a mathematical model to predict total project costs.
 37. **Answer B.** PMBOK® Guide p. 243 – Analogous estimating means using the actual cost of previous, similar projects as the basis for estimating the cost of the current project.
 38. **Answer C.** The opportunity cost for any selection is defined as the value of the next highest alternative.
 39. **Answer D.** Life cycle costing is the requirement that the project manager take into consideration the cost of operation and the cost of maintenance for the product or service being created. It is an ethical responsibility of the project manager.
 40. **Answer B.** PMBOK® Guide p. 261-267. In most cases, the best way to report level of completeness is to use the actual level of physical completeness as part of the earned value calculations. This is the actual amount of work product produced. However, the real key to this question is to remember that PMI® always wants you to use earned value reporting.
 41. **Answer D.** PMBOK® Guide p. 261-267. The cost performance index or CPI is defined as the Earned Value divided by the Actual Costs. It tells you how close to the forecasted budget you actually are. If the CPI is 0.92 that tells you the project is 1 - .92 or 0.08 over budget.
 42. **Answer A.** PMBOK® Guide p. 261-267. The cost performance index or CPI is defined as the Earned Value divided by the Actual Costs. It tells you how close to the forecasted budget you actually are. If the CPI is 0.79 that tells you the project is 1 - .79 or 0.21 over budget.
 43. **Answer C.** PMBOK® Guide p. 261-267. The cost performance index or CPI is defined as the Earned Value divided by the Actual Costs. It tells you how close to the forecasted budget you actually are. If the CPI is 0.87 that tells you the project is 1 - .87 or 0.13 over budget.
 44. **Answer B.** PMBOK® Guide p. 261-267. The Schedule Performance Index or SPI is defined as the Earned Value divided by the Planned Value. It tells you how close to the forecasted schedule you actually are. If the SPI is 0.91 you know that your project is currently 1 - 0.91 or 0.09 behind schedule.
 45. **Answer D.** PMBOK® Guide p. 261-267. The cost variance, or CV is calculated using the formula Earned Value – Actual Cost. A project with a negative value is over budget and a project with a positive value is currently under budget.
 46. **Answer C.** PMBOK® Guide p. 248 – The cost baseline is an output of the determine budget process. In order to determine which it is, you would need the WBS to see all the deliverables of the project, a network diagram to see the dependencies between deliverables, and the listing of potential risks to establish any contingency. However, you would not need your scope change management plan to determine the cost baseline.

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47. **Answer A.** PMBOK® Guide p. 172 – Parametric estimating is a technique that uses a statistical relationship between historical data and other variables to calculate a cost estimate. In other words a mathematical model.
48. **Answer D.** PMBOK® Guide p. 168 – A Rough Order of Magnitude estimate, or ROM, is done in the initiating phases of the project. This estimate has a range of –25% to –75% the widest variance, and is therefore used as the earliest estimate in the project, often in a project charter.
49. **Answer B.** Marginal analysis, which uses the law of diminishing returns is an attempt to find the point investing \$1 gets you exactly \$1 in return and investing any more gives you less. In those situations, it usually does not make sense to invest more. This is an important measure, but does not help you compare projects. The Benefit/Cost Ratio, Internal Rate of Return and Net Present Value all can help compare projects.
50. **Answer A.** Marginal analysis, which uses the law of diminishing returns is an attempt to find the point investing \$1 gets you exactly \$1 in return and investing any more gives you less. In those situations, it usually does not make sense to invest more.
51. **Answer C.** Opportunity cost is defined as the value of the next highest, not selected alternative. In this case, the correct answer is \$75,000.
52. **Answer D.** In this case the training is directly related to the project and is therefore a direct cost of the project.
53. **Answer D.** The setup of a project does not have a direct tie to the amount or number of products produced. It is generally done before any production occurs and therefore is a fixed cost.
54. **Answer A.** This is a simple memorization question. You must remember that value analysis is all about determining the least costly way to complete work (e.g. obtain the most value).
55. **Answer B.** PMBOK® Guide p. 261-267. There are three key variables to establish the earned value calculations:
- ⇒ Earned value – the work product
 - ⇒ Planned value – the budget
 - ⇒ Actual costs – how much you really spent
56. **Answer B.** This is a trick question of sorts. The question provides both the term of the project and the NPV. This would seem to indicate that you must do something with the term. However, the NPV takes into account the project term making this information unnecessary. All you have to do is select the largest value.
57. **Answer D.** This is an ethics question. PMI’s standards are very clear in this area. Although it is a largely western way of thinking about this topic you should only present the actual estimate.

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58. **Answer A.** Team development or training is considered a direct cost to the project as it represents paying for the skills required to complete the project.
59. **Answer C.** The primary purpose of value analysis is finding a less costly way to do the same work.
60. **Answer A.** With such limited information, it is best to estimate in a range. The range can be narrowed as planning progresses and risks are addressed.
61. **Answer A.** Determining why the sponsor wants such an accurate estimate sounds like a good idea at first; however, analogous estimates are less accurate than other forms of estimating, as they are prepared with a limited amount of detailed information. You need to realize that analogous estimating is a form of expert judgment.
62. **Answer B.** The overall project budget may be included in the project charter but not the detailed costs. Even small projects should have a budget and a schedule. It is not impossible to create a project budget before the project management plan is created. However, it is not wise to do so, as the budget will not be accurate. The project budget and baseline are not finalized and accepted until the planning processes are completed.

Quality Management

Overview

The next knowledge area found in the PMBOK® Guide is quality management. According to the PMBOK® Guide, quality management is concerned with “all the activities of the performing organization that determine quality policies, objectives, and responsibilities, so that the project will satisfy the needs for which it was undertaken”. This is another relatively small knowledge area in terms of the number of processes it contains, and most candidates only have a moderate level of difficulty with it. For many, the greatest area of difficulty is differentiating between the perform quality assurance and perform quality control processes, so make sure the differences are clear in your mind before proceeding to the next knowledge area.

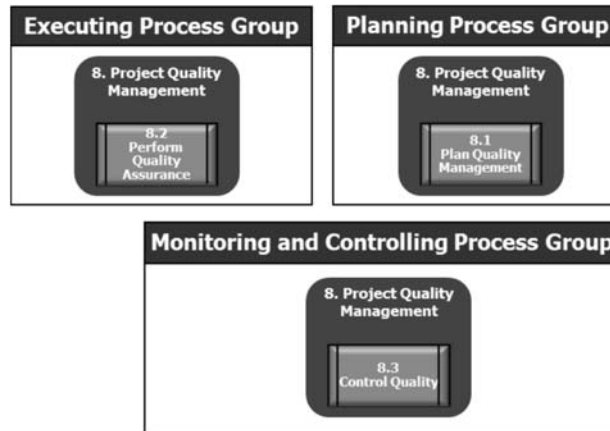


Image 69: The Quality Management Processes

As with several knowledge areas, quality management places an emphasis on the project manager understanding their role in managing the quality of both the project and the product, or service of the project. To some extent, this is similar to saying you must ensure the project delivers the right product or service and the delivery is done well. Success with the quality management knowledge area also requires memorization of a number of key terms and thought leaders. These include the following:

- ⇒ **Gold plating** — Giving the product extra functionality past the point of worth adds no value to the project. PMI® argues against gold plating.
- ⇒ **Marginal analysis** — Finding the point where the cost of the incremental improvement in quality equals the value of the improvement.
- ⇒ **International organization for standardization (ISO)** — The United Nations of standards bodies. It is composed of national standards bodies, one per economy and, is based on Geneva, Switzerland. It was founded in 1947. The PMBOK® Guide is the ANSI standard for project management (American National Standards Institute).
- ⇒ **Total quality management (TQM)** — The original continuous process improvement methodology, TQM was created by Juran and provides the starting point for more current methodologies such as Six Sigma and Lean.
- ⇒ **Six Sigma** — A continuous process improvement framework or methodology made famous by Jack Welch and General Electric.



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- ⇒ **Kaizen** — A Japanese process improvement methodology which focuses on making small, incremental improvements rather than a few large improvements.
 - ⇒ **Quality vs. Grade** — Quality is “the degree to which a product, service, or results fulfill its requirements.” Grade is a much more subjective measure. “Grade is a category assigned to products or services having the same functional use but different technical characteristics.” [PMBOK® Guide p.274] In project management, the project manager and team either meet the requirements or do not. They cannot sort-of meet the requirements. Therefore, projects cannot have “some” quality. Grade, on the other hand, can be debated. Compare a luxury car to a discount vehicle. Which one has the higher quality? The answer in many cases is they have the same level of quality, so long as they meet the requirements for which they were developed. However, few would argue they are equally desirable. This is the characteristic of grade.
 - ⇒ **Precision vs. Accuracy** — Both precision and accuracy are used in determining issues such as quality and grade on a project. Precision represents the level of detail used on a measure. A simple example would be to what decimal value something is measured. Accuracy answers the question, how well does a measure actually represent the value. Something that is accurate is said to be true. Often computer monitors provide an excellent example of accuracy. If you are using an older monitor, the screen might be showing an off blue color when the computer told the monitor to show purple. In this case the monitor is inaccurate.
 - ⇒ **PDCA** — The concept of PDCA is based on the scientific method, as developed from the work of Francis Bacon (Novum Organum, 1620). The scientific method can be written as: hypothesis, experiment, evaluation—or plan, do, and check. Shewhart described it as a three step process of specification, production, and inspection. He also specifically related this to the scientific method of hypothesis, experiment, and evaluation. Shewhart says that the statistician “must help to change the demand [for goods] by showing how to close up the tolerance range and to improve the quality of goods.”
 - ⇒ **W.E. Deming** — William Edward Deming is considered by many to be the father of the modern quality management movement. Dr. Deming did much of his work in post World War II Japan. He is best known for his definition of quality: quality = results of work efforts / total costs; his 14 key principles for management to transform a business; the PDCA cycle (plan, do, check, act); and the idea that poor quality is 85% process and only 15% worker.
 - ⇒ **Joseph Juran** — Joseph Juran is best known for applying the Pareto principle to quality management. He also developed “Juran’s trilogy,” an approach to cross-functional management that is composed of three managerial processes: quality planning, quality control, and quality improvement. These functions all play a vital role when evaluating quality. For Juran, human relations problems were the ones to isolate. Resistance to



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change — or, in his terms, cultural resistance — was the root cause of quality issues. For Juran, quality is defined based on a product or service’s “fitness for use” or ability to meet its intended purpose. The fitness for use concept is key for the PMP® exam.

⇒ **Philip Crosby** — Crosby became famous after initiating the zero defects program at the Martin Company Orlando, Florida, plant. As the quality control manager of the Pershing missile program, Crosby was credited with a 25% reduction in the overall rejection rate and a 30 percent reduction in scrap costs. He developed the principle of “doing it right the first time” (DIRFT). He would also include four major principles:

- ◇ the definition of quality is conformance to requirements
- ◇ the system of quality is prevention
- ◇ the performance standard is zero defects
- ◇ the measurement of quality is the price of nonconformance

⇒ **Kaoru Ishikawa** — Ishikawa introduced the concept of quality circles in the 1960s. However, he is best known for developing cause-effect (fishbone) diagrams and innovating design statistics.

⇒ **Genichi Taguchi** — Taguchi is influential in industrial statistics. Key elements of his quality philosophy, which became known as the Taguchi method include the following:

- ◇ The Taguchi Loss Function, used to measure financial loss to society resulting from poor quality;
- ◇ The philosophy of off-line quality control, designing products and processes so that they are insensitive (“robust”) to parameters outside the design engineer’s control
- ◇ Innovations in the statistical design of experiments, notably the use of simulations for factors that are uncontrollable in real life, but are systematically varied in the experiment.

To prepare for the PMP® exam, there are a few general concepts you must understand. The concepts include the following:

- ⇒ Project management and quality management are separate but complementary disciplines that both place significant importance on customer satisfaction.
- ⇒ PMI® focuses most of its attention on the prevention of quality problems rather than inspection. Remember, you cannot inspect quality into a product. You can only prevent the poor products from getting to your stakeholders.
- ⇒ It has already been said, but it will be again and again: PMI® emphasizes continuous improvement. You must continue to get better.

⇒ For a project to succeed, all parties must engage. However, success is still a central management responsibility.

Agile development uses the retrospective process to create frequent review steps throughout the project. Whereas reviews examine the product of the project, retrospectives examine the process. They allow the team to gather and evaluate what is going well and not without interference from stakeholders.

8.1 Plan Quality Management

The plan quality management process is where the project manager and team identify which quality standards are relevant to the project and determine how to satisfy them. The plan quality management process is performed in parallel with the other planning processes. For the exam, it is important to remember that quality is planned, designed, and built-in, but cannot be inspected into a product or service. The primary output of the plan quality management process is the quality management plan, which defines which quality standards are relevant to the project, how the team will meet those standards, the relevant quality metrics, and how the project will continuously be improved. It is important to recognize that quality management is one of the few knowledge areas with a formal process designated to create its management plan.



Image 70: The Plan Quality Mgmt.

The inputs to the plan quality management process include the following:

- ⇒ **.1 Project charter**— The project charter provides the project five-line including the business need, justification, success criteria, constraints and assumptions, and project prioritization.
- ⇒ **.2 Project Management Plan** — If managing quality is really about delivering expected requirements, then it is important to know what those requirements are, as well as all other rules the team has agreed to. The specific documents called out by PMI® include: the requirements management plan, the risk management plan, stakeholder engagement plan, scope baseline.
- ⇒ **.3 Project documents** — There are a number of documents that the team needs to examine including the assumption log, requirements documentation, requirements traceability matrix, risk register, stakeholder register.
- ⇒ **.4 Enterprise environmental factors** — Like most of the 47 processes, enterprise environmental factors can impact the planning of quality and are thus are an important input.
- ⇒ **.6 Organizational process assets** — Any policies, procedures, or existing plans that might aid in planning quality should be used.

The tools and techniques used in the plan quality management process include the following:

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- ⇒ **.1 Expert judgment** — Project quality is an area is an area requiring a great deal of specialized expert knowledge, much of which is industry specific.
- ⇒ **.2 Data gathering** — Data gathering is an important aspect of establishing a quality management plan. It requires the team to use tools such as benchmarking, brainstorming, and interviews.
- ◇ **Benchmarking** — Benchmarking is the process of comparing the project, or project practices to other projects or organizations to identify best practices and generate ideas for continuous improvement. Benchmarking can be done within the organization or with outside organizations. However, the project team must be careful because spending too much time and energy on benchmarking can be dangerous and may cause the team to loose focus on delivering real project results.
 - ◇ **Brainstorming** — Brainstorming is a group information gathering technique we have talked about earlier in the course.
 - ◇ **Interviews** — Whereas brainstorming is a group technique, interviews are conducted one on one.
- ⇒ **.3 Data analysis** — Data analysis is all about examining the data just collected it uses several different tools.
- ◇ **Cost-benefit analysis** — In many instances, cost-benefit analysis is referred to as benefit-cost analysis. Either way, it is the same thing. It is the process of evaluating the benefits of doing or not doing something versus the costs of the activity. It is often expressed as the benefits divided by the costs because it allows for anything greater than 1 to be seen as good. Often the acronyms BCI or BCR (benefit cost index or benefit cost ratio) are used to signify this term.
 - ◇ **Cost of quality** — The cost of quality (COQ) includes all costs incurred over the life of the product to meet the requirements or failing to do so. The cost of quality is typically broken into two categories: the cost of conformance and the cost of non-conformance. The specific potential costs are shown below:

Conformance		Non-Conformance	
Prevention	Planning	Scrap	Failure
Appraisal	Training	Rework	Expediting
Auditing	Testing	Warranty Service	Recalls
Controlling			

Image 71: The Costs of Quality

- ⇒ **.4 Decision making** — Decision making simply provides a marker for the team to make decisions about the best way to develop the quality management plan.



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⇒ **.5 Data representation** — Data representation techniques are all about presenting information in a visual way so it can be more easily understood. These tools are sometimes referred to as information radiators. PMI[®] specifically calls out four tools in this category including: flowcharts, logical data model, matrix diagrams, and mind mapping.

- ◇ **Flowcharts** — A flowchart is a graphical representation of a process or an algorithm. It shows the relationships between steps and often uses different shapes to represent specific components such as data, decisions or termination points. Since the 1960s the American National Standards Institute (ANSI) has set the standards for flowcharts and the basic symbols used in them.


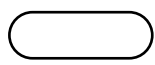
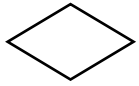
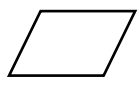
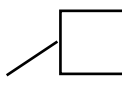
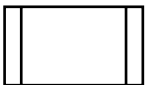


Shape	Name	Description
	Flowline	Show the process order of operation. Arrowheads are added if the flow is not the standard top-to-bottom, or left-to-right.
	Terminal	A terminal is the beginning or ending of a program or sub-process. A terminal typically contains the word “Start” or “End” to signify where it is.
	Decision	A decision is a conditional operation where one of two paths is taken. The operation is typically a yes/no or true/false question.
	Input / Output	This is the input or output of data. For example, it can be entering data or displaying results.
	Annotation	An annotation provides additional information about a step in the program. It is represented as an open rectangle with a dashed or solid line connecting it to its corresponding symbol on the flowchart.
	Predefined Process	A predefined process is one that is defined elsewhere. It is represented by a rectangle with double-struck vertical edges.
	On-Page Connector	An on-page connector replaces long or confusing lines on a flowchart with a small circle with a letter inside.
	Off-Page Connector	An off-page connector is used when the target is on another page. It is represented by a home plate shaped pentagon.

Image 72: Flowchart Legend

Another form of flowchart is called SIPOC. SIPOC is an acronym that was used in total quality management (TQM) in the 1980s and is still used in Six Sigma, lean manufacturing, and business process management. SIPOC is often presented at the beginning of process improvement efforts, such as Kaizen, or during the defining phase of the DMAIC process. In most cases, it has three potential uses:



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- ⇒ To give people who are unfamiliar with a process a high level overview.
- ⇒ To reacquaint people whose familiarity with a process has faded or become out-of-date due to process changes.
- ⇒ To help people in defining a new process.

SIPOC helps the team find or identify all the relevant elements of a process improvement project before work actually begins.

The acronym SIPOC stands for Suppliers, Inputs, Process, Outputs, and Customers, which each form columns in a table or diagram. The steps used to create the diagram include the following:

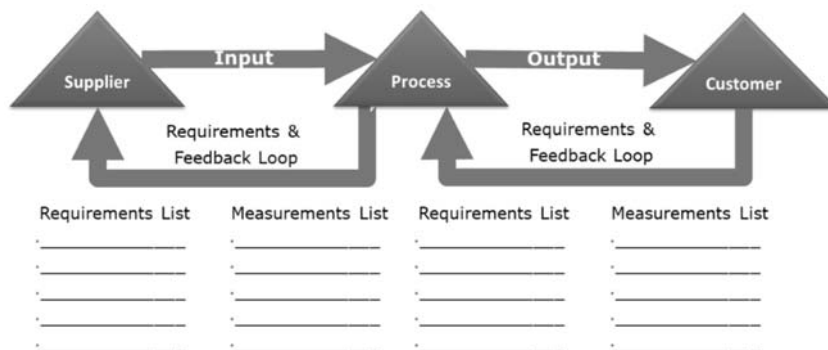
1. Create an area that will allow the team to post additions to the SIPOC diagram. This could be a transparency (to be projected by an overhead) made of the provided template, flip charts with headings (S-I-P-O-C) written on each, or headings written on post-it notes posted to a wall.
2. Begin with the process. Map it in four to five high level steps.
3. Identify the outputs of this process.
4. Identify the customers that will receive the outputs of this process.
5. Identify the inputs required for the process to function properly.
6. Identify the suppliers of the inputs that are required by the process.
7. Optional: Identify the preliminary requirements of the customers. This will be verified during a later step of the Six Sigma measurement phase.
8. Discuss with project sponsor, Champion, and other involved stakeholders for verification.



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A SIPOC model can be especially useful when attempting to answer questions like the following:

- ⇒ Who supplies inputs to the process?
- ⇒ What specifications are placed on the inputs?
- ⇒ Who are the true customers of the process?
- ⇒ What are the requirements of the customers?



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Image 73: The SIPOC Model

- ◇ **Logical data model** — A logical data model is also referred to as a logical schema. It is a data model of a specific problem domain that is expressed independently of any specific named database product or storage technology. Instead, it focuses on the foundational data structure and its elements such as relational tables, columns, object-oriented classes and/or XML tags. It represents the abstract structure of a domain of information. A logical data model is most often used in business process seeking to capture the important aspects of the organization and how they relate to one another. The logical data model is the basis for the physical data model. It is sometimes used as a synonym for a domain model, but the two are not the same. A domain model is more focused on capturing the concepts in the problem domain rather than the structure of the data associated with that domain. Make sure you understand the differences between a conceptual, logical, and a physical data model. Use the table below to avoid confusion.

Conceptual Data Model	Logical Data Model	Physical Data Model
Includes high-level data constructs	Includes entities (table), attributes (columns/fields) and relationships (keys)	Includes tables, columns, keys data types, validation rules, database triggers, stored procedures, domains, and access constraints.
Non-technical names, so that executives and managers at all levels can understand the data basis of architectural description	Uses business names for entities and attributes	Uses more defined and less generic specific names for tables and columns, such as abbreviated column names, limited by the database management system (DBMS) and any company defined standards.
Uses general high-level data constructs from which architectural descriptions are created in non-technical terms.	Is independent of technology (platform, DBMS)	Includes primary keys and indices for fast data access.
May not be normalized.	Is normalized to forth normal form (4NF)	May be de-normalized to meet performance requirements based on the nature of the database. If the nature of the database is online transaction processing (OLTP) or operational data store (ODS) it is usually not de-normalized. De-normalization is common in data warehouses.
Represented in the DIV-1 viewpoint (DoDAF V2.0)	Represented in the DIV-2 Viewpoint (DoDAF V2.0), and OV-7 View (DoDAF V1.5)	Represented in the DIV-3 Viewpoint (DoDAF V2.0), and SV-11 View (DoDAF V1.5)

Image 74: Data Model Comparison

- ◇ **Matrix diagrams** — A matrix diagram, also called a matrix chart, is used to show the relationship between two, three or four groups of information. The American Society for Quality (ASQ) offers significant additional information about matrix diagrams. There are six possible shapes to the matrix: L, T, Y, X, C, and roof-shaped depending on how many variables or groups are being compared. The table on the next page shows when to use the different shaped matrices.



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Shape	# of Groups	What the Matrix Shows
L-Shaped	2 Groups	A \longleftrightarrow B (or A \longleftrightarrow A)
T-Shaped	3 Groups	B \longleftrightarrow A \longleftrightarrow C but NOT B \longleftrightarrow C
Y-Shaped	3 Groups	A \longleftrightarrow B \longleftrightarrow C \longleftrightarrow A
C-Shaped	3 Groups	All three simultaneously (3-D)
X-Shaped	4 Groups	A \longleftrightarrow B \longleftrightarrow C \longleftrightarrow D \longleftrightarrow A but not
Roof-shaped	1 Group	A \longleftrightarrow A when also A \longleftrightarrow B in L or T

Image 75: Types of Matrix Diagrams

Matrix diagrams also have a series of symbols in addition to numeric values that are commonly used. These symbols include:

- ⊙ Strong relationship
- Moderate relationship
- △ Weak or potential relationship
- S Supplier
- C Customer
- D Doer
- O Owner
- + Positive relationship
- Neutral relationship
- Negative relationship
- ↑ Item on left influences item at top
- ← Item at top influences item on left. The arrows usually are placed next to another symbol indicating the strength of the relationship

Image 76: Matrix Diagram Symbols

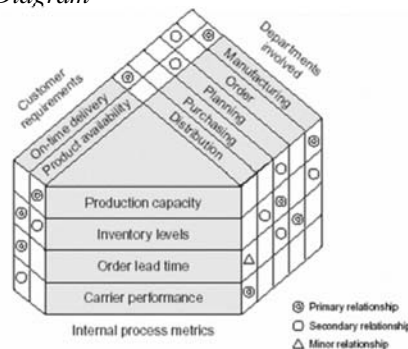
Putting this information together, you end up with the basic L-shaped matrix diagram.

	Customer A	Customer B	Customer C	Customer D
Measure #1	15	22	19	12
Measure #2	95	105	125	97
Measure #3	29	36	27	56
Measure #4	41	58	36	61

Image 77: L-Shaped Matrix Diagram

Lastly, here is a Y-shaped matrix diagram.

- ◇ **Mind mapping** — We have previously described mind maps. Please refer to that discussion for questions.



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- ⇒ **.6 Test and inspection planning** — Every industry is different, but regardless of the products, services or results being created by the project team testing and inspection is critical. Although how you will test might be different, there are some commonalities we can establish. The first is that every project team must spend time during the planning phase of the project to determine how they will test or inspect their results to ensure they meet the defined project success criteria. This becomes increasingly complex when you factor in the various project methodologies. The software industry talks about alpha, beta, red, green and refactoring as part of their testing and inspection processes and this is just one industry. Engineering adds field tests, load tests, and nondestructive tests. This is a lot of testing. The key is that the team defines their testing process as part of planning.
- ⇒ **.7 Meetings** — You have spent enough time in the field as a project manager to qualify for the PMP® you know that you spend a huge amount of your time in meetings collecting information and communicating with people.

The outputs of the plan quality process include the following:

.1 Quality management plan — The quality management plan defines how the project manager and the team will implement the organization's quality policy. It becomes part of the project management plan. It specifically defines how the organization will control quality, do quality assurance, and provide for continuous process improvement on the project.

.2 Quality metrics — Quality metrics define how the project manager and the team will measure the quality performance of the project. It also defines the tolerances for those metrics. According to the PMBOK® Guide “specifically describes a project or product attribute and how the control quality process will verify compliance to it.” [6th ed. p. 287]

.3 Project management plan updates — We consistently see the planning processes causing the team to revisit other plan documents with updates. This is true here as well. Most likely to be impacted are the risk management plan and the scope baseline.

.4 Project documents updates — Although any of the project documents might need to be updated, the PMBOK® Guide lists the lessons learned register, the requirements traceability matrix, the risk register, and the stakeholder register.

8.2 Manage Quality

With the 6th edition of the PMBOK® Guide changed the second process found in quality management from perform quality assurance to manage quality. This change dramatically reduced the amount of confusion found in quality management and made the knowledge area more consistent with the rest of the Guide. The concept is you first plan the area, then you manage the area before finally controlling



Image 78: The Manage Quality Process



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the area. The manage quality process is all about translating the quality management plan into the activities that translate the quality policies into positive outcomes for the project. One aspect of this process that did not change with the name was the importance of quality assurance within its framework. This means that the manage quality process includes all quality assurance activities and also addresses product design and process improvements. It provides an umbrella for continuous improvement. The plan quality process answers the question: “How will the project team achieve quality?” The quality management process answers the question: “Are we following our standards?” This process focuses on determining if the various project activities comply with organizational and project policies, procedures, and processes. It uses the measurement information from the control quality. What makes it so confusing is the fact that it is often going on at the same time and using information from the control quality process.

The inputs to the manage quality process include the following:

- ⇒ **.1 Project management plan** — Within the project management plan, the quality management plan is specifically called out. It defines how the team intends to manage quality on the project.
- ⇒ **.2 Project documents** — The project documents provide the team with the lessons learned register, quality control measurement, quality metrics, and risk reports. Quality control measurements are the results of quality control activities. They are important to evaluate and analyze the quality standards and processes of the performing organization. Quality metrics include things such as on-time performance, failure rates, availability, defect frequency, and other such measures.
- ⇒ **.3 Organizational process assets** — Many organizations have policies, procedures, and guidelines directing projects in the area of quality. Along with these policies and procedures they often provide checklists, test plans and other tools to give the team a jump start. If these items exist, the team should take advantage of them.

Many of the tools and techniques found in the manage quality process are the same as what was found in the plan quality management process. They include things such as cost-benefit analysis, cost of quality, control charts, benchmarking, and flowcharting. The tools and techniques used in the manage quality process include the following:

- ⇒ **.1 Data gathering** — As part of the data gathering process, it often makes a lot of sense to make use of a checklist of some kind. Remember, a checklist is used to verify that a set of required processes or steps have been performed or to ensure a set of requirements have been completed. The risk with checklists is that users believe they have covered everything and do not think beyond the checklist. Therefore, you must use other data gathering techniques as well.



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⇒ **.2 Data analysis** — We have already repeatedly had to analyze our collected data so this process should already be familiar to you. Generally, PMI® is consistent with the individual tools called out when conducting this kind of analysis so we will not delve too deeply into most. In this case you might need to analyze potential alternatives, review documents, or examine your processes. The examination of processes in agile development is done through a retrospective. Retrospectives are quickly becoming best practice across a wide range of industries regardless of development methodology because they establish a cadence within the project team of regularly examining the processes used by the team to deliver the project.

The team may also have to use **root cause analysis**. The goal of root cause analysis is to determine the foundational reason for a specific error or problem. The definition of a root cause is if removing the item from the problem-fault sequence prevents the final undesirable outcome from occurring then the item is considered a root cause. Compare a root cause to a causal factor. A causal factor is one that affects the event's outcome, but does not meet the threshold of a root cause. At the end of the day, removing a causal factor can benefit the outcome, but it does not prevent its recurrence with certainty. Root cause analysis is based on four foundational principles.

- ◇ **Define and properly describe the event or problem.** This is done through the data gathering process. There are a number of techniques the team may use to complete this task. One is the five whys technique. This technique is an iterative interrogative technique used to specifically explore the cause and effect relationship of the issue being discussed by the team. The goal of the technique is to determine the root cause of the problem. The technique begins with the team asking why the problem occurred. Upon receiving an answer the team asks, “why is that?” This process continues until the team has repeated the why question five times. The “5” in the name is derived from anecdotal observation by the technique's creator Taiichi Ohno and Sakichi Toyoda that it took repeating the question five times to get to the root cause.
- ◇ **Establish a timeline from the normal situation until the failure.** This step is typically done on a whiteboard or flip chart and often closely resembles a fishbone diagram. The goal is to find the linear, time-based relationship with the steps in the problem.
- ◇ **Distinguish between root causes and causal factors.** This step requires discernment as the team must examine each idea they discovered and determine if it has core causality or is secondary to the problem.
- ◇ The team then focuses on problem prediction to determine when the problem will happen next and what must happen to prevent future occurrence.

⇒ **.3 Decision making** — The 6th edition of the PMBOK® Guide places a



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much more overt focus on the decision making process. One of the most common tools used in this process is multicriteria decision making or MCDM. This process is actually a subdiscipline of operations research that evaluated situations where there are multiple conflicting criteria in the decision making process. A simple example of this concept is the relationship between price and functionality.

⇒ **.4 Data representations** — As the team progresses through this process, they often need one or more ways of visually representing the information they are collecting and analyzing. PMI® lists a number of possibilities including:

◇ **Affinity diagrams** — An affinity diagram is one of the “Seven Management and Planning Tools”, and was originally devised by Jiro Kawakita in the 1960s. It is also sometimes referred to as the KJ Method. Affinity diagrams are commonly used in project management to sort a large number of ideas created during brainstorming based on their natural relationships for review and analysis. To organize ideas using brainstorming the team uses the following steps:

- ⇒ Record each idea on card or PostIts™
- ⇒ Look for ideas that seem related
- ⇒ Sort the cards into groups until all the cards have been used.
- ⇒ Once the cards are sorted create clusters or subgroups for easier analysis.

Once completed, the affinity diagram can be transitioned to a cause and effect diagram for further analysis and discussion. *Image 79* below shows a simple affinity diagram.

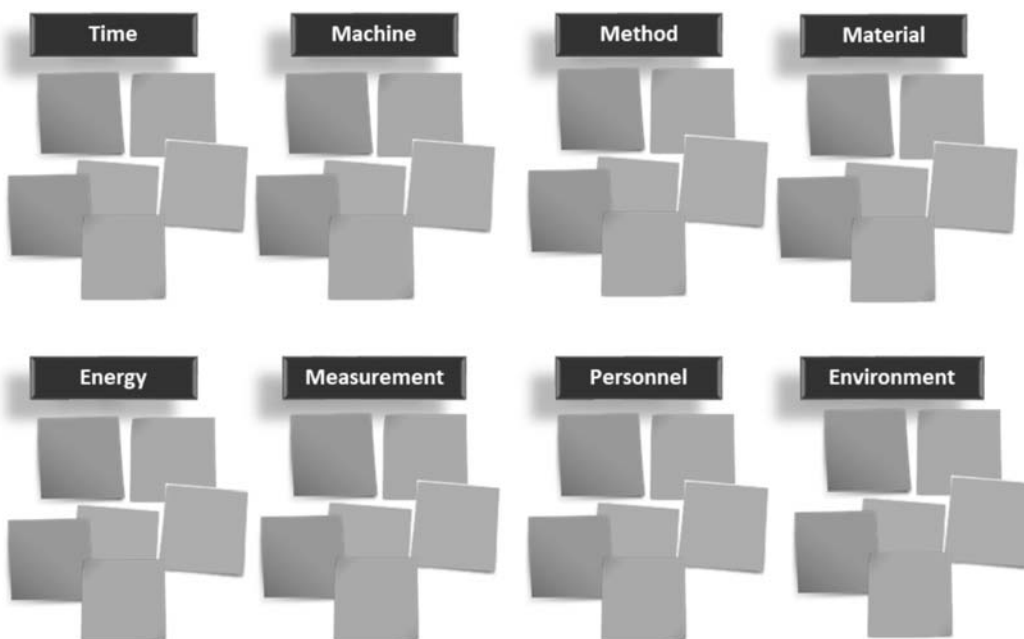


Image 79: An Affinity Diagram

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- ◇ Another common tool used to define and describe an event or problem is the **cause and effect diagrams**. A cause and effect diagram is also called a fishbone or Ishikawa diagram, these diagrams are group tools to help the project team visualize the potential causes of a problem which require further investigation. A cause and effect diagram is done in a team environment. The team begins by agreeing on a problem statement. Once the team has a problem, the next step is to brainstorm about the major causes of the problem. To help the team, this process often uses the categories of methods, equipment or hardware, people, materials, measurement, and environment. These categories are used as the primary branches off of the problem spine in the diagram. The team then creates branches off of the mains as they continue to brainstorm and ask why for each item. When the team runs out of ideas they focus their attention on the chart areas where the ideas are the fewest. *Image 80* shows an example of a cause and effect diagram.

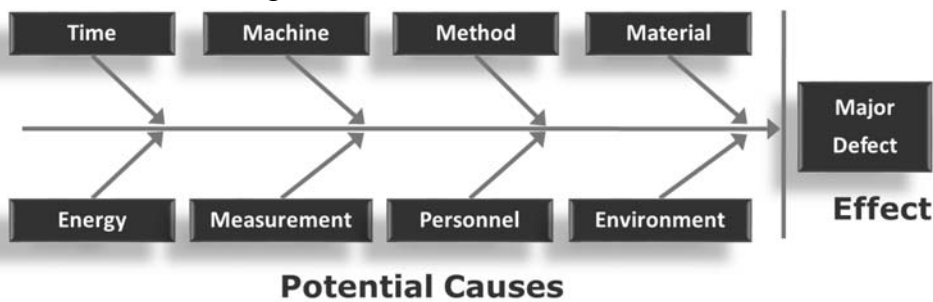


Image 80: A Cause and Effect Diagram

- ◇ **Flowcharts** — Earlier in this course we introduced the concept of flowcharts as a tool to visually display a series of steps in a process. They are equally useful here. They are a graphical representation of a process or an algorithm, and use different shapes to represent specific components such as data, decisions or termination points.
- ◇ **Histogram** — A histogram is a graphical representation of numerical data. However, it does not just show any data. It displays an estimate of the probability distribution of a continuous variable. Histograms appear as bar graphs and were first introduced by Karl Pearson. Be careful to not confuse histograms with simple bar charts. A histogram is used for continuous data

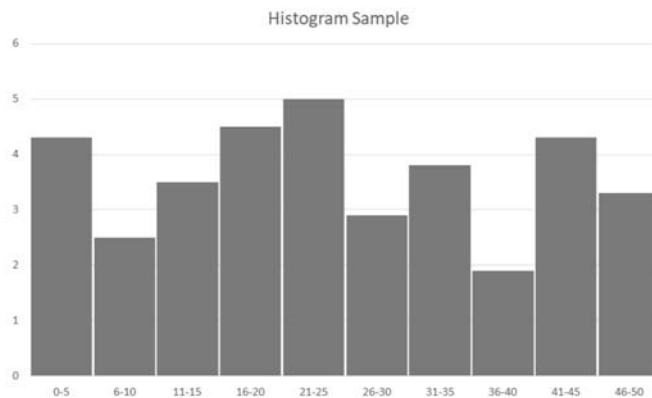


Image 81: A Histogram



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where the bars represent ranges of data. A bar chart is a plot of categorical data. That is why you often see gaps between the bars in bar charts and there should be no gap between the bars in a histogram. Histograms are one the seven basic tools of quality.

- ◇ **Matrix diagram** — We have previously discussed the matrix diagrams, and they are a useful tool here as well.
- ◇ **Scatter Diagram** — A scatter plot or scatter graph is a type of mathematical diagram using Cartesian coordinates to display values for two variables for a set of data. The data is displayed as a collection of points, each having the value of one variable determining the position on the horizontal axis, and the value of the other variable determining the position on the vertical axis. This kind of plot is also called a scatter chart, scatter diagram, and scatter graph.

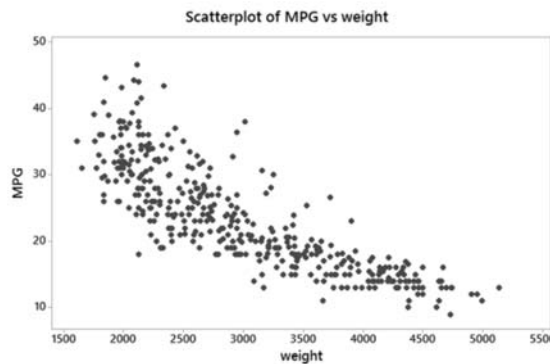


Image 82: A Scatter Diagram

- ◇ **Control charts** are visual tools used to determine if a process is stable, with predictable results. With the 6th edition of the PMBOK® Guide, they are no longer specifically called out, but it is very important you know them well for the test as they are one of the Seven Quality Tools. A control chart is a line graph with time appearing on the x axis and the defects found or other key measure on the y axis. In addition to the line which shows the actual performance, two threshold lines appear above and below the tracking line. These lines are referred to as control limits. The limit which appears above the line is the Upper Control Limit (UCL) and the line which appears below the line is the Lower Control Limit (LCL). As long as the tracking line is between these two control limits, the process is said to be “in control.” For the PMP® exam it is also important to remember something called the Rule of Sevens. The **Rule of Sevens** states any time there are seven consecutive cases above or below the Mean, the Mean has shifted. Image 83 shows an example of a control chart.
- Specification Limits** are an additional important concept for understanding control charts.

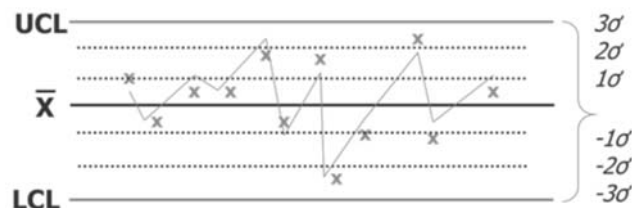


Image 83: A Control Chart

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Specification limits represent the customer's expectations or contractual requirements for performance and quality on the project. To ensure the project team meets the customer's expectations, the project team must set the control limits inside the specification limits.

- ◇ **Pareto chart** — A Pareto chart or diagram, named after Vilfredo Pareto, is a type of chart that contains both bars and a line graph, where individual values are represented in descending order by bars, and the cumulative total is represented by the line. *Image 84* below shows an example of a Pareto Chart.

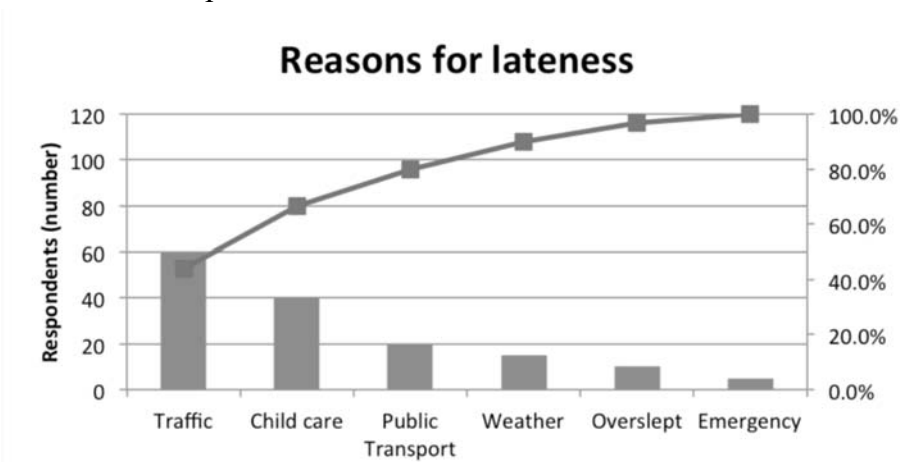


Image 84: A Pareto Chart

- ◇ **Run Chart** — Also known as a run-sequence plot, a run chart is a graph that displays observed data in a time sequence. Often, the data displayed represent some aspect of the output or performance of a manufacturing or other business process. *Image 85* shows an example of a run chart.

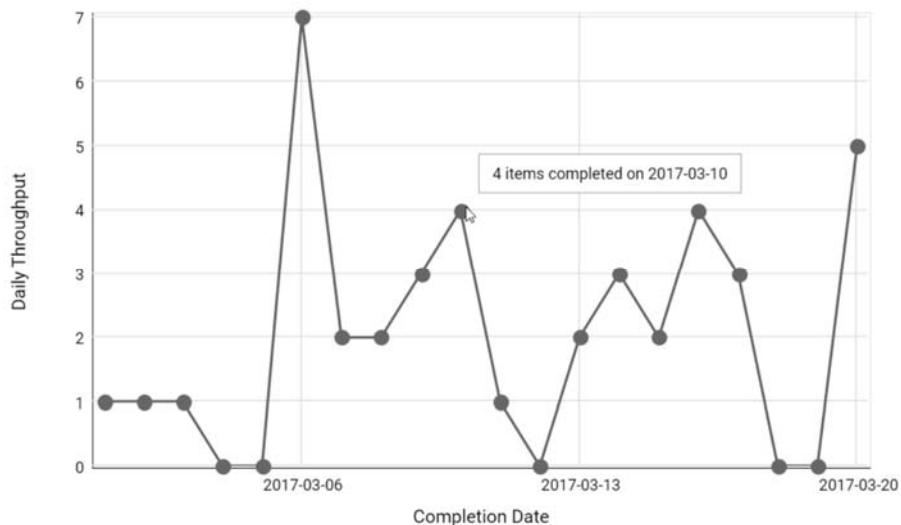


Image 85: A Run Chart

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- ⇒ **.5 Audits** — Many people are familiar with the term audit, but most believe it is something negative and only applies to the world of accounting. This is not true. An audit is simply a structured process completed by someone independent from the organization who examines processes, procedures and/or records to ensure the team is complying with existing rules and standards. A quality audit in project management is often conducted by members of the PMO or an external auditor to ensure best practices are implemented, offering assistance to improve productivity, or to identify nonconformity and shortcomings. These audits can be scheduled or random.
- ⇒ **.6 Design for X** — Design for X or design for excellence (DfX) are terms and expressions used interchangeably in the engineering world. The X can have a number of potential meanings depending on the industry, but common substitutes include: assembly (DfA), cost (DfC), logistics (DfL), manufacturing (DfM), reliability (DfR), and serviceability (DfS). Each design guideline addresses a specific issue that is caused by, or affects the traits of, a product. The design guidelines usually propose an approach and corresponding methods that may help to generate and apply technical knowledge to control, improve, or even invent particular traits of a product. A common part of the DfX concept is mistake proofing the various processes. Mistake proofing is the idea that you make the process such that it only can be done one way, the right way. In a manufacturing process, imagine creating the parts so that some are square and others round. The square parts only fit in the square hole and the round only in the round hole. It is not physically possible to put the square peg in the round hole even if the worker wants it to. Another common principle is simplifying the design by minimizing the total number of parts, using logical labels on parts and guides, and making spare parts readily available.
- ⇒ **.7 Problem solving** — Thomas J. D'Zurilla in 1988 defined problem solving as a “cognitive–affective–behavioral process through which an individual (or group) attempts to identify, discover, or invent effective means of coping with problems encountered in every day living”. Problem solving is used in when products or processes fail, so corrective action can be taken to prevent further failures. It can also be applied to a product or process prior to an actual fail event, i.e., when a potential problem can be predicted and analyzed, and mitigation applied so the problem never actually occurs. Techniques such as failure mode effects analysis can be used to proactively reduce the likelihood of problems occurring. There are a wide range of problem solving methods such as GROW model, How to Solve It, OODA loop, PDCA, Rapid Problem Resolution and many others.
- ⇒ **.8 Quality improvement methods** — There are a large number of quality improvement methods available today. TQM, Six Sigma, PDCA, and Lean are just some of the alternatives available to a project manager.

The outputs to the perform quality assurance process include the following:



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- ⇒ **.1 Quality reports** — Quality reports provide both the team and leadership with graphical, numerical or qualitative information about what is going on within the quality processes. This information can include recommendations, bug fixes, corrective action recommendations, quality management issues, and a wide range of other quality information depending on what is happening with the project.
- ⇒ **.2 Test and evaluation documents** — Test and evaluation documents are not used in every industry, but for some they represent important outputs to evaluate the achievement of quality objectives. They can come in many forms such as checklists or requirements traceability matrices.
- ⇒ **.3 Change requests** — As with most of the processes found in the PMBOK® Guide, the manage quality process can generate change requests. In this case, the changes are often focused on quality improvements that could be made.
- ⇒ **.4 Project management plan updates** — The manage quality process can cause updates to several components of the project management plan, such as the quality management plan, the scope baseline, the schedule baseline or the cost baseline.
- ⇒ **.5 Project document updates** — The manage quality process can also cause updates to other project documents such as the issue log, lessons learned register or the risk register

8.3 Control Quality

The final process found in the quality management knowledge area is the control quality process. This process occurs throughout the project and is focused on monitoring and recording the results of executing the various quality activities, as defined in the quality management plan and other components of the project management plan. Specific project results — such as deliverable production, schedule and cost performance — are often included in the analysis. PMI® assumes the project team has at least a rudimentary working knowledge of statistics to perform this function because several of the tools and techniques used involve statistics. This is also the most lengthy process found in the quality management knowledge area. Fortunately, most of the information follows basic common sense so it is not difficult, so long as you are comfortable with the relationship between this process and the manage quality process.

The inputs to the control quality process include the following:

- ⇒ **.1 Project management plan** — The specific component of the project management plan that is of the most interest is the quality management plan.



Image 86: The Perform Quality Control Process



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-
- ⇒ **.2 Project documents** — PMI® calls out three documents that are part of the project documents. These include the lessons learned register, quality metrics, test and evaluation documents. The lessons learned register is important because it provide insight from past projects on the topic of quality. The quality metrics include things such as on-time performance, failure rates, availability, defect frequency and other such measures. The test and evaluation documents describe how the team plans on handling major components of quality.
 - ⇒ **.3 Approved change requests** — Approved change requests can include things such as defect repair, revised work methods, and a revised schedule. It is important to implement any approved changes as quickly as possible.
 - ⇒ **.4 Deliverables** — Notice the input is not the final product, service or result of the project. It is the deliverables defined in the WBS.
 - ⇒ **.5 Work performance data** — The work performance measurements of concern here are all comparisons of actual results to the planned results in the areas of cost, schedule and technical performance.
 - ⇒ **.6 Enterprise environmental factors**— The project management information system, quality management software the team is using to track errors and variances both could be powerful inputs to controlling quality. Additionally, any applicable government regulations or rules, standards, or guidelines that are specific to the industry also might be important to controlling quality.
 - ⇒ **.8 Organizational process assets** — Quality standards and policies, work guidelines, issue and defect reporting procedures, and communication policies can all be organizational process assets that are inputs to the Control Quality Control Process.

Most consider Kaoru Ishikawa, a professor of engineering at Tokyo University to be the father of modern quality management techniques. He argued there are seven basic tools of quality. The 5th edition of the PMBOK® Guide specifically called out his seven tools of quality management. However, in the 6th edition of the Guide the tools are not called out as a set. Instead, most of Ishikawa's Seven Basic Tools of Quality appear specifically within the tools and technique sections of either the manage quality or control quality processes. If you struggle in understanding any of these research the Seven Basic Tools of Quality for more information.

The tools and techniques used to control quality include:

- ⇒ **.1 Data gathering** — Data gathering is a simple group heading, but don't be fooled. A number of these tools are used repeatedly throughout the project management process. For the control quality process, the list includes: checklists, check sheets, statistical sampling, and questionnaires and surveys. We have already talked about checklists extensively in this course. However, we have not visited check sheets, and the two are not the same. A check sheet is also sometimes referred to as a tally sheet. They are simple grids



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used to record data about a potential quality problem. A simple example is shown below:

	Monday	Tuesday	Wednesday	Thursday	Friday
Color Blemish	4	6	3	4	5
Scratch	5	8	6	7	5
Dent	3	3	5	4	2
Poor Fit	1	2	5	4	3

Image 87: A Check or Tally Sheet

In many manufacturing environments it is impossible to test every product created. Statistically sampling provides a way to ensure quality without sampling each unit produced. There are a number of terms that must be understood to manage quality using statistical sampling. There are a number of terms which must be understood to manage quality using statistical sampling. These terms include the following:

- ◇ **Attribute** – A quality, character, characteristic, or property a thing might have.
- ◇ **Variable** – A quantity or function that may assume any given value, set of values, or attributes.
- ◇ **Producer's risk** – (Alpha) chance of rejecting a good lot. Type I error.
- ◇ **Consumer's risk** – (Beta) chance of accepting a bad lot. Type II error.
- ◇ **Sampling plan** – Sample size (n) and acceptance criteria.
- ◇ **Mean** – Sum of the values divided by the count.
- ◇ **Median** – the middle value.
- ◇ **Mode** – the most commonly occurring value.
- ◇ **Standard deviation** – This is the second time you have encountered the term standard deviation. The first was in the time management knowledge area during the discussion of PERT. Do not confuse the two topics. This is the traditional calculation for Standard Deviation and is defined as:

To better understand this equation, let's walk through a simple

$$\sqrt{\frac{\sum(x - \bar{x})^2}{n - 1}}$$

Σ = Sum of ...
 \bar{x} = the value of the case
 x = Mean
 N = Number of cases

example. Imagine you have a population with five values (1, 2, 3, 4, and 5) . Here are the steps to determining the standard deviation:

1. Determine the mean by adding the cases together and diving by the count or $(1+2+3+4+5)/5 = 3$



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2. Take each of the cases and subtract the mean. Then square the result.
 $(1-3)^2, (2-3)^2, (3-3)^2, (4-3)^2, (5-3)^2$
3. Next, add the results. $= 4+1+0+1+4 = 10$
 Divide this result by the number of cases minus one or $10/(5-1) = 2.5$. This result is called the Variance of the population.
4. Finally, take the square root of the variance or the SQ. Root of 2.5 $= 1.58$. This is the Standard Deviation.

Questionnaires and surveys can be either formal or informal. Both collect information from a group of individuals in a way that can be tabulated and summarized for analysis.

- ⇒ **.2 Data analysis** — There are two types of data analysis called out by PMI®. These are performance reviews and root cause analysis. Both tools have been discussed previously in this course. The less technical is the performance review which reviews measures before comparing and analyzing the quality metrics defined in the quality management plan against results.
- ⇒ **.3 Inspection** — An inspection is the examination of a work product to determine whether or not it conforms to documented standards.
- ⇒ **.4 Testing / product evaluation** — PMI® defines testing as an organized and constructed investigation conducted to provide objective information about the quality of the product or service under test in accordance with the project requirements. The intent of testing is to find errors, defects, bugs, or other nonconformance problems in the product or service [PMBOK® 6th Ed. P.303]. Test techniques include the process of executing a program or application with the intent of finding software bugs (errors or other defects), and verifying that the software product is fit for use.
- ⇒ **.5 Data representation** — How are you going to present information to the team and stakeholders so they clearly understand what is happening in terms of the quality of the project? Common tools include Ishikawa diagrams, control charts, histograms, and scatter diagrams.
- ⇒ **.6 Meetings** — Regardless of the other tools and techniques you might use, meetings are still an important aspect of how the project leader delivers results.

The outputs to the control quality process include the following:

- ⇒ **.1 Quality control measurements** — The documented results of the various quality control activities. It is important that they are presented in the format defined in the quality management plan.
- ⇒ **.2 Verified deliverables** — A key goal of quality control is to determine the correctness of the deliverables defined in the WBS and WBS dictionary. This is the big output from the control quality process.

- ⇒ **.3 Work performance information** — This is a description of how is the work being done and what is being accomplished.
- ⇒ **.4 Change requests** — If the recommended corrective actions, preventive actions, or defect repairs require a change to the project management plan, a change request should be initiated.
- ⇒ **.5 Project management plan updates** — The control quality process can result in updates to the quality management plan and/or the process improvement plan.
- ⇒ **.6 Project documents updates** — Often the control quality process can cause updates to various project documents including the issue log, the lessons learned register, the risk register and test or evaluation documentation.
- ⇒ **.8 Organizational process assets updates** — The performance of quality control should also cause completed checklists to appear, and lessons learned documentation to be provided.

Quality Management Summary

To successfully answer the quality management questions on the PMP® exam, make sure to spend time studying the following:

- ⇒ **Three processes** — Make sure you know and understand the three processes.
- ⇒ **Management vs. control** — Pay special attention to the differences and relationship between quality management and quality control.
- ⇒ **Principles advocated by Deming, Juran, Ishikawa, Crosby, Taguchi** — Know the thought leaders and their main ideas.
- ⇒ **Control chart and the rule of seven** — Know how to read a Control chart and what the rule of seven is, as well as how to use it.
- ⇒ **PM and team have primary responsibility for conformance to standards** — Remember the project manager's role in terms of delivering quality on the project.
- ⇒ **Importance of continuous improvement** — Continuous improvement is a huge idea to PMI®. Make sure you fully understand it and how it applies to most areas of the project.
- ⇒ **Tools for controlling quality** — Make sure you understand all the charting, mathematical, and statistical tools a project manager may use to execute the control quality process.
- ⇒ **Variable vs. attribute sampling** — Know the differences between attribute and variable sampling, and how they are used.
- ⇒ **Gold plating** — Remember, PMI® considers gold plating ineffective and it should always be avoided.



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⇒ **Metrics** — Make sure you understand the important role PMI® believes metrics has on the successful delivery of quality. Quantification is a key element of success.

Exercise 16 — Quality Management



Exercise 16 — Quality Management

1. A new software development project is in progress and the project manager is working with the quality assurance department. They want to improve everyone's confidence that the project will satisfy the quality standards. Which of the following do they need to have before they start this process?
 - A. Completed checklists
 - B. Quality management plan
 - C. Rework
 - D. Results of quality control measurements
2. A project manager and team from a firm that designs railroad equipment are tasked to design a machine to load stone onto railroad cars. The design allows for 2% spillage, amounting to over two tons of spilled rock per day. In which of the following does the project manager document quality control, quality management, and quality improvements for this project?
 - A. Quality management plan
 - B. Quality policy
 - C. Control charts
 - D. Project management plan
3. The project has had a major defect, and the project manager has involved the project team and process engineers in analyzing the situation. One of the group says that the real fault is the age of the equipment. Another says it is the lack of a material for the correct quality. To address the root of the problem, the project manager decides to use an Ishikawa diagram. Which of the following BEST describes the step of the quality management process in which the group is involved in this situation?
 - A. Quality analysis
 - B. Control quality
 - C. Manage quality
 - D. Plan quality management
4. You are a project manager for a major information systems project when someone from the quality department comes to see you about beginning a quality audit of your project. The team, already under pressure to complete the project as soon as possible, objects to the audit. You should explain to the team that the purpose of a quality audit is:
 - A. Part of an ISO 9000 investigation.
 - B. To check if customer is following its quality process.
 - C. To identify lessons learned that can improve performance on the project.
 - D. To check accuracy of costs submitted by the team.

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5. The project has had a major defect, and the project manager has involved the project team in analyzing the situation. One of the group says that the real fault is the technology being used. Another says it is the age of the material. To address the root of the problem, the project manager decides to use a Control Chart. Which of the following BEST describes the step of the quality management process in which the group is involved in this situation?
 - A. Analyze quality
 - B. Control quality
 - C. Manage quality
 - D. Plan quality management
 6. The project has had a major defect, and the project manager has involved the project team and process engineers in analyzing the situation. One of the group says that the real fault is using a new machine when an older machine was specified. Another says it is a change in subcomponent suppliers. To address the root of the problem, the project manager decides to use a cause and effect diagram. Which of the following BEST describes the step of the quality management process in which the group is involved in this situation?
 - A. Perform quality analysis
 - B. Control quality
 - C. Manage quality
 - D. Plan quality management
 7. Which of the following is NOT a valid definition of project quality?
 - A. The degree to which the project team meets customer expectations
 - B. The degree to which a set of characteristics fulfill requirements
 - C. The degree to which a product has no obvious defects
 - D. Quality is something that both the project manager and project management team are responsible for delivering
 8. Which of the following is the first process in quality management?
 - A. Manage quality
 - B. Control quality
 - C. Plan quality management
 - D. Perform quality definition
 9. In which of the following processes do you ensure that the quality standards will allow the project to achieve its desired quality goals?
 - A. Control quality
 - B. Manage quality
 - C. Plan quality management
 - D. Perform quality definition

-
10. Which of the following is not an input to the quality planning process?
- A. Product scope baseline
 - B. Risk register
 - C. Enterprise environmental factors
 - D. Organizational quality metrics
11. Which of the following is a tool and technique used in the plan quality management process?
- A. Project charter
 - B. Process analysis
 - C. Cause and Effect Diagrams
 - D. Design of Experiments
12. What is the effect of a project product, service or result that meets customer requirements while being ahead of schedule and over budget?
- A. The project is successful.
 - B. The project is significantly over budget.
 - C. Project quality has been achieved.
 - D. The project is behind schedule.
13. Which of the following statements best describes marginal analysis?
- A. The process of determining the point at which the value of incremental quality improvements will not equal the cost to attain them.
 - B. The process of determining the point at which the value of incremental quality improvements equal the cost of those improvements.
 - C. The process of determining the optimal quality standards for the project.
 - D. The process for determining the optimal profitability based on the differentiation of the cost and pricing.
14. Sally is talking to a coworker and states she believes her boss is being unfair with her regarding her current project and the project's level of quality. Who is owns final responsibility for project quality?
- A. Project resources
 - B. Project sponsor
 - C. Project manager
 - D. The entire project team
15. Your project team is currently using Cost-Benefit Analysis. In which of the quality management processes are you in?
- A. Plan quality management
 - B. Manage quality
 - C. Control quality
 - D. Integrated change control

-
16. You are a project manager leading a team that is currently using the cost of quality to evaluate the project. In which of the quality management processes are you in?
- A. Manage quality
 - B. Control quality
 - C. Develop project management plan
 - D. Plan quality management
17. You are leading an engineering project. Your team is completing a quality audit. In which of the quality management processes are you in?
- A. Manage quality
 - B. Quality planning
 - C. Control quality
 - D. Close project
18. Your project team is using control charts to determine the current quality status of your project. In what part of the quality management process are you in?
- A. Plan quality
 - B. Control quality
 - C. Manage quality
 - D. Direct and manage project execution
19. You are the project manager on a project that has struggled with the quality of the deliverables throughout the entire project. Your boss, the Senior Vice President has come to you and stated that quality is the most important project constraint. On Monday morning you come into the office and find that another problem with quality has occurred. What is the best thing for you to do?
- A. Absorb a cost increase to fix the root cause of the problem.
 - B. Fix the problem immediately.
 - C. Cut project costs and allow the schedule to slip.
 - D. Allow project risks to increase by allowing the schedule to slip.

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20. You are a project manager leading a project that has an SPI 1.03 and a CPI 1.05. The ETC is \$247,905. In a meeting you are conducting with your team to discuss the quality of the project one of your team members complains that the schedule is seriously compressed and you do not have time for the meeting. You have consistently rewarded your team according to the reward system you put in place and have a great team that has worked well together. Which of the following best explains why the complaining individual is wrong?
- A. Improved quality leads to increase productivity, decreased cost effectiveness, and increased technology risks.
 - B. Improved quality leads to increased productivity, increased cost effectiveness, and decreased cost risk.
 - C. Improved quality leads to increased productivity, increased cost effectiveness, and increased cost risk.
 - D. Improved quality leads to increased productivity, decreased cost effectiveness, and decreased cost risk.
21. Quality attributes from the perspective of a project:
- A. Provide the basis for judging the project's success or failure.
 - B. Determine how effectively the team supports the project.
 - C. Are specified characteristics for which a product is designed and tested.
 - D. Are objective criteria that must be met.
22. Which of the following best defines quality?
- A. Meeting and exceeding the customer's expectations.
 - B. Conformance to management's objectives.
 - C. Adding extras to keep the customer happy.
 - D. The degree to which the project meets requirements.
23. You are a project manager working through some issues on your project. A member of your team suggests you make use of a Pareto diagram. Why might a Pareto diagram be helpful?
- A. Focus on the most critical issues to improve quality.
 - B. Allow you to effectively brainstorm.
 - C. Examine potential future outcomes.
 - D. Determine if a process is out of control.
24. As a project manager which of the following will a Control chart help you do?
- A. Focus on the most critical issues to improve quality.
 - B. Determine if a process is functioning within set limits.
 - C. Allow you to effectively brainstorm.
 - D. Examine potential future outcomes.

-
25. You are a project manager trying to decide the best way to evaluate the quality of a manufactured product. Which of the following best explains why you choose not to test the entire population?
- A. It would create noise in the data.
 - B. It would exclude other testing methods.
 - C. It would take too long.
 - D. It would show type II errors.
26. All of the following are examples of the cost of conformance except:
- A. Auditing
 - B. Controlling
 - C. Appraisal
 - D. Expediting
27. All of the following are examples of the cost of nonconformance except:
- A. Expediting
 - B. Warranty service
 - C. Auditing
 - D. Recalls
28. You are a project manager working on a large, highly visible project. Your most recent control chart shows seven consecutive points on one side of the mean. What should you do next?
- A. Find the cause of the change.
 - B. Nothing. The project is not necessarily in trouble.
 - C. Notify your sponsor that there is a problem.
 - D. Adjust the chart to reflect the new mean.
29. You are a project manager leading a large project within your organization. Last week you were on vacation. Upon your return you discover the team added several deliverables to the project because they determined it would benefit the customer. What is wrong with this situation?
- A. The project manager was not present when the decision was made.
 - B. Nothing, this is the best way to have a happy customer.
 - C. Nothing. The team needed to keep moving in your absence.
 - D. The team is gold plating.
30. You are working on creating a financial plan for your project. If you are planning on using JIT, how much inventory should you plan on maintaining?
- A. 0%
 - B. 15%
 - C. 25%
 - D. 40%

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31. When planning your project which would generally have the highest priority: schedule, cost or quality?
- A. Quality
 - B. Schedule
 - C. Cost
 - D. It should be determined for each project.
32. You are a project sponsor with several projects falling within your authority. You are concerned about the accuracy of the performance reporting you have recently been receiving. Which of the following would best allow you to validate your concerns?
- A. Control charts
 - B. Quality audits
 - C. Monte Carlo analysis
 - D. Logit analysis
33. You are leading a large manufacturing project for a new automobile. The current design allows for a 1.3% defect rate and expects to produce 1.2 million units. In which of the following would you document quality control, quality assurance, and quality improvements?
- A. The quality policy
 - B. The project management plan
 - C. The quality management plan
 - D. Organizational processes and templates
34. You are a project manager leading a road construction project. The road is almost 80% complete according to your most recent EVMS report when a senior executive informs you that she is worried the project will not meet the quality standards. What should you do in this situation?
- A. Assure the executive that during the plan quality process it was determined that the project would meet the quality standards.
 - B. Use EVMS to predict future results.
 - C. Check the results from previous projects' quality management plans.
 - D. Form a quality assurance team.
35. You are a project manager leading a small information technology project. You ask two members of your team to select tools and techniques to implement a quality assurance program that will be combined with existing quality control activities. Which of the following would you not expect to see in the program?
- A. Histograms
 - B. Focus groups
 - C. Quality audits
 - D. Statistical sampling

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36. You are the project manager on a major engineering project. You are working with the quality assurance department to make sure everyone has confidence that the project will satisfy the quality standards. Which of the following must you have before starting the process?
- A. Defined areas of concern
 - B. Requested quality improvements
 - C. Quality control measurements
 - D. Rework
37. You have just taken over a project from another project manager. The project is currently in the execution process group. The previous project manager created a project budget, determined communications requirements, and went on to complete work packages. What should you do next?
- A. Complete the WBS.
 - B. Complete the identify risk process.
 - C. Complete the project according to the plan.
 - D. Identify the quality standards.
38. You are a project coordinator leading an information technology project. Your project is facing major changes to its deliverables. If you are involved in determining which quality standards are relevant to the changes, you must also be involved in:
- A. Quality management
 - B. Manage quality
 - C. Plan quality management
 - D. Control quality
39. You are the project manager for a large manufacturing project in the electronics industry. Your project has completed all of its deliverables. As you examine the lessons learned you conclude that the project has added five areas of performance and three areas of functionality. The customer has signed off on the delivery of the product of the project and is very happy with the results. What does this mean in terms of success of the project?
- A. The project was unsuccessful because it was gold plated.
 - B. The project was successful because the team learned from the effort and the customer was satisfied.
 - C. The project was an unqualified success.
 - D. The project was unsuccessful because making the customer happy meant the team had to do more work.

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40. You are a project coordinator on an information technology project within your organization. One of your team members comes to you and states that a completed work package does not meet the specified quality metric and that they do not believe it is possible to meet the metric. You gather the appropriate team members together to discuss the situation. Which process in the quality management knowledge area are you in?
- A. Monitoring and control
 - B. Manage quality
 - C. Control quality
 - D. Project execution
41. Management assigns you to be the project manager of a project that crosses functional lines and is designed to operate at 6-sigma levels. The sponsor has given you cost and schedule requirements. Which of the following would not be an appropriate action on your part?
- A. Evaluating the project risks.
 - B. Accepting the requirements.
 - C. Creating a detailed estimate.
 - D. Working with the team to come up with a project plan.
42. The project has had a major defect, and the project manager has involved the project team and process engineers in analyzing the situation. One of the group says that the real fault is the age of the equipment. Another says it is the lack of a material for the correct quality. To address the root of the problem, the project manager decides to use an Ishikawa diagram. Which of the following BEST describes the step of the quality management process in which the group is involved in this situation?
- A. Perform quality analysis
 - B. Manage quality
 - C. Control quality
 - D. Plan quality management
43. An external stakeholder suggests to the project manager that the team does not have enough time to hold quality meetings when the schedule has been significantly compressed. The current CPI is 1.12 and the team has performed very well under adverse circumstances. Which of the following best explains why the stakeholder is wrong?
- A. Improved quality leads to increased productivity, increased cost effectiveness, and decreased cost risk.
 - B. Improved quality leads to increased productivity, decreased cost effectiveness and increased cost risk.
 - C. Increased quality leads to increased productivity, increased cost effectiveness, and increased cost risk.
 - D. Improved quality leads to increased productivity, decreased cost effectiveness, and decreased cost risk.

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44. You are leading a project to develop food packaging equipment. The current specifications call for less than one percent spillage per container. In which of the following do you document quality control, quality assurance, and quality improvements for the project?
- A. Quality management plan
 - B. Quality policy
 - C. Project documents
 - D. Project management plan
45. As the project manager, you have created a plan for how the team will implement the quality policy. It addresses the organizational structure, responsibilities, procedures, and other information about plans for quality. If this plan changes during the project, which of the following plans will also change?
- A. Quality assurance plan
 - B. Quality management plan
 - C. Project management plan
 - D. Quality control plan
46. You are in the middle of a major new facility construction project. The structural steel is in place and the heating conduits are going into place when a senior manager informs you that he is worried the project will not meet the quality standards. When should you do in this situation?
- A. Assure senior management that during the plan quality process, it was determined that the project would meet the quality standards.
 - B. Analogously estimate future results.
 - C. Form a quality assurance team.
 - D. Check the results from the last quality management plan.

Exercise 16—Quality Management Answers

1. **Answer D.** To give the stakeholders confidence you first need to have information about where you are at. Your quality control measurements provide the information about where you are at in meeting the quality standards.
2. **Answer A.** The Quality Management Plan contains all the information that documents how quality will be managed throughout the project.
3. **Answer B.** At this point the team has already completed the planning steps and ensured that the plan will deliver the desired level of quality. The issue is making sure you are actually delivering against the plan.
4. **Answer C.** Lessons learned are always key elements of any project as they allow continuous process improvement. Constantly getting better is key to PMI®.
5. **Answer B.** This is not a situation where you are planning for quality or making sure the plan would lead to the desired level of quality. You are in execution and trying to determine why you are not achieving the desired goals. This is control quality.
6. **Answer B.** Don't be confused by the fact the project manager selected a cause and effect diagram (a poor choice for this situation). The correct answer is still control quality.
7. **Answer A.** PMBOK® Guide p. 274 – Quality should never be defined as meeting customer expectations. Quality is best defined as the ability to fulfill the project's stated requirements. This definition explains why requirements definition is so critical to project success.
8. **Answer C.** PMBOK® Guide p. 272 – Like most defined processes in the PMBOK® Guide, the first step is define what quality means for the project and the steps that will be used to achieve quality.
9. **Answer B.** PMBOK® Guide p. 288 – Manage quality is the process where the project team uses systematic quality activities to ensure that the project will employ all the processes needed to meet requirements.
10. **Answer A.** The scope baseline includes both the project and the product. PMBOK® Guide p. 277 – The inputs to the plan quality management process include:
 - ⇒ .1 Project charter
 - ⇒ .2 Project management plan
 - ⇒ .3 Project documents
 - ⇒ .4 Enterprise environmental factors
 - ⇒ .5 Organizational process assets

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11. **Answer D.** PMBOK® Guide p. 277 – The tools and techniques used in plan quality management include:
- ⇒ .1 Expert judgment
 - ⇒ .2 Data gathering
 - ⇒ .3 Data analysis
 - ⇒ .4 Decision making
 - ⇒ .5 Data representation
 - ⇒ .6 Test and inspection planning
 - ⇒ .7 Meetings
12. **Answer C.** The only thing that can be stated definitively is that the project’s quality level has been achieved. With the information provided you cannot be sure the project was successful as the project is over budget. However, you also cannot tell if the project is significantly over budget. The project is not behind schedule.
13. **Answer B.** Marginal analysis is an analytical process used in determining the point at which spending any more money to improve the project quality will exactly match the value of the improvements. It is a one for one exchange.
14. **Answer C.** PMBOK® Guide p. 273-275 – The project management team and not the entire project team is ultimately responsible for the level of quality on a project. However, in this case the best answer is the project manager.
15. **Answer A.** PMBOK® Guide p. 272 – Cost-benefit analysis is a tool and technique used in the Plan Quality Management Process.
16. **Answer D.** PMBOK® Guide p. 272 – Benchmarking is a tool and technique used in the plan quality management process.
17. **Answer A.** PMBOK® Guide p. 288 – A quality audit is a tool or technique used in the perform quality assurance process.
18. **Answer B.** PMBOK® Guide p. 304 – Control charts are one of several tools and techniques that make up the control quality process.
19. **Answer A.** The key phrase in the answers is “root cause”. Only A fixes the root cause of the problem. B might only be a temporary solution. Neither C nor D provide a solution to the quality problem.
20. **Answer B.** This is a very long winded question, but is typical for the exam. Most of the question has little to do with coming up with the correct answer. Just remember from PMI’s perspective improving the quality of the project will lead to lot of good stuff including decreasing the long term cost of the project, making the team more productive and reducing risks.
21. **Answer C.** PMBOK® Guide p. 273-274 – This question is almost a straight definitional question. Quality is “the degree to which a set of inherent characteristics fulfill requirements.”

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22. **Answer D.** PMBOK® Guide p. 273-274 – This question is almost a straight definitional question. Quality is “the degree to which a set of inherent characteristics fulfill requirements.”
23. **Answer A.** PMBOK® Guide p. 304 – A Pareto diagram is a type of histogram and is conceptually related to Pareto’s law, which holds that a relatively small number of causes will typically produce a majority of the problems or defects.
24. **Answer B.** PMBOK® Guide p. 304 – Control Charts are used to determine whether or not a process is stable or has predictable performance.
25. **Answer C.** PMBOK® Guide p. 303 – The primary reason for not testing an entire population is that it can be extremely time consuming. For this reason sampling is often used.
26. **Answer D.** PMBOK® Guide p. 283 – The costs of conformance include:
- ⇒ Prevention
 - ⇒ Appraisal
 - ⇒ Planning
 - ⇒ Training
 - ⇒ Auditing
 - ⇒ Testing
 - ⇒ Controlling
27. **Answer C.** PMBOK® Guide p. 283 – The costs of nonconformance include:
- ⇒ Scrap
 - ⇒ Rework
 - ⇒ Expediting
 - ⇒ Warranty service
 - ⇒ Recalls
 - ⇒ Failure
28. **Answer A.** PMBOK® Guide p. 304 – This is a trick question of sorts. Hopefully, the first thing you would do is notice the Rule of Seven was in play and you needed to determine why you had 7 consecutive cases on one side of the mean.
29. **Answer D.** Be careful in reading the question. Nothing gives you an indication that the customer actually approved the changes. Do not simply assume they have. The correct answer is the team is gold plating.
30. **Answer A.** JIT refers to Just in Time inventory management. It is a technique where you attempt to carry no inventory and only have material arrive when needed. Therefore, 0% is the correct answer.
31. **Answer D.** PMBOK® Guide p. 294 – Don’t get trapped because this is a quality question. The correct answer is always it depends and must be determined for each project.

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32. **Answer B.** PMBOK® Guide p. 294 – This question reflects the definition of a quality audit. It is a structured, independent review to determine whether project activities comply with organizational and project policies, processes, and procedures.
33. **Answer C.** PMBOK® Guide p. 277 – The quality management plan is where all aspects for how quality will be managed on the project are defined.
34. **Answer D.** The real question here is which option helps ensure you meet the appropriate quality standards. The only choice is forming a quality assurance team.
35. **Answer B.** PMBOK® Guide p. 288 – This question is basically asking which item from the list is not a tool or technique from manage quality and control quality processes combined. The tools and techniques from control quality and manage quality combined include:
- ⇒ Data gathering
 - ⇒ Data analysis
 - ⇒ Data representation
 - ⇒ Decision making
 - ⇒ Audits
 - ⇒ Design for X
 - ⇒ Problem solving
 - ⇒ Quality improvement methods
 - ⇒ Inspection
 - ⇒ Testing / product evaluations
 - ⇒ Meetings
36. **Answer C.** The key word in this question is must. The only one of the four items you must have is the quality control measurements. Everything else is optional.
37. **Answer D.** For some this is an easy question because it appears in the quality section. However, if you did not know which process group you were in would you have gotten it correct? Identifying the quality standards is the correct answer because no one has yet completed the planning process. The next step in that process calls for the creation of the quality standards, and then completing the identify risks process. The WBS is already done and you cannot execute the project until the planning is complete.
38. **Answer C.** Although quality planning usually occurs during project planning, sometimes you have to go back to planning from other processes to re-evaluate or make another decision.
39. **Answer A.** This question might be considered a trick by some, but it is not. The correct answer is the project was gold plated (you have no information that the customer approved the changes prior to implementation). So even though they were happy with the product of the project it was gold plated and that is bad. This is a situation with a great product and a failed project.

-
40. **Answer C.** Measuring is by definition part of the control quality process. Be careful here as the question is about the quality management knowledge area and not the project management process groups.
 41. **Answer B.** As a project manager you should never simply accept requirements or anything else without understanding the implications of acceptance on the project.
 42. **Answer C.** You have a standard you are trying to meet which takes both plan quality and manage quality out of the mix. Perform quality analysis is a made up process. Only control quality represents a process where you are measuring against targets and trying to analyze the variances.
 43. **Answer A.** Improving the quality of the project improves the processes being used by the team. This will lead to improved productivity, increased cost effectiveness and decreased cost risk.
 44. **Answer A.** Be very careful with this question. Two answers are technically correct. The quality management plan is part of the project management plan so both are technically correct, but the quality management plan is the best, most accurate answer.
 45. **Answer C.** The plan described is the quality management plan. Since the quality management plan is included in the project management plan, changing the quality management plan will also change the project management plan.
 46. **Answer C.** Assuring management that it was determined in planning that the project meet quality standards is not productive, since it does not solve the problem. An analogous estimate looks at the past history of other projects. This would not be appropriate to determine how the current project is going. The quality management plan does not provide results. A quality assurance team could help to determine whether the team is following the correct process to satisfy the relevant quality standards.

Project Resource Management

Overview

Chapter Nine of the PMBOK® Guide is dedicated to the project resources management knowledge area. Although it is one of the easiest areas on the exam for most test-takers, some candidates struggle with this section because PMI's perspective of the project manager's role is often very different from the role they are used to completing in the real world. To be successful, remember the project you are leading for the exam, it is a large, multi-million US dollar project with resources in multiple countries for a manufacturing organization. As the project manager you have responsibility to organize, attract, retain and train the team as well as lead them in the completion of the project. The project team or staff are the people who have assigned roles and responsibilities for completing the project. It is very important that they be involved in planning as soon as possible. The project resources management knowledge area is comprised of six processes with two in the planning process group, three in the executing process group, and one in the monitoring and controlling process group.

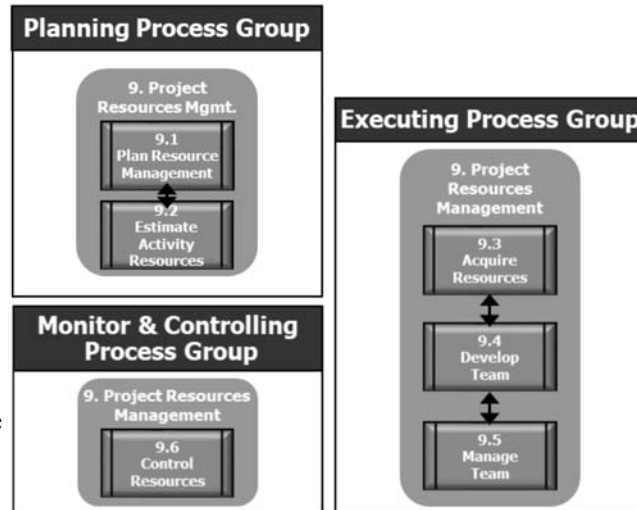


Image 88: The Project Resources Management Processes

9.1 Plan Resource Management

The first process found in the project resources management knowledge area is the plan resource management process. This is the process where the team defines how to estimate, acquire, manage, and use both team and physical resources. Its primary output — as is apparent by the process title — is the resource management plan. This is a relatively small area in terms of content, so it does not require significant study. It does require common sense. Agilists often struggle or argue with some of the concepts presenting in this knowledge area because it argues the project manager should be both leader and manager of the project team. This means they hold primary responsibility for proactively developing the skills and competencies of the team AND the team's satisfaction and motivation. This burden is an area that will continue to evolve over the next several years as the profession continues to develop. For the exam, it is not important that you agree with any particular perspective. However, it is important that you understand these viewpoints and how they impact projects in the real world.

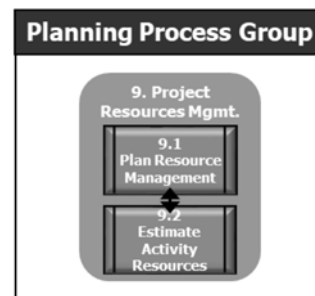


Image 89: Plan Resource Mgmt



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The inputs to the plan resource management process are as follows:

- ⇒ **.1 Project charter** — The project charter provides the project team and stakeholders with the project’s top level information, that which we have called the five-line including the business need and justification, the success criteria, any constraints and assumptions, and
- ⇒ **.2 Project management plan** — The project management plan contains most of the critical information about what the project includes and what the resources are required to do. PMI® draws special attention to the quality management plan and scope baseline because the quality management plan informs the team about the level of resources required to achieve and maintain the core metrics defined, and the scope baseline defines the deliverables so the team understands the types and quantities of resources required to generate the correct work product.
- ⇒ **.3 Project documents** — The team may need to examine a lot of additional documents that are part of the “other” project documents. These include the all important project schedule, the requirements documentation, the risk register, and the stakeholder register. Each of these informs the project team about the work that must be accomplished and when it should be done.
- ⇒ **.4 Enterprise environmental factors** — Key enterprise environmental factors include the following:
 - ◇ The organizational structure and culture
 - ◇ Any existing resources
 - ◇ Existing human resource policies
 - ◇ Marketplace conditions
- ⇒ **.5 Organizational process assets** — Items such as organizational standards, policies, and standard role descriptions, as well as templates, organizational charts, and position descriptions, can all impact the development of the Human Resources Plan. Additionally, historical information can provide important information.

The tools and techniques used in the plan resources management process include the following:

- ⇒ **.1 Expert judgment** — You have already seen that expert judgment is almost always PMI’s preferred tool and technique. When dealing with resource management planning team leaders must be able to negotiate for the resources they need to successfully deliver the project. They also must have the experience to manage and develop people. One of the biggest problems real-world project managers face is either not understanding the organizational culture or estimates being based upon having more experienced resources than are actually assigned to the project. A true project management professional knows to avoid this issue.
- ⇒ **.2 Data representation** — Data representations represents visual methods of providing information in a way that allows the team to make effective use



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of it. When done correctly, these tools ensure that each work package is owned by someone who has not doubt they own the package and all the other resources understand their role with the package. PMI® lists three groups of tools within this area hierarchical charts, assignment matrices, and text-oriented formats.

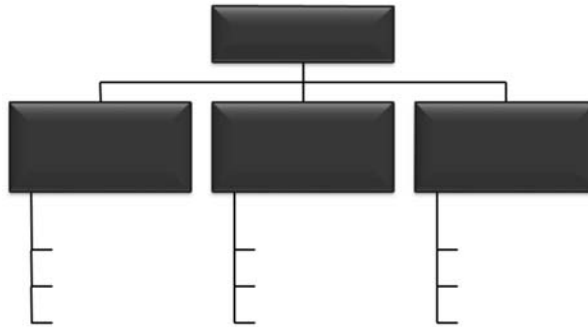


Image 90: A Sample Resource Breakdown Structure

Hierarchical charts are used to show each member of the team how they fit into the project organization.

Typically, these tools show a top-down view of the organization. Examples of this kind of image include work breakdown structures (WBS), organizational breakdown structures (OBS) or a resource breakdown structure (RBS). Image 90 shows resource breakdown structure. Notice that it presents a simple hierarchy of boxes or positions.

The second group of visual tools are called assignment matrices. Assignment matrices or RAMs bring together resources and work packages or activities which is different from hierarchical charts that either show work packages or resources but not typically both. A Responsibility Assignment Matrix (RAM) such as the one shown in Image 91. A common form of a RAM is a RACI diagram. The RACI acronym stands for Responsible, Accountable, Consult and Inform. It defines the role each resource has for each deliverable or activity.

Person \ Deliverables	Person						
	Sally	Bob	Jim	Kate	Fran	Cal	...
Feature 1	S	R	A	P	P		
Feature 2	S		A	P		P	
Feature 3	S		R	A	I		P
Feature 4		R	S	A		P	P
Feature 5			S	P	I	A	P

P = Participant A = Accountable R = Review Req'd I = Input Req'd S = Sign-off Req'd
RACI = Responsible, Accountable, Consult, Inform

Image 91: A Responsibility Assignment Matrix. Also, called a RACI diagram for Responsible, Accountable, Consult, Inform

The third group of items within data representation are text-oriented formats. These are typically verbal descriptions of the work to be done and the role for each team member.

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⇒ **.2 Organizational theory** — The area requiring the most study in the project resources management knowledge area is that of organizational theory. As you study these theories remember they are just theories. Many of them are contradictory and you do not necessarily have to agree with any of them. However, you must be able to compare and contrast the different theories.

- ◇ **Maslow's Hierarchy of Needs** — The first theory is Maslow's Hierarchy of Needs. Abraham Maslow argued in 1943 that people do not work for money or security. They work for something he called self-actualization. However, Maslow contended that one could not attain self-actualization until they had taken care of lesser needs. To explain these needs Maslow created a hierarchy with self-actualization at the top. *Image 88* shows Maslow's Hierarchy. At the bottom of the pyramid are the physiological needs such as air, water, food, housing and clothing. Once these needs are taken care of a person progresses to the next level, safety, and they must address those needs before continuing up the pyramid until reaching the top. A project manager must address these issues because the best workers are at the top of the pyramid.



Image 92: Maslow's Hierarchy of Needs

- ◇ **McGregor's Theory of X and Y** — Douglas McGregor proposed this theory in the 1960s while at the Sloan School of Business at MIT. McGregor argued people generally fall into one of two classes: X or Y. Group X represents people that need to be watched every minute and are incapable, avoid responsibility and avoid work whenever possible. These people you do not want as resources on your team. The second group are Y people. Y people represent the exact opposite. They are willing to work without supervision and want to achieve. Y people can direct their own efforts. As a project manager you want Y people as resources because they will make your job easier.



Image 93: X People You Don't Want



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Image 94: Y People You Do Want

◇ **Herzberg's Theory** — The next theory was proposed by Frederick Herzberg in 1959 and is also known as the Two Factor Theory of Job Satisfaction. According to his theory, people are influenced by two sets of factors: hygiene factors and motivating agents. Poor hygiene factors may destroy motivation but improving them, under most circumstances, will not improve motivation. *Image 91* shows examples of typical hygiene factors and motivating agents.

Motivator Factors	Hygiene Factors
<ul style="list-style-type: none"> •Achievement •Recognition •Work Itself •Responsibility •Promotion •Growth 	<ul style="list-style-type: none"> •Pay and Benefits •Company Policy and Administration •Relationships with co-workers •Supervision •Status •Job Security •Working Conditions •Personal life

Image 95: Hygiene Factors & Motivating Agents

◇ **Theory Z** — Theory Z was developed by William Ouchi in his 1981 book, *Theory Z: How American Business Can Meet the Japanese Challenge*. Theory Z is often referred to as the 'Japanese' management style. Theory Z essentially advocates a combination of all that's best about McGregor's XY Theory and modern Japanese management, which places a large amount of freedom and trust with workers, and assumes that workers have a strong loyalty and interest in teamwork and the organization. It also places more reliance on the attitude and responsibilities of the workers, whereas McGregor's XY Theory is mainly focused on management and motivation from the manager's and organization's perspective. Theory Z focuses on enabling workers to become generalists, rather than specialists to increase their knowledge of the company and its processes through job rotations and continual training.

◇ **McClelland Theory of Needs** — David McClelland proposed that an individual's specific needs are acquired over time and are shaped by one's life experiences. Most of these needs can be classed as either achievement, affiliation, or power. A person's motivation and effectiveness in certain job functions are influenced by these three needs. McClelland's theory sometimes is referred to as the three need theory or as the learned needs theory.

⇒ **.4 Meetings** — In addition to all the specific tools, a project manager must meet with the team and other stakeholders to ensure the human resource management plan reflects the true resources needs.



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Knowing the organizational theories and being able to compare and contrast them is critical to passing the exam. There are three outputs to this first resource management process. They include:

- ⇒ **.1 Resource management plan** — the resource management plan is the most important output from this process. It provide key guidance on how the team plans to categorize, allocate, manage and release resources on the project. When you think about the resource management plan it is important that you think practically about the different things it is designed to do. Most importantly, the resources management plan identifies the resources needed to complete the project. It also defines how the team intends to obtain the team and other physical resources necessary to complete the project. Many of these plans define the role, level of authority, specific responsibilities and required skills of the team members. Often the resource management plan includes organization charts or other visual tools to help in this definition. It also defines various strategies for training team members and developing the team as a cohesive unit.
- ⇒ **.2 Team charter** — Just as the project has a charter which defines the high level of the project, so too does the team itself. The team charter establishes the basic ground rules the team agrees to use to function as a collective unit. It includes the team’s values, agreements, and operational guidelines in areas such as communication, decision making, conflict resolution, and meetings.
- ⇒ **.3 Project document updates** — As part of planning the project resource management area, the team often discovers new information that requires them to update their assumption log or risk register because often resourcing a project involves making significant assumptions which are found to be untrue later in the process. As soon as the new information is discovered, regardless of area, the team must update the appropriate documents.

9.2 Estimate Activity Resources

The second process in the project resource management knowledge area is estimate activity resources. If you are at all familiar with the PMBOK® Guide you recognize this as a new process in the 6th edition of the Guide. However, it is not really new. The 5th edition of the Guide positioned the same process as the 4th process in the time management knowledge area (now called schedule management). This change is a nod to common sense organization as the process is all about defining the number and types of people, equipment and other supplies necessary to complete the work of the project. Remember, many of these processes are going on at the same time and/or directly relate to one and other even though they cross knowledge areas.

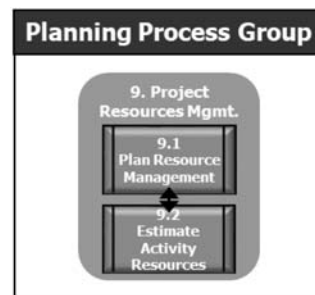


Image 96: Acquire Project Team

The estimate activity resources process begins by examining the primary inputs defining the deliverables and work of the project to ensure those defining resources clearly understand the stakeholders’ expectations. These inputs include:



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-
- ⇒ **.1 Project management plan** — Within the project management plan, the team must examine the resource management plan and the scope baseline. The first defines how the team plans to acquire, train and manage the project resources. The second define the agreed upon project work at that moment in time.
 - ⇒ **.2 Project documents** — Hopefully, the process of examining these processes is beginning to sound repetitive. That is because it is! Many of these processes look very much like one and other. With almost every process the team considered the project management plan and other project documents as key inputs. This process is no different. When working to estimate the required activity resources to complete the project the team must look at the list of activities, the activity attributes, assumption log, cost estimates, resource calendars, and the risk register to gain a full picture of project what is needed.
 - ⇒ **.3 Enterprise environmental factors** — If the team is using the tried and true why stop with just the project management plan and project documents? Enterprise environmental factors are always at play so they fit as an input here.
 - ⇒ **.4 Organizational process assets** — Most organizations have tools in place to assist the project leader in the definition and acquisition of resources. These tools often provide valuable inputs as the team attempts to define the required resources.

The tools and techniques used in this process are going to seem very familiar. That is because you used most of them just a few chapters prior when we discussed estimating costs. These include:

- ⇒ **.1 Expert judgment** — Just as we have seen in most other processes, the tool or technique is expert judgment. It is absolutely critical that project leaders trust their team and surround themselves with individuals who possess significant knowledge about the work of the project.
- ⇒ **Bottom-up estimating** — When combined with expert judgment, bottom-up estimating is PMI's preferred way of generating estimates of anything. This is because your subject matter experts have the most knowledge and are most likely to be accurate at the lowest or smallest unit of delivery.
- ⇒ **.3 Analogous estimating** — Early in the project's life cycle the team often lacks critical information to make a highly accurate estimate. In these situations the team still needs to generate an estimate knowing it will be refined later when more information becomes available. In these situations, analogous estimates are often preferred. An analogous estimate uses the actual results from a previous, similar project to estimate the current one in question.
- ⇒ **.4 Parametric estimating** — Parametric estimating involves generating an estimate using a mathematical model. A simple example might involves estimating the number of developers on a software project based on the total



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number of modules and an estimate of the total number of lines of code assuming an average coding rate. These models can be highly accurate, but are subject to the accuracy of the equation. If the equation fails to accurately define the situation the estimate can vary wildly from actuals.

- ⇒ **.5 Data analysis** — When examining the data the team must carefully examine potential alternatives to find the optimal resourcing solution.
- ⇒ **.6 Project management information system** — Many project management software solutions offer advanced calculations for generating resource estimates. These solutions often dramatically simplify the job of the project leader.
- ⇒ **.7 Meetings** — In addition to all the other tools and techniques described here, the team will also have to conduct a number of meetings to obtain accurate estimates. Like expert judgment, enterprise environmental factors, organizational process assets, meetings are a constant for a good project leader.

There are four basic outputs to the estimate activity resources process. Three of these outputs are closely linked.

- ⇒ **.1 Resource requirements** — This output is the big one. Hopefully, it is also incredibly obvious. The biggest thing you get by estimating activity resources is a list of your resource requirements. This list identifies the kinds and quantities of resources needed to complete each work package. It might also include any assumptions made to create the estimates.
- ⇒ **.2 Basis of estimates** — The basis estimates provides the supporting detail for the resource requirements. This information includes how the estimate was derived, resources used to develop the estimate, any assumptions associated with the estimation process, the estimate range and confidence level, and any documentation of risks that influenced the estimate.
- ⇒ **.3 Resource breakdown structure** — As has previously been discussed, the resource breakdown structure is a hierarchical picture of the project team organized by resource category and type. The most common categories seen are labor, materials, equipment, and supplies, but these are not the only allowed categories.
- ⇒ **.4 Project document updates** — Like many of our earlier processes, the process of estimating the activity resources will likely generate a lot of new information requiring the team to update a number of project documents such as the activity attributes, assumption log, and/or the lessons learned register.

9.3 Acquire Resources

The third process in the project resources knowledge area moves away from the planning process group into the executing process group. This process focuses on obtaining the people needed to complete the project. PMI® does not assume the project manager has control over these resources. It assumes you are in some

form of a matrix organization. To gain a better understanding let's review the inputs for the acquire resources process now. They include the following:

- ⇒ **.1 Project management plan** — The project management plan provides the team with the just created resource management plan the cost baseline, and the procurement management plan which combine to inform the project team about what they need in terms of resources to deliver the project and the processes they must use to obtain those resources.
- ⇒ **.2 Project documents** — In addition to the resource and procurement management plans, the team needs to examine the project schedule, resource calendars, resource requirements, and stakeholder register to fully understand the project needs.
- ⇒ **.3 Enterprise environmental factors** — These are the factors outside the actual team that can influence how the team is obtained, trained and managed. It includes factors such as market conditions, culture, technology, and many others.
- ⇒ **.4 Organizational process assets** — A good project manager makes use of every tool they have at their disposal to obtain the best possible team. This includes every process, template, document, contract, or other item within the organization's cache of tools.

The tools and techniques used in the acquire resources process are as follows:

- ⇒ **.1 Decision making** — In this process, the project leader is required to examine all the data a make the best possible decision. A common type of decision making tool is the multicriteria decision analysis we have discussed earlier in this course.
- ⇒ **.2 Interpersonal and team skills** — Successful project managers are typically outstanding negotiators because rarely does a team get everything they need. Often it is up to the project manager to barter, reduce the price, or in some other way negotiate for necessary resources. Therefore, a leader's ability to engage others is critical to success.
- ⇒ **.3 Pre-assignment** — Often project leaders begin a project with resources already assigned to the team. These resources are said to be pre-assigned.
- ⇒ **.4 Virtual teams** — Many projects are not capable of being completed with a team that is co-located (meaning sitting at the same location). When this happens the project must be done using communication techniques such as e-mail, phone calls and webinars.

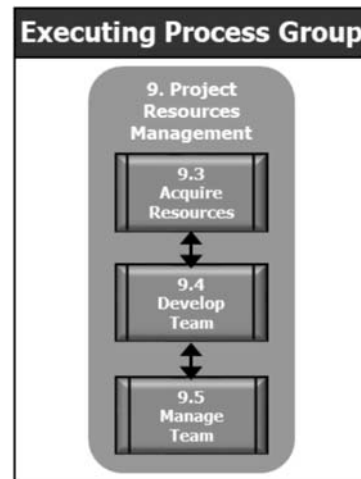


Image 97: Develop Project Team



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When dealing with team members you must also be aware of the halo effect. The **halo effect** is the tendency to rate team members high or low on all factors due to the impression of a high or low rating on one particular factor.

The outputs to the acquire resources process include the following:

- ⇒ **.1 Physical resource assignments** — Physical resources represent the equipment, supplies and materials the team needs to deliver the project. When appropriate, it can also represent the physical locations.
- ⇒ **.2 Project team assignments** — The project is considered “staffed” when appropriate people have been assigned to the project, which can include a project team directory, memos to team members, and/or resource names inserted into the project plan.
- ⇒ **.3 Resource calendars** — Resource calendars document when each resource is available to work on the project.
- ⇒ **.4 Change requests** — As the team acquires the resources it needs to deliver the project many factors surrounding the project can change. This output allows the team to recognize the new information and run the change through the change management process.
- ⇒ **.5 Project management plan updates** — Specifically, acquiring the project team might require the updating of the resource management plan or the cost baseline.
- ⇒ **.6 Project documents updates** — As resources are applied to the project a lot can change. Therefore, teams might have to update the lessons learned register, the project schedule, the resource breakdown structure, resource requirements, risk register, and/or the stakeholder register to account for those changes.
- ⇒ **.7 Enterprise environmental factors updates** — This is the first time you have seen updates to the enterprise environmental factors, but stop and think. Your project could easily impact resource availability within the organization and/or the amount of material resources the organization has on hand.
- ⇒ **.8 Organizational process assets updates** — Just as your project likely impacts the enterprise environmental factors, you also may impact organizational process assets.

9.4 Develop Team

Once the team is acquired, the next step in the resource management knowledge area is to develop the team so they have the necessary skills to complete the project successfully. A key goal of the project manager is to improve skills, team interaction, and overall team environment. In any project, teamwork is a critical factor for success. Team development is a project manager’s responsibility. The develop team process is a relatively straightforward process focused on the different ways to develop skills and teamwork.



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The inputs to the develop team process include the following:

- ⇒ **.1 Project management plan** — Within the project management plan the resource management plan defines all the rules and processes to obtain, manage and train the team.
- ⇒ **.2 Project documents** — Within the project documents there are a number of documents to help develop the team grow and develop. These include the lessons learned register, the project schedule, the project team assignments, resource calendars, and the team's charter. Each of these documents help the project leader understand who is on the team, their role, what they need to do, and what they already know.
- ⇒ **.3 Enterprise environmental factors** — The organization often has human resources policies. Performance reviews and reward and recognition already in place that will impact the team's ability to develop.
- ⇒ **.4 Organizational process assets** — The organizational process assets that can quickly impact the team as it develops is any historical relationships and the lessons learned repository.

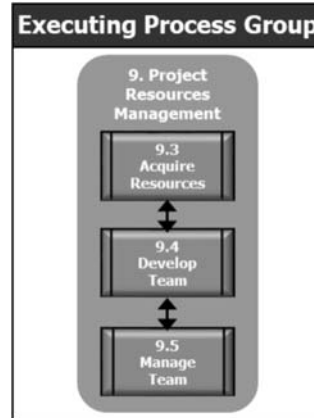


Image 98: Develop Team

The tools and techniques used in the develop team process include the following:

- ⇒ **.1 Colocation** — This is the second time the term colocation has been used. PMI® recognizes that teams are more effective when everyone is able to sit at the same location. Unfortunately, this is not always realistic. Many of the agile methods suggest colocation is an imperative, but again, it is not always possible. In those situations, the team may need to look to the second tool on the list.
- ⇒ **.2 Virtual teams** — When it is not possible to have the team physically sit in the same physical location modern technology makes virtual teams possible. The use of virtual teams can often allow projects to bring additional specialized resources to the team that would not be available if it was required that all team members be collocated.
- ⇒ **.3 Communication technology** — The ability to quickly use internet technology to video conference in an entire team, share a presentation, team board or other information radiator makes the demand that a team be collocated less stringent than in the past.
- ⇒ **.4 Interpersonal and team skills** — Interpersonal and team skills are those skills used to relate with people and engage with them on a one-on-one basis or in small groups. Remember, teamwork is critical to the success of the project, and no tool is more important to developing good teamwork than interpersonal skills. PMI® groups five specific tools and techniques in this area:



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- ◇ **Conflict management** — A conflict represents a difference of opinion between two or more parties. Within a project conflicts are common, and can occur between team members, stakeholders and team members, or between the project manager and any of the above. The fact that conflict exists does not in and of itself represent a negative. However, how the people experiencing the conflict choose to deal with the issue can dramatically impact the likelihood of project success. *Image 99* shows a table with the most common conflict resolutions modes or methods. Each of them is described by a style which addresses the interaction and two areas of concern. Personal goals addresses how interested the individual selecting the mode is toward their objective. The relationship addresses how much the individual cares about the relationship with the other party involved in the conflict.

Resolution		Concern	
Mode	Style	Personal Goals	Relationship
Withdrawal	Lose—Leave	Low	Low
Smoothing	Yield—Lose	Low	High
Compromising	Compromise	Medium	Medium
Forcing	Win — Lose	High	Low
Problem Solving (Confronting)	Integrative	High	High

Image 99: The Conflict Resolution Modes & Their Impacts

As you review the table, keep in mind that a number of factors can influence the resolution of the conflict including its importance, any time pressure, and the relative power of the players.

- ◇ **Influencing** — PMI® does not ever assume that the project manager has full or direct authority over the project. Without that level of authority, a project leader must rely on the ability to influence stakeholders at all levels of the organization to ensure project success.
- ◇ **Motivation** — Motivation represents providing a reason for someone to act. Most teams are motivated by being empowered to plan and manage their own work. This is a core aspect of agile methods.
- ◇ **Negotiating** — Negotiating has already been discussed extensively.
- ◇ **Team building** — Team building is the responsibility of the project leader. It is the process of leading activities that enhance the team's social relations and build an environment where people want to work together. It leads to higher degrees of cooperation and collaboration. Every day, the successful project leader must do something to increase the levels of team effectiveness.



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- ⇒ **.5 Recognition and rewards** — PMI® does not assume the project leader has unlimited resources to develop rewards and recognition for the project team, but it does suggest having them is critical to success and it is your responsibility that they happen.
- ⇒ **.6 Training** — Training refers to activities that lead the overall improvement of skills for the team. Over the last several years how training is done has changed dramatically. Now, a significant portion of training is done using the internet as the delivery vehicle.
- ⇒ **.7 Individual and team assessments** — Individual and team assessments or evaluations represent methods used to determine what the team does well and what it does not. There are a wide range of these tools available to the team. Typically, these assessments are looking for major areas of improvement often in topics dealing with social interaction. An example of a team assessment is found in the Table Group's Five Dysfunctions of a Team Assessment based on Patrick Lencioni's best selling book of the same title.

Best selling author Patrick Lencioni is often cited by Agilists to describe common dysfunctions experienced by even the best team. Lencioni identified five specific but all too common dysfunctions. All teams have the potential to become dysfunctional because they are made up of people whose needs must be met. Understanding what the potential dysfunctions are and how to overcome them are critical to the success of any team.



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Image 100: Lencioni's Five Dysfunctions of a Team

Absence of Trust

Trust is the real foundation of team structure. Often team members don't feel comfortable enough with the other members to fully disclose or share information that is needed for the team to succeed. Common indicators that your team is struggling with an absence of trust include:

- ◇ Concealing weaknesses and/or mistakes
- ◇ Not asking for help or providing constructive criticism
- ◇ Not offering to help other team members outside their own areas
- ◇ Quickly jumping to conclusions



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- ◇ Failing to recognize others' capabilities
- ◇ Holding grudges from previous meetings/projects
- ◇ Dreading meetings and finding reasons to avoid each other

If you identify that you have an absence of trust within your team, here are some tools for getting the team back on track:

- ◇ **Personal Histories Exercise** — Have each team member review what they did prior to becoming part of this team. This will allow everyone to better understand the strengths of each member.
- ◇ **Team Effectiveness Exercise** — Use team building exercises to allow each member to gain personal and team insight to how they act in the team setting.
- ◇ **Personality and Behavioral Preferences Profiles** — Team Dimensions Profile
- ◇ **360 Degree Feedback** — Reviews by team members, managers and subordinates on your performance. This will provide team members with valuable information about their performance.

These exercises and activities will not be the panacea for the problem, rather the first step for the team to recognize problems and realize that they all need to work toward resolving the team's trust issue.

Absence of Conflict

Team members are surrounded by conflict from other team members and stakeholders because of the varying points of view that naturally exist throughout a project. Not all conflicts are bad. On the contrary, constructive conflicts can allow the team to identify issues, solutions and potential problems within the project. It is important that the entire team recognize conflict as a potentially beneficial thing. If your team often suffers from any of the following you likely have an absence of conflict:

- ◇ Boring meetings.
- ◇ Back channel politics.
- ◇ Personal attacks.
- ◇ Ignoring controversial topics that are critical.
- ◇ Opinions and perspectives of all team members are not heard or are silenced.
- ◇ Lots of posturing and interpersonal risk management.

To be able to deal with the fear of conflict try the following techniques:

- ◇ **Conflict Mining** — Create situations within the meeting to make the conflicts come into the conversation and force people to talk about them.
- ◇ **Real Time Permission** — You must have a culture where it is acceptable to have a difference of opinion and your people must be willing to express those opinions.
- ◇ **Thomas-Kilmann Conflict Mode Instrument (TKI)** — This tool is similar to a personality test but brings out conflict in a very thought-provoking way for the team to discuss.



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Lack of Commitment

The third major dysfunction of a team is a lack of commitment. When an organization suffers from a lack of commitment they rarely stick with difficult decisions or find it impossible to make the decisions necessary to ensure project success. Often these issues create exponentially increasing problems as project resources become more and more frustrated. Each of the following represent telltale signs of a lack of commitment within an organization:

- ◇ Ambiguity about direction and priorities.
- ◇ Paralysis by analysis.
- ◇ Lack of confidence and fear of failure.
- ◇ Revisiting discussions and decisions repeatedly.
- ◇ Second guessing amongst the team.

If you identify that you have a commitment issue within your team or organization, implement the following:

- ◇ **Cascading Messaging** — Ensure messaging flows from the top of the organization. Senior management must have belief in their ideas and set a consistent direction for the organization.
- ◇ **Deadlines** — Set deadlines and make everyone live up to them.
- ◇ **Contingency and Worst-case Analysis** — Make sure you have contingency plans in place and conduct a worst-case analysis of all plans to ensure that you and the team can deal with it.
- ◇ **Low-risk Exposure Therapy** — Identify the risk exposure tolerances within the organization and your team.

Avoidance of Accountability

Without committing to a clear plan of action, even the most focused and driven team members will hesitate to call out actions and behaviors that seem counterproductive to the good of the project and organization. Members will hold deep seeded resentment for team members that fail to live up to their standards, although they may say nothing. The avoidance of accountability is exemplified by the following indicators:

- ◇ Resentment among team members of different performance standards.
- ◇ Encouraged mediocrity.
- ◇ Missed deadlines and key deliverables.
- ◇ Team leader is the sole source of discipline.

If you identify that you have an accountability issue within your team or organization, implement the following:

- ◇ Publish goals and standards for all team members.
- ◇ Simple and regular progress reviews.
- ◇ Team rewards.



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Inattention to Results

Inattention to results occurs when team members put their individual needs (such as ego, career development, or recognition) above the collective goals of the team. This will cause the team to fail to meet most, if not all, of the original objectives of the project. Inattention to results can be indicated by any of the following:

- ◇ Team stagnates and fails to grow.
- ◇ The organization rarely defeats a competitor.
- ◇ Loses achievement-oriented employees.
- ◇ Team members encouraged to focus on their own goals.
- ◇ Easily distracted.

If you identify that you have an inattention to results issue within your team or organization, implement the following:

- ◇ Public declaration of results
- ◇ Results-based rewards

⇒ **.8 Meetings** — Meetings are still the constant tool of the project leader regardless of how much things change. You must always consider them something available as a core tool.

The outputs from the develop team process include the following:

- ⇒ **.1 Team performance assessments** — The team performance assessments include how well the team is doing on assigned work, where knowledge gaps exist, and how the team is functioning as a unit. Specific measures might be reduced staff-turnover rates or improvements in assessed skills.
- ⇒ **.2 Change requests** — Going through the process of developing your team often causes you to learn things about the project. When this happens the team must follow its own change management process or no one else will either.
- ⇒ **.3 Project management plan updates** — Just as going through the process of developing the team can cause changes, it can also cause updates to the project management plan. Specifically, this process can change the resource management plan.
- ⇒ **.4 Project document updates** — The process of developing your team can also cause updates to documents outside the project management plan. These documents include: the lessons learned register, the project schedule, project team assignments, resource calendars, and the team charter.
- ⇒ **.5 Enterprise environmental factors updates** — As the project progresses, the environment is likely to change. It is important the project manager recognizes the changes and adapts the organization as required. Specific environmental factors that might be updated include things such as employee training records and/or skills assessments.



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- ⇒ **.6 Organizational process assets updates** — This process can cause updates to your teams training requirements and personnel assessments.

9.5 Manage Project Team

The manage team process is the last process found in the resources management knowledge area. It is slightly more difficult than the last process because it does have some theories and concepts which require memorization. However, it is significantly easier than many of the topics found in cost, time, or other areas of the PMBOK® Guide. The manage team process is all about tracking team member performance, providing feedback, resolving issues, and coordinating changes to enhance project performance.

The inputs to the manage team process include the following:

- ⇒ **.1 Project management plan** — Specifically within the project management plan is the resource management plan which provides the core rules and processes used to obtain, manage and develop members of the project team.
- ⇒ **.2 Project documents** — The additional project documents the project leader uses to manage the team include the issue log, the lessons learned register, the project team assignments, and the team charter.
- ⇒ **.3 Work performance reports** — The performance reports tell the project manager what has been accomplished and how you are doing in terms of schedule and cost performance.
- ⇒ **.4 Team performance assessments** — How is the team doing in terms of their cooperation? The team performance assessments provide this information.
- ⇒ **.5 Enterprise environmental factors** — The leader must consider the human resource management policies of the organization which are outside both the project management plan and project documents.
- ⇒ **.6 Organizational process assets** — Many organizations have existing certificates of appreciation, corporate apparel and other gifts. These are often referred to as “swag”. The formal name for these items is perquisites, but they are also called fringe benefits, or perks.

The tools and techniques provide most of the detail in this process. The tools and techniques used in the manage team process include the following:

- ⇒ **.1 Conflict management** — PMI® uses a somewhat unique definition of conflict. To PMI®, a conflict is simply a disagreement between two parties. The existence of a conflict is not seen as a negative. How the conflict is

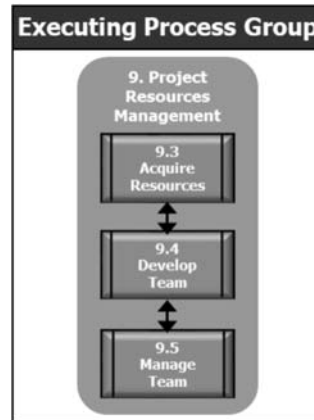


Image 101: The Manage Team Process



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resolved defines whether it is positive or negative. There are five approaches possible to resolving a conflict. These are referred to as conflict resolution modes. They are as follows:

- **Withdraw / avoid** — Often referred to as the ostrich approach. This approach only offers temporary resolution to the conflict because it represents a situation where one party refuses to engage the other about the conflict. Of course, this resolves nothing but the immediate confrontation. This is only a temporary solution!
- **Smoothing / accommodating** — Smoothing, or the kumbaya approach, is also a temporary solution to conflict. In this approach both parties engage each other and make each other feel better, but they refuse to discuss the issue which caused the conflict. In this resolution mode, the person smoothing cares a lot about the other party but does not care about the issue.
- **Compromise / reconcile** — Compromise is the first conflict resolution mode that provides a permanent solution. However, it is also considered suboptimal because compromise is all about both parties finding the solution with which they can live. They are not interested in finding the best solution. Therefore neither party is totally satisfied. The two parties care a medium amount for the other party and a medium amount about the issue.
- **Force / direct** — When someone uses forcing to resolve a conflict they make the other party accept their solution to the issue. In this mode the person doing the forcing has a high regard for the issue but a low regard for the other party.
- **Collaborate / problem solve** — Problem solving is also referred to as confronting and is the preferred mode to resolve any conflict. When problem solving, both parties have a high regard for each other and for the issue being discussed. The parties are more concerned over finding the correct solution rather than just having their solution.

Each of these problem solving techniques is shown in the table represented in *Image 102*. This is the same table shown earlier in this chapter.

Resolution		Concern	
Mode	Style	Personal Goals	Relationship
Withdrawal	Lose—Leave	Low	Low
Smoothing	Yield—Lose	Low	High
Compromising	Compromise	Medium	Medium
Forcing	Win — Lose	High	Low
Problem Solving (Confronting)	Integrative	High	High

Image 102: The Conflict Resolution Modes & Their Impacts

- ⇒ **Decision making** — PMI® never assumes the project leader has total control over the project. In fact, PMI® actually makes the exact opposite assumption that the project leader will lack the autonomy to make major decisions without assistance from others. Therefore, PMI® suggests project leaders must negotiate and influence the organization to deliver the desired project results.
- ⇒ **Emotional intelligence** — Emotional intelligence is the ability to identify and manage your own emotions and the emotions of others. Most scholars however, take the definition further. They argue that it requires people to discriminate between different emotions and label them appropriately and to use emotional information to guide thinking and behavior. Further, it also reflects the ability to combined intelligence, empathy, and emotions to enhance one’s thought and understanding of interpersonal dynamics. It is generally said to include three skills:
- ◇ Emotional awareness, including the ability to identify your own emotions and those of others;
 - ◇ The ability to harness emotions and apply them to tasks like thinking and problems solving;
 - ◇ The ability to manage emotions, including the ability to regulate your own emotions, and the ability to cheer up or calm down another person.

Although there is general agreement on this definition significant disagreement exists with regard to EI terminology and operationalizations.

The term first gained prominence in 1995 when Daniel Goleman released his book entitled Emotional Intelligence. However, this was not the first time the term was used. In 1964, Michael Beldoch used the term in a scholarly paper as did N. Leuner in 1966. The first significant use of the term came in Wayne Payne’s 1985 doctoral thesis. Central to the themes we now consider key to EI was Howard Gardner’s 1983 *Frames of Mind: The Theory of Multiple Intelligences* that introduced the idea that traditional types of intelligence, such as IQ, fail to fully explain cognitive ability. He introduced



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the idea of multiple intelligences which included both interpersonal intelligence (the capacity to understand the intentions, motivations and desires of other people) and intrapersonal intelligence (the capacity to understand oneself, to appreciate one's feelings, fears and motivations). In 1989 Stanley Geenspan put forward another model to describe EI and was followed by Peter Salovey and John Mayer later that year. All of this simply points to the fact that significant scholarly research was done on the topic before Goleman, but it was his work that became a best seller and hence popularized the term.

All of this research has led to several models have appearing each with a slightly different take on the basic themes. Repeated studies have shown that people with high emotional intelligence have greater mental health, exemplary job performance, and more potent leadership skills. For example, Goleman's research in his book, *Working with Emotional Intelligence*, indicated that EI accounted for 67% of the abilities deemed necessary for superior performance in leaders, and mattered twice as much as technical expertise or IQ. Other research finds that the effect of EI on leadership and managerial performance is non-significant when ability and personality are controlled for, and that general intelligence correlates very closely with leadership. Markers of EI and methods of developing it have become more widely coveted in the past few decades. In addition, studies have begun to provide evidence to help characterize the neural mechanisms of emotional intelligence.

The different models of emotional intelligence has led to a significant industry in the construction and application of EI assessments. Most researchers who examine these different instruments agree that the differences can be significant.

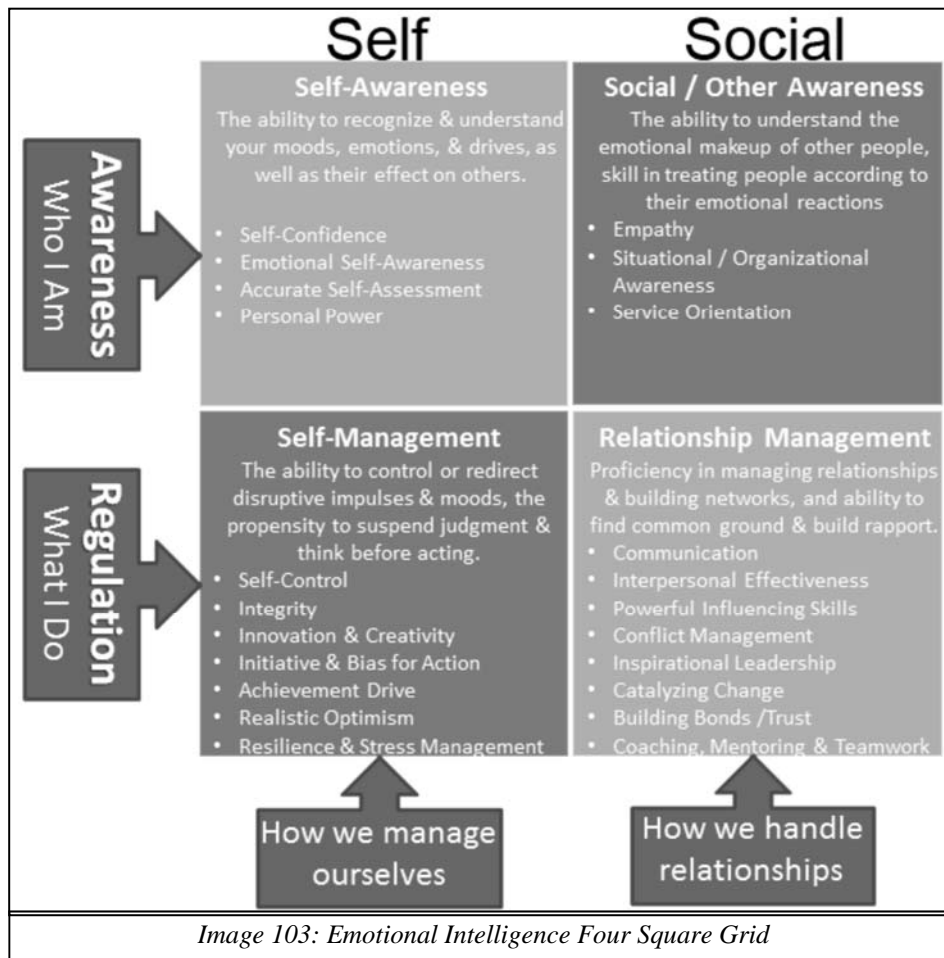
Criticism of emotional intelligence centers on whether EI is a real intelligence and whether it has incremental validity over IQ and the Big Five personality traits. Several scholarly reviews of the research supporting emotional intelligence argue that, in most studies, poor research methodology has exaggerated the significance of EI. This criticism has not slowed the significant use of EI in the workplace as an attempt to created higher functioning leaders.

For the exam, it is important that you understand the basic concepts of EI and some of the fundamentals surrounding the three main models that exist.

- ◇ Ability Model
- ◇ Mixed Model
- ◇ Trait Model

Before describing the three models, it is important that you gain a solid understanding of the underpinnings of the concept.

The easiest way to understand emotional intelligence for most people is to



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focus on the Goleman model and think about a four-square grid. At the top of the grid are the two column headings, self and social. Self describes how we manage ourselves while social describes how we handle relationships. The two rows represent recognition or who the individual is, and regulation or what the individual does with respect to both themselves and others. The first quadrant is self-awareness. This quadrant represents a person's ability to recognize and understand your moods, emotions and drives as well as their effect on others. Leaders who are self-aware display self-confidence as well as a strong sense of emotional self-awareness. They also display the ability to accurately assess themselves. Those around the self-aware leader has significant personal power.

The other quadrant that appears in the top row of the image is the social or other awareness. This is the ability to understand the emotional makeup of other people, and represents a skill in treating others according to their individual emotional reactions. It is highlighted by empathy and both a situational awareness that is combined with a clear understanding of the organization and a strong service orientation. These two quadrants define who the individual truly is according to emotional intelligence believers.

The bottom row of the grid represents regulation or management. It combines with both the self and others to define how we choose to manage ourselves and how we handle relationships. It begins with the quadrant Self-Management. This quadrant is about the ability to control or redirect disruptive impulses and moods. It is the propensity to suspend judgment and think before acting. There are a number of characteristics that highlight the exercise of self-management. They include, most importantly, self-control or the ability to control one's own actions and prevent disruptive impulses from turning into action. Self-management also requires integrity, innovation and creativity. Leaders who possess strong self-management tend to take the initiative while displaying a bias towards action. Their achievement drive and high level of realistic optimism combines with a high degree of resilience and stress management.

The final quadrant is relationship management. Proficiency in managing relationships and building networks is key to relationship management. It requires the leader to possess the ability to find common group and build rapport with their team and the rest of the organization. There are a large number of characteristics that define a leader strong in relationship management. Skills such as communication, effectiveness with interpersonal relationships, the ability to influence others, manage conflicts, and inspire others combine with the ability to catalyze the organization for change, build bonds with others in the organization through trust while providing coaching and mentoring in a team-based environment.

Salovey and Mayer created the ability-based emotional intelligence model. This model attempts to define EI within the boundaries of the standard criteria for a new intelligence. Based on their research, they redefined EI as, "The ability to perceive emotion, integrate emotion to facilitate thought, understand emotions and to regulate emotions to promote personal growth." However, after pursuing further research, they again revised the definition to, "the capacity to reason about emotions, and of emotions, to enhance thinking. It includes the abilities to accurately perceive emotions, to access and generate emotions so as to assist thought, to understand emotions and emotional knowledge, and to reflectively regulate emotions so as to promote emotional and intellectual growth."

The ability-based model views emotions as useful sources of information that help one to make sense of and navigate the social environment. The model proposes that individuals vary in their ability to process information of an emotional nature and in their ability to relate emotional processing to a wider cognition. This ability is seen to manifest itself in certain adaptive behaviors. The model claims that EI includes four types of abilities:

- ◇ **Perceiving Emotions** — the ability to detect and decipher emotions in faces, pictures, voices, and cultural artifacts—including the ability to identify one's own emotions. Perceiving emotions represents a basic aspect of emotional intelligence, as it makes all other processing of emotional information possible.



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- ◇ **Using Emotions** — the ability to harness emotions to facilitate various cognitive activities, such as thinking and problem solving. The emotionally intelligent person can capitalize fully upon his or her changing moods in order to best fit the task at hand.
- ◇ **Understanding Emotions** — the ability to comprehend emotion language and to appreciate complicated relationships among emotions. For example, understanding emotions encompasses the ability to be sensitive to slight variations between emotions, and the ability to recognize and describe how emotions evolve over time.
- ◇ **Managing Emotions** — the ability to regulate emotions in both ourselves and in others. Therefore, the emotionally intelligent person can harness emotions, even negative ones, and manage them to achieve intended goals.

The current measure of Mayer and Salovey's model of EI, the Mayer-Salovey-Caruso Emotional Intelligence Test, or MSCEIT, is based on a series of emotion-based problem-solving items. Consistent with the model's claim of EI as a type of intelligence, the test is modeled on ability-based IQ tests. By testing a person's abilities on each of the four branches of emotional intelligence, it generates scores for each of the branches as well as a total score.

Central to the four-branch model is the idea that EI requires attunement to social norms. Therefore, the MSCEIT is scored in a consensus fashion, with higher scores indicating higher overlap between an individual's answers and those provided by a worldwide sample of respondents. The MSCEIT can also be expert-scored, so that the amount of overlap is calculated between an individual's answers and those provided by a group of 21 emotion researchers.

Although promoted as an ability test, the MSCEIT is unlike standard IQ tests in that its items do not have objectively correct responses. Among other challenges, the consensus scoring criterion means that it is impossible to create items (questions) that only a minority of respondents can solve, because, by definition, responses are deemed emotionally "intelligent" only if the majority of the sample has endorsed them. This and other similar problems have led some cognitive ability experts to question the definition of EI as a genuine intelligence.

The model introduced by Daniel Goleman focuses on EI as a wide array of competencies and skills that drive leadership performance. This concept is key to the Agilist, and is the model you should spend the most time coming to know. Goleman's model outlines five main EI constructs. If after reading through this discussion you still have questions refer to "What Makes A Leader" by Daniel Goleman, best of Harvard Business Review, 1998. These five areas include:

- ◇ **Self-Awareness** — the ability to know one's emotions, strengths, weaknesses, drives, values and goals and recognize their impact on others while using gut feelings to guide decisions.



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- ◇ **Self-Regulation** — involves controlling or redirecting one's disruptive emotions and impulses and adapting to changing circumstances.
- ◇ **Social Skill** — managing relationships to move people in the desired direction.
- ◇ **Empathy** — considering other people's feelings especially when making decision.
- ◇ **Motivation** — being driven to achieve for the sake of achievement.

Goleman includes a set of emotional competencies within each construct of EI. Emotional competencies are not innate talents, but rather learned capabilities that must be worked on and can be developed to achieve outstanding performance. Goleman posits that individuals are born with a general emotional intelligence that determines their potential for learning emotional competencies.

Two measurement tools are based on the Goleman model:

- ◇ **The Emotional Competency Inventory or ECI** — The ECI was created in 1999, and the Emotional and Social Competency Inventory (ESCI), a newer edition of the ECI was developed in 2007. The Emotional and Social Competency - University Edition (ESCI-U) is also available. These tools developed by Goleman and Boyatzis provide a behavioral measure of the Emotional and Social competencies.
- ◇ **The Emotional Intelligence Appraisal or EIA** — The EIA created in 2001 and can be taken as a self-report or 360-degree assessment.

The third model of Emotional Intelligence is the Trait Model. Konstantinos Vasilis Petrides proposed a conceptual distinction between the ability based model and a trait based model of EI and has been developing the latter over many years in numerous publications. Trait EI is "a constellation of emotional self-perceptions located at the lower levels of personality". In lay terms, Trait EI refers to an individual's self-perceptions of their emotional abilities. This definition of EI encompasses behavioral dispositions and self-perceived abilities and is measured by self-reporting, as opposed to the ability based model which refers to actual abilities, which have proven highly resistant to scientific measurement. Trait EI should be investigated within a personality framework. An alternative label for the same construct is trait emotional self-efficacy. The trait EI model is general and subsumes the Goleman model.

There are many self-report measures of Emotional Intelligence used for the Trait Model, including the EQ-i, the Swinburne University Emotional Intelligence Test (SUEIT), and the Schutte EI model. None of these assess intelligence, abilities, or skills, but rather, they are limited measures of trait emotional intelligence. One of the more comprehensive and widely researched measures of this construct is the Trait Emotional Intelligence Questionnaire (TEIQue), which was specifically designed to measure the construct comprehensively and is available in many languages.



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Although Emotional Intelligence is extremely popular within the Agile Community and several others not everyone supports its theories. Mayer, Roberts and Barsade in 2008 criticized Goleman's model as nothing more than "pop Psychology". The ability EI model has also been criticized in the research for lacking face and predictive validity in the workplace. However, in terms of construct validity, ability EI tests have great advantage over self-report scales of EI because they compare individual maximal performance to standard performance scales and do not rely on individuals' endorsement of descriptive statements about themselves.

- ⇒ **Influencing** — Influencing represents the ability to impact others with over whom you have no power or authority. Influencing requires the ability to persuade by articulating positions and ideas along with strong listening skills. The successful project leader will be aware of and consider a wide range of perspectives as they gather relevant information to address issues and reach agreements. When successful, the influential leader will build a team based on mutual trust.
- ⇒ **Leadership** — Leadership represents the ability to drive and inspire a team to do their jobs well. It is a skill that is often difficult to pinpoint, but most know it when they see it. There are a wide range of leadership theories that you need to know for the exam, and this is an important skill to study.

There are several potential leadership styles including:

- ◇ **Autocratic** – They solicit little or no informational input from their group and make managerial decisions solely by themselves.
- ◇ **Consultative Autocratic** – Intensive information input is solicited, but these leaders keep all substantive decision-making authority to themselves.
- ◇ **Consensus Manager** – They throw open the problem to the group and encourage the entire team to make the relevant decision.
- ◇ **Shareholder Manager** – (Poor Management) Little or no information input and exchange takes place within the group context, yet the group is provided the authority for the final decision.

There are also conflicting ideas about which leadership style is best. PMI® does not define a "best" style. However, two theories need to be reviewed for the exam. The first theory is the **leadership contingency model** by Fielder. Fiedler's contingency model postulates that the leader's effectiveness is based on 'situational contingency' which is a result of interaction of two factors: leadership style and situational favorableness. It argues leadership is a function of having the leader's style aligned with the situation because there is no perfect leader. In this model leadership is dependent on several key variables including: the team leader versus team member relations, the degree of task structure, and the position of power of the leader. The second major theory is the **situational leadership theory**. The situational leadership theory is a leadership theory developed by Paul



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Hersey and Ken Blanchard. The Theory was first introduced as "Life Cycle Theory of Leadership". The theory holds there is no single "best" style of leadership. Effective leadership is task-relevant and that the most successful leaders are those that adapt their leadership style to the maturity of the individual or group they are attempting to lead/influence, and that effective leadership varies, not only with the person or group that is being influenced, but it will also depend on the task, job or function that needs to be accomplished. Within this theory there are four styles of leadership:

- ◇ **Telling** — is characterized by one-way communication in which the leader defines the roles of the individual or group and provides the what, how, why, when, and where to do the task.
- ◇ **Selling** — while the leader is still providing the direction, he or she is now using two-way communication and providing the socio-emotional support that will allow the individual or group being influenced to buy into the process.
- ◇ **Participating** — this is now shared decision making about aspects of how the task is accomplished and the leader is providing less task behaviors while maintaining high relationship behavior.
- ◇ **Delegating** — the leader is still involved in decisions; however, the process and responsibility has been passed to the individual or group. The leader stays involved to monitor progress.

How a leader gets their power is also important. There are several sources of power you must know to prepare for the exam. These sources are not exclusive. Meaning the total power possessed by any leader is a combination of the power provided and is defined by the equation below.

Total Power = Positional + Personal Power

The specific types of power include:

- ◇ **Legitimate** — Legitimate power is derived from the individual's position in the organization. It is sometimes referred to as formal authority or power.
- ◇ **Coercive** — Coercive power is based upon intimidation. It can be physical, emotional or most commonly based on the ability to impact one's job security. It is predicated on fear.
- ◇ **Reward** — Involves positive reinforcement for desired behavior. One of the simplest examples is Pavlov's dog experiment. Every time a bell was rung the dog got fed. Eventually the dog began salivating at the ringing of the bell. People will often act the same way. You can condition resources to respond in a desired fashion with positive reinforcement.



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- ◇ **Expert** — When using expert power a leader will attempt to get resources to act in a desired way because the leader has some special skill or knowledge and the resource wants to impress the leader.
- ◇ **Referent** — When using referent power a leader gains authority based upon who they know or with whom they are associated. A simple example is when the project leader is friends with the company president.

Power Source	Power Base	Team Commitment	Team Compliance	Team Resistance	Meaning
Position	Legitimate	Possible	Likely	Possible	Formal authority to direct, a boss
Position	Reward	Possible	Likely	Possible	The ability to give value such as a raise
Position	Coercive	Possible	Possible	Likely	The right to reprimand or terminate
Personal	Informational	Possible	Possible	Possible	Ability to give facts, reasoning, or logic
Personal	Expert	Likely	Possible	Possible	Seeming to have superior knowledge or experience
Personal	Referent	Likely	Possible	Possible	Goodwill, team members admire the person

Image 104: Sources of Power and Their Impacts

Another key concept found in leadership is the idea of servant leadership.

Servant leadership is a philosophy and set of practices that is supposed to enrich the lives of individuals, builds better organizations, and ultimately creates a more just and caring world. The phrase “servant leadership” was coined by Robert K. Greenleaf in *The Servant as Leader*, an essay that he first published in 1970. In that essay, Greenleaf said:

“The servant-leader is servant first... It begins with the natural feeling that one wants to serve, to serve first. Then conscious choice brings one to aspire to lead. That person is sharply different from one who is leader first, perhaps because of the need to assuage an unusual power drive or to acquire material possessions... The leader-first and the servant-first are two extreme types. Between them there are shadings and blends that are part of the infinite variety of human nature.”

“The difference manifests itself in the care taken by the servant-first to make sure that other people’s highest priority needs are being served. The best test, and difficult to administer, is: Do those served grow as persons? Do they, while being served, become healthier, wiser, freer, more autonomous, more likely themselves to become servants? And, what is the effect on the least privileged in society? Will they benefit or at least not be further deprived?”



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A servant-leader focuses primarily on the growth and well-being of people and the communities to which they belong. While traditional leadership generally involves the accumulation and exercise of power by one at the “top of the pyramid,” servant leadership is different. The servant-leader shares power, puts the needs of others first and helps people develop and perform as highly as possible.

Robert Greenleaf recognized that organizations as well as individuals could be servant-leaders. Indeed, he had great faith that servant-leader organizations could change the world. In his second major essay, *The Institution as Servant*, Greenleaf articulated what is often called the “credo.” There he said:

“This is my thesis: caring for persons, the more able and the less able serving each other, is the rock upon which a good society is built. Whereas, until recently, caring was largely person to person, now most of it is mediated through institutions – often large, complex, powerful, impersonal; not always competent; sometimes corrupt. If a better society is to be built, one that is more just and more loving, one that provides greater creative opportunity for its people, then the most open course is to raise both the capacity to serve and the very performance as servant of existing major institutions by new regenerative forces operating within them.”

- ⇒ **.2 Project management information system** — The PMIS often offers a wide range of tools to help the project leader manage the project team.

The outputs to the manage project team include the following:

- ⇒ **.1 Change requests** — The work done to manage the project team results in discovering new information that requires changes to the project.
- ⇒ **.2 Project management plan updates** — As the project progresses, nothing will produce more information about what needs to change for success than the team. These changes can have significant impacts to the project management plan.
- ⇒ **.3 Project document updates** — If the project management plan is going to be updated, doesn't it make sense to update the other documents that are part of the project?
- ⇒ **.4 Enterprise environmental factor updates** — This is yet again our old friend. In this case, the focus is on updating those factors.

9.6 Control Resources

The last process found in the project resources management knowledge area is new in the 6th edition of the PMBOK® Guide. It represents another move toward standardizing the knowledge area. Control resources is the process where the project leader works to ensure the physical resources assigned and



Image 105: Control Resources Process



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allocated to the project are actually available as planned. It is also the process where the project leader works to monitor the team's actual resource utilization versus what was planned and take any required corrective action. Be very careful with this process. Human resources are managed in the last process. This process is focused on the physical resources such as equipment, materials, facilities and infrastructure. Do not get confused on this point.

The inputs to the control resources process include:

- ⇒ **.1 Project management plan** — The key component of the project management plan included in this process is the resource management plan created at the beginning of this knowledge area. It defines how resources are to be managed within the project.
- ⇒ **.2 Project documents** — The resource management plan found in the project management plan. It is missing a lot of key information. Much of that needed information is founded in the additional project documents. Specifically, PMI® lists the issue log, any physical resource assignments, the project schedule, the resource breakdown structure, the resource requirements, and the risk register. Each of these documents is critical to the leader understanding how the project is being resourced.
- ⇒ **.3 Work performance data** — The work performance data for controlling resources tells the project manager about the number and type of resources used on the project.
- ⇒ **.4 Agreements** — Often projects rely on the purchasing of equipment or sub-systems from outside vendors to complete project work. This means there are also often contracts or other agreements in place defining the way that work is conducted. The project leader must have access to this information to successfully control project resources.
- ⇒ **.5 Organizational process assets** — Within the performing organization, there is often organizational process assets such as escalation procedures for handling issues within the performing organization, the lessons learned repository for information about past projects, and any policies about resource control and reassignment.

There are four primary tools and techniques used to control resources according to PMI®

- ⇒ **.1 Data analysis** — Controlling resources on a project requires a significant amount of both time and energy analyzing information from the project to ensure the resources are completing the necessary work. This is done using alternatives analysis, cost-benefit analysis, performance reviews, and trend analysis.
- ⇒ **.2 Problem solving** — No project ever goes exactly as planned. When the unexpected happens a good leader knows they must examine the current information and solve problems. It is about finding solutions. Weak leaders tend to throw up their arms in frustration.



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- ⇒ **.3 Interpersonal and team skills** — The project leader must use negotiations, influencing and a number of other soft skills to navigate the management of resources on any project.
- ⇒ **.4 Project management information system** — The PMIS provides many tools the project manager can use to successfully control their resources. These tools show the leader what is currently happening along with forecasts and trends.

There are four primary outputs to the control resources process. Most, if not all of these outputs are common sense. After eight other chapters they should be relatively familiar to you. They include:

- ⇒ **.1 Work performance information** — The work performance information shows how the project is progressing against what was expected and any gaps that require adjustments.
- ⇒ **.2 Change requests** — Like most of the processes found in the PMBOK® Guide, controlling resources can cause the team to recommend a change to the change management process. Remember, in this case we are talking about physical resources and not people.
- ⇒ **.3 Project management plan updates** — Controlling project resources can generate many updates to the resource management plan, the schedule baseline, or the cost baseline.
- ⇒ **.4 Project document updates** — The project documents likely to be updated through this process are the assumption log, the issue log, the lessons learned register, any physical resource assignments, the resource breakdown structure, and the risk register.

Final Terms

There are several additional terms you must know to prepare for the exam. These include the following:

- ⇒ **Expectancy theory** — Employees who believe their efforts will lead to effective performance and who expect to be rewarded for their accomplishments will remain productive as rewards meet the expectations.
- ⇒ **Arbitration** — In arbitration, a neutral party hears and resolves a dispute.
- ⇒ **Perquisites** — Often referred to as perks, occur when some employees receive special rewards, such as assigned parking spaces, corner offices, and executive dining.
- ⇒ **Fringe benefits** — These are benefits formally given to all employees, such as educational benefits, health insurance, 401Ks, and employee stock ownership.



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- ⇒ **Motivation theory** — This is a fancy way of talking about what people really want. If most projects are operated in a matrix environment, then one of the few things a project manager can do to gain cooperation of team members is to understand how to motivate them.

Human Resources Management Summary

To summarize, the human resources knowledge area is one of the easiest on the exam, but you cannot pass it without some studying. Make sure to focus on the following:

- ⇒ **Six processes** — Make sure it makes sense to you and you have a firm grasp on most of the inputs, tools and techniques, and outputs for each of the six processes.
- ⇒ **Sources of power** — Study the sources of power and how each combine to give the project manager the ability to deliver a successful project.
- ⇒ **Types of conflict and conflict resolution** — Conflict resolution is a key skill for successful project management. Remember, conflict is not inherently bad. It is how we resolve the conflict that makes it good or bad.
- ⇒ **Purpose and value of team building** — Team building is a constant requirement to ensure good collaboration and efficient effort.
- ⇒ **Organizational theories** — Make sure you can compare and contrast the organizational theories proposed by Maslow, McGregor, and Ouchi.
- ⇒ **Theories of management style** — Spend time studying the two different theories of management styles and make sure you know these well.



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Exercise 17 — Resource Management



Exercise 17 – Resource Management

1. Which of the following is the last process in the resources management knowledge area?
 - A. Plan resource management
 - B. Acquire resources
 - C. Develop team
 - D. Manage team
2. Which of the following is not a process found in the resource management knowledge area?
 - A. Plan resource management
 - B. Acquire team
 - C. Train team
 - D. Manage team
3. Which of the following is not an output of the manage team process?
 - A. Organizational process updates
 - B. Change requests
 - C. Enterprise environmental factors updates
 - D. Project management plan updates
4. Which of the following is not a form of positional power for a new project manager?
 - A. Legitimate
 - B. Expert
 - C. Reward
 - D. Coercive
5. Which of the following sources of power would likely cause a project resource to be committed to the effort?
 - A. Legitimate
 - B. Reward
 - C. Referent
 - D. Informational
6. Which of the following needs from Maslow's Hierarchy of Needs must be dealt with first?
 - A. Self-actualization
 - B. Social
 - C. Physiological
 - D. Safety

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7. You are a project manager managing a resource who has been an outstanding performer in the past. On your project she has repeatedly missed deadlines. You discover she is going through a difficult divorce. According to Maslow, which of the following needs is most likely not being met for this resource?
- A. Self-actualization
 - B. Physiological
 - C. Safety
 - D. Social
8. Which of the following is the ultimate goal in Maslow's Hierarchy of Needs?
- A. Self-actualization
 - B. Esteem
 - C. Social
 - D. Physiological
9. Sally has been a senior technical resource with her company. She is considered the best technical resource in her organization. One day she is told she is being promoted to be the project manager on a large complex project. Which of the following best describes Sally's situation?
- A. Promoting within
 - B. The halo effect
 - C. Ensuring technical competence
 - D. A good general business practice is to move people from technical fields to project management because they will best understand the project needs.
10. Which of the following is not one of the terms represented by the acronym RACI?
- A. Responsible
 - B. Accountable
 - C. Consult
 - D. Initiates
11. Which of the following is not a primary need in McClelland's Theory of Needs or the Acquired Needs Theory?
- A. Need for achievement
 - B. Need for affiliation
 - C. Need for esteem
 - D. Need for power
12. Which of the following is not a hygiene factor in Herzberg's Theory?
- A. Responsibility
 - B. Personal life
 - C. Relationships at work
 - D. Status

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13. Which of the following is not a motivating agent according to Herzberg's Theory?
- A. Responsibility
 - B. Self-actualization
 - C. Status
 - D. Recognition
14. According to McClelland's theory of needs, which of the following is not a behavioral style associated with the primary need for affiliation?
- A. People working best when cooperating with others
 - B. People seeking approval rather than recognition
 - C. People seeking to organize and influence others
 - D. All of the above
15. Which of the following is the lowest point on Maslow's hierarchy of needs?
- A. Safety
 - B. Physiological
 - C. Social
 - D. Physical
16. Which project role is best described as helping to prevent unnecessary changes to project objectives?
- A. Stakeholders
 - B. Customers
 - C. Sponsor
 - D. Project manager
17. Which of the following conflict resolution modes is most likely to be permanent?
- A. Confronting
 - B. Smoothing
 - C. Compromising
 - D. Forcing
18. The most common causes of conflict on a project are schedules, project priorities and:
- A. Personalities
 - B. Resources
 - C. Cost
 - D. Management

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19. You are a project manager leading a bridge construction project. One day you are meeting with one of your resources when they exclaim, “I cannot deal with this right now!” What conflict resolution technique are they using?
- A. Confronting
 - B. Smoothing
 - C. Forcing
 - D. Withdrawal
20. What does a resource histogram show that a RAM does not?
- A. Reporting relationships
 - B. The person responsible for each activity
 - C. Key activities
 - D. Time
21. It is the first day on your new job as a project manager at a large snack food manufacturing facility. You are taking over a project for a PM that has gone on maternity leave that is approximately 40% complete and is expected to take another seven months to complete. There are 15 people working on the project. You need to determine who is responsible for doing the specific activities for the entire project. Where would you find this information?
- A. Responsibility assignment matrix
 - B. Brakestone organization chart
 - C. Team board
 - D. Control chart
22. You are the new project manager on a project that is significantly behind schedule. The organization uses a matrix structure. You determine that three additional resources are required. From whom would you request these resources?
- A. Project team
 - B. Project manager
 - C. Functional manager
 - D. Project sponsor
23. You have just been brought into an organization as a project management consultant to work with an inexperienced project manager. Upon examining the project with the PM you discover several important tasks are expected to get behind because the assigned resource lacks the specific experience to perform the required work. After doing some research you find there isn't another resource available that is better qualified. What is the best solution for this situation?
- A. Provide the resource with greater time reserves to complete the work.
 - B. Hire a new resource to complete the work.
 - C. Provide the resource with additional incentives if they complete the work on time.
 - D. Arrange for the team member to obtain the necessary training to perform the task.

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24. You are leading one of five sub-teams for a large project. One of the sub-teams is consistently late with their deliverables forcing your sub-team to have to crash the critical path repeatedly. What should you do?
- A. Meet with the project manager and the leader of the consistently tardy team together
 - B. Meet with the project manager alone
 - C. Meet with the leader of the consistently tardy team alone
 - D. Meet with the leader of all the sub-teams together
25. You are leading your first project with a very experienced team. The team has 25 resources fully dedicated to the effort. Approximately 35% through the execution of the project one of the stakeholders requests a major change to the scope of the project. Unfortunately, two of your most senior resources have very different opinions on how the changes should be accomplished. How should you deal with this conflict?
- A. Listen to the different opinions, determine the best choice and implement that choice.
 - B. Postpone further discussions, meet with each team member, and determine the best approach.
 - C. Listen to the different opinions, encourage logical discussions, and facilitate an agreement.
 - D. Help the team focus on the agreeable aspects of their opinions and build unity by using team building exercises.
26. Today is your first day with XYZ Company. You have been hired to lead a new project with 8 different departments, 45 different resources, and a single project sponsor. You must maintain less than a 10% variance on both schedule and cost. What type of management power will best help you gain the cooperation of others?
- A. Referent
 - B. Expert
 - C. Fear
 - D. Formal
27. Today is your first day with XYZ company. You have been hired to lead a new project with 8 different departments, 45 different resources, and a single project sponsor. Unfortunately, two of your most senior resources have very different opinions on how the project testing should be accomplished. One says the systems should be integrated before testing and the other maintains each system should be tested before integration. The sponsor is demanding the project is completed on time. What is the best thing to do to resolve the conflict?
- A. Force a solution on both parties.
 - B. Refocus the parties on the project goals.
 - C. Table the discussion until the next meeting.
 - D. Require the team to do limited testing before integration and finish testing after integration.

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28. A two year project is coming to an end. It has been a difficult project to complete due to three major overhauls, two of which involved replacing the project manager. When you came in this morning one of your senior resources was waiting in your office to inform you that one of the last key deliverables did not pass its QA test and the resource working on the item has been moved off the project by their direct supervisor. Additionally there is an email in your in box requesting a major shift in scope. With whom should you address these issues?
- A. Senior management
 - B. Project sponsor
 - C. The customer
 - D. The team
29. You are eating lunch with a friend who is explaining why they love their organization. The friend says, “The team really enjoys our leadership team. The set clear goals for our performance and explain why those performance goals are important for our mission. They also establish excellent rewards for achieving those goals. The best part is, everyone can see the rewards happening along with the achievement of our goals. Which of the following theories best describes this scenario?”
- A. McGregor’s theory of X and Y
 - B. Conditional reinforcement
 - C. Expectancy theory
 - D. Maslow’s hierarchy of needs
30. The project you are leading has been going very well. You are more than 50% through the execution phase and have an SPI of 1.02 and a CPI of 0.99. The customer has accepted all presented deliverables and your sponsor just told you they were very pleased with the results to date. Unfortunately, you have one team member who is not happy. They are always complaining about how much time it takes to complete their deliverables. Which of the following would be the best thing for the project manager to do?
- A. Show the resource the formal, written acceptance from the customer.
 - B. Review the reward system for the project.
 - C. Show the resource the SPI performance.
 - D. Obtain a schedule exception from the sponsor.

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31. You are leading a project that contains a great deal of stress. The entire team has been on edge due to a very tight deadline. This tension has grown to the point that many team meetings end in shouting matches with little work being accomplished. Several key stakeholders have asked that scope be added to the project to better meet their needs. The sponsor has heard rumors that the project might be having difficulties and wants to attend a team meeting to get a better sense of how the project is doing and any issues involved with achieving the desired targets. In this situation, it would be best for the project manager to:
- A. Hold a team-building session that involves all team members.
 - B. Meet with each resource individually to determine the real issues.
 - C. Create and implement new ground rules for the team.
 - D. Ask the sponsor if you can send a written report instead of wasting their time in the meeting.
32. Which of the following describe how an individual team member is performing on the project?
- A. Project performance appraisals
 - B. Team performance appraisals
 - C. Annual performance reviews
 - D. Project performance plans
33. In January you make a decision as the project manager on a complex issue facing your project. Everything goes smoothly until July when the same issue reappears. What did you most likely not do?
- A. Proper risk analysis
 - B. Quantify the risk
 - C. Have the project sponsor validate the solution
 - D. Confirm the solution solved the problem
34. The halo effect refers to the tendency to:
- A. Promote from within
 - B. Hire the best
 - C. Move people into project management because they are good in their technical fields
 - D. Move people into project management because they have had project management training
35. You have just been assigned as a project manager for a large information technology project. This one-year project is about halfway. The project team consists of seven external resources and 30 internal resources. You want to understand who is responsible for doing what on the project. Where would you find such information?
- A. Responsible assignment matrix
 - B. Resource histogram
 - C. Bar chart
 - D. Project organization chart

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36. During your regular status meetings you ask each resource to describe the work they are doing and then you assign new activities to the resources as required. The length of these meetings has increased because of the many different activities requiring assignment. This could be happening for all the following reasons except:
- A. A lack of a WBS
 - B. A lack of a RAM
 - C. A lack of resource leveling
 - D. A lack of involvement in project planning
37. You are leading a large manufacturing project in a weak matrix organization. Given that you lack the ability to reward your team, none of the resources report to you, and the project is complicated and difficult, which of the following types of project management power will likely be the most effective?
- A. Referent
 - B. Expert
 - C. Penalty
 - D. Formal
38. One of your team members is not performing well because they are inexperienced in the particular technical skill. You do not have any other resources available to complete the work. Which of the following is the best thing to do?
- A. Consult with the functional manager to determine project completion incentives for the team member.
 - B. Obtain a new resource with more technical skills.
 - C. Arrange for the team member to get training.
 - D. Allocate some of the project schedule reserve.
39. You are leading your first project and have a very experienced team. The product of your project is highly technical and represents something your organization has never done. However, your team is very confident. There are more than 30 resources on the project; 15 of these resources are considered true subject matter experts. In one of your team meetings you are reviewing a preliminary WBS when one of the experts argues a deliverable should not be done at all. Another of the experts says the deliverable should be broken into three distinct deliverables and a third expert agrees with both of them. How should the project manager deal with this conflict?
- A. Listen to the differences of opinion, determine the best choice, and implement accordingly.
 - B. Postpone further discussions, meet with the experts individually, and determine the best approach.
 - C. Listen to the differences of opinion, encourage logical discussions, and facilitate an agreement.
 - D. Help the team focus on agreeable aspects of their opinions and build unity by focusing on team building.

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40. You have just been hired as the project manager for a \$2,000,000 manufacturing project that has been underway for six months. The project draws on resources from more than a dozen different departments and has three primary sponsors. The project has more than 50 major requirements that must be met. During your first meeting with the primary sponsors you are told the project must maintain an SPI of between .95 and 1.05. Additionally, the project has a CPI of .97. Which of the following types of project management power will best help the project manager gain the cooperation of the team?
- A. Formal
 - B. Referent
 - C. Penalty
 - D. Expert
41. The project manager is trying to settle a dispute between two subject matter experts who are team members on their project. One says the systems should be integrated before testing, and the other maintains each system should be tested before integration. The project involves more than 50 people and 15 different systems must be integrated. The sponsor is demanding the project be completed on time. What is the best statement the project manager can make to resolve the conflict?
- A. Do it my way.
 - B. Let's calm down and get the job done.
 - C. Let's deal with this again next week after we all calm down.
 - D. Let's do limited testing before integration and finish testing after integration.
42. The installation project has a CPI of 1.06 and an SPI .97. There are 21 team members. The project manager was careful to ensure each resource had input into the schedule and project management plan. The customer has accepted the six deliverables completed so far and the RAM has not changed since the project began. The project is being completed in a matrix environment and there are no external resources being used on the project. Although the sponsor is happy with the status of the project, one of the team members is always complaining about how much time his deliverables are taking. Which of the following would be the best thing for the project manager to do?
- A. Review the reward system for the project.
 - B. Try to improve the project schedule performance.
 - C. Meet with the customer to try and extend the schedule.
 - D. Gain formal acceptance in writing from customer.

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43. The project manager is looking at the project's resource needs and lessons learned from past projects. This information causes the project manager to be concerned about the ability to acquire enough resources for the project in six months. Which of the following would be the least effective preventive action?
- A. Make sure functional managers have a copy of the resource histogram.
 - B. Show the sponsor the data and explain the project manager's concern.
 - C. Determine metrics to use as an early warning sign that resources will not be available.
 - D. Ask functional managers for their opinions.
44. A large project is underway when one of the team members reviews the project status report. He sees the project is currently running late. As he looks at the report further he notices the delay will cause one of his activities to be scheduled during a time he will be out of the country and cannot work on the activity. This is of great concern to the team member because he is very committed to the success of the project and he does not want to be the cause of the project being further delayed. What is the best thing for him to do?
- A. Contact the project manager immediately to provide the project manager with his schedule.
 - B. Include the information in his next report.
 - C. Request the issue be added to the project issue log.
 - D. Recommend preventive action.
45. There have been many work packages completed successfully on the project, and the sponsor has made some recommendations for improvements. The project is on schedule to meet an aggressive deadline when the successor activity to a critical path activity suffers a major setback. The activity has 14 days of float and is being completed by four people. There are two other team members with the skill set to assist the troubled activity, if needed. The project manager receives a call that three other team members are attempting to be removed from the project because they do not feel the project can be successful. When the project manager pursues this, he discovers that those team members have issues that have not been addressed. Which of the following is the best thing to do to improve the project?
- A. Have the team members immediately assist the troubled activity.
 - B. Investigate why the project schedule is aggressive.
 - C. See who can replace the three team members.
 - D. Create an issue log.

Exercise 17 — Resource Management Answers

1. **Answer D.** PMBOK® Guide p. 308 – The control resources process is the last process found in the Human Resources Management Knowledge Area.
2. **Answer C.** PMBOK® Guide p. 308 – Train project team is a made up term. The correct process is the develop team.
3. **Answer A.** PMBOK® Guide p. 308 – The outputs from the Manage Project Team Process include:
 - ⇒ Change requests
 - ⇒ Project management plan updates
 - ⇒ Project document updates
 - ⇒ Enterprise environmental factor updates
4. **Answer B.** Expert power is not provided formally. It occurs when one complies with instructions because they believe the person providing the instruction is a subject matter expert.
5. **Answer C.** Referent power is the only of the choices to likely get commitment as it focuses on the resource having goodwill towards the PM because of who the PM knows or is associated with.
6. **Answer C.** Maslow's hierarchy of needs goes from physiological, safety, social, esteem, and ends with self actualization at the top as the ultimate goal. However, one cannot achieve the top level until achieving the levels beneath it.
7. **Answer D.** Maslow's hierarchy of needs goes from physiological, safety, social, esteem, and ends with self actualization at the top as the ultimate goal. However, one cannot achieve the top level until achieving the levels beneath it. In this case the social need is most likely not being met as it is the one focused on love, affection, approval, friends and association.
8. **Answer A.** Maslow's hierarchy of needs goes from physiological, safety, social, esteem, and ends with self actualization at the top as the ultimate goal. However, one cannot achieve the top level until achieving the levels beneath it.
9. **Answer B.** The halo effect refers to tendency of moving technical people into project management because of their technical successes. These people might or might not be successful as project managers.
10. **Answer D.** The RACI diagram is a tool used to show the role each resource will play on the project. The acronym stands for Responsible, Accountable, Consult and Inform.
11. **Answer C.** McClelland's theory of needs states that people are most motivated by one of three needs:
 - ⇒ The need for achievement
 - ⇒ The need for affiliation
 - ⇒ The need for power

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12. **Answer A.** According to Herzberg's theory the following are examples of hygiene factors:
- ⇒ Working conditions
 - ⇒ Salary
 - ⇒ Personal life
 - ⇒ Relationships at work
 - ⇒ Security
 - ⇒ Status
13. **Answer C.** According to Herzberg's theory the following are examples of motivating agents:
- ⇒ Responsibility
 - ⇒ Self-actualization
 - ⇒ Professional growth
 - ⇒ Recognition
14. **Answer C.** According to McClelland's theory of needs the following behavioral styles are associated with primary need for affiliation:
- ⇒ People working best when cooperating with others
 - ⇒ People seeking approval rather than recognition
15. **Answer B.** Maslow's hierarchy of needs argues that people are not most motivated to work by security or money. Instead, the highest motivation is to contribute and use one's skills or self-actualization. The hierarchy from top to bottom is:
- ⇒ Self-actualization
 - ⇒ Esteem
 - ⇒ Social
 - ⇒ Safety
 - ⇒ Physiological
16. **Answer C.** The sponsor is responsible for issuing the project charter and the charter contains the project objectives. Therefore, it is the role of the sponsor to help prevent unnecessary changes to project objectives.
17. **Answer A.** Confronting is the preferred conflict resolution method as it requires the parties to both present their solutions and value the other party's ideas and is the method most focused on finding the right solution.
18. **Answer B.** This is a simple memorization question. The four most common causes of conflict on a project are:
- ⇒ Schedule
 - ⇒ Project priorities
 - ⇒ Resources
 - ⇒ Technical opinions
19. **Answer D.** The failure of the person to engage with the issue is a perfect example of withdrawal.

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20. **Answer D.** Time is shown on a schedule or bar chart. The RAM or responsibility assignment matrix explains the role each party will take against the specific deliverables or activities. A resource histogram shows the resources or groups of resources over time.
 21. **Answer A.** The RAM or responsibility assignment matrix explains the role each party will take against the specific deliverables or activities. A team board does show who is responsible for different activities, but only for the current iteration and the question asks specifically for the entire project.
 22. **Answer C.** This might be viewed as a trick question. If the question asked whom would you see to get permission for more resources, the answer would be the project sponsor. However, in this case the question is asking from whom do you have to get the resources? In a matrix organization the functional manager controls the resources.
 23. **Answer D.** One of the four processes in the human resources management area is develop project team. This highlights the importance PMI® places on training.
 24. **Answer A.** The best way to resolve a problem is through problem solving or confronting. This requires you to meet with all the interested parties. Therefore, you should meet with the leader of the tardy team and the project manager.
 25. **Answer C.** This question is big, but don't get lazy and not read all the choices. The key to this question is remembering the best problem solving technique, confronting. In this case, it is important that you act as the facilitator allowing the team to resolve the issue in a timely manner.
 26. **Answer D.** In most cases expert power is best. However, in this case you have not had the time to establish yourself as a subject matter expert. Therefore, formal authority is the best you can hope for.
 27. **Answer D.** Confronting is not offered in this question as a potential answer. This leaves you with the next best option which is compromise. Therefore, D is the correct answer.
 28. **Answer B.** It is the project sponsor's job to prevent unnecessary changes and set priorities for all the different projects.
 29. **Answer C.** This is the definition of expectancy theory: employees who believe that their efforts will lead to effective performance and who expect to be rewarded for their accomplishments will stay productive as rewards meet their expectations.
 30. **Answer B.** This question is more about answers that are wrong than one that is correct. First, it is important that you recognize there is nothing wrong with this project. It is on time and under budget. The only real problem you have is a resource that is always complaining. The only option that has a chance of addressing that issue is the one attempting to deal with the reward system.

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31. **Answer C.** This is an example of a question requiring you to remember to ask yourself what would you do first. You might want to do several items on the list, but you must first deal with the tension in the meeting requiring new ground rules be established.
 32. **Answer A.** Project performance appraisals examine how well a specific resource is performing on the project. Team performance appraisals address how well the team is functioning together. Annual performance reviews are for individuals across all their projects and other work and project performance plans represents a made up term.
 33. **Answer D.** Sometimes we read too much into a question. In this case, it is actually a very easy question. Often when a problem reappears it is because we treated the symptoms and not the root cause. In this case it is best to make sure the solution actually solved the problem.
 34. **Answer C.** The halo effect refers to the tendency to move a person into project management because they are good in their technical field. Just because someone is good at a technical skill does not make them a good manager.
 35. **Answer A.** The responsibility assignment matrix (RAM) or a RACI diagram show who is doing what on the project.
 36. **Answer C.** Resource leveling refers to using the same number of resources and reducing the work to the point where it does not exceed the available hours for a time period without increasing the number of resources.
 37. **Answer B.** Reward and expert are the best types of power to use in such a circumstance. Reward is not listed as a choice, and the question says you do not have the authority to reward team members.
 38. **Answer C.** The question says you don't have any other resources and adding incentives will not help a resource who lacks skills. This leaves reserves and training. Training should always be the first choice.
 39. **Answer C.** The very best problem solving technique is confronting. When that is not available compromise is the next best alternative. In this case you should focus on getting the experts to confront their disagreement and facilitate a resolution.
 40. **Answer A.** Generally speaking, the best forms of power are reward or expert. In this case the project manager is new and nothing in the question indicates specific expert knowledge or proximity to senior leadership. The only thing that makes any sense is to use your positional power.
 41. **Answer D.** Doing limited testing before integration represents a form of compromise and is the best option.
 42. **Answer A.** The only choice that has any impact on the resources is analyzing the reward system. Although it is not a great choice, it is the best answer.

-
43. **Answer A.** Sending data without pointing out the issue does not mean the communication will be adequately decoded by the recipient. The other choices describe more effective communication in this instance.
44. **Answer D.** Notice the question asks what the team member should do. It is important for the project manager to understand the team member's role and possibly even instruct team members on how to work on projects and what is expected of them. Providing the project manager with his schedule, including the information in a report, and requesting that the issue be added to the issue log have one thing in common. They all involve the team member asking the project manager to do something. In reality, it may very well be the team member who will come up with a solution. Therefore, recommending preventive action is the best choice for the team member.
45. **Answer D.** Sometimes complex problems are caused by not doing simple things. The data in the first part of the question, once you read the choices, is completely extraneous. The troubled activity has float and so does not need immediate attention. It may not be necessary for additional team members to assist the troubled activity, but none of the choices suggest investigating whether the amount of float is enough to cover any delay caused by the trouble. Rather the choices take you in different directions. Investigating why the schedule is so aggressive should have been done before the project began. Replacing team members does not solve the root cause of the problem. Wouldn't it be more effective to discover the root cause of those troubled team members' concerns so the problem does not surface again? The creation of an issue log will let the troubled team members know their concerns have been heard, are noted, and will be resolved. This might be enough to stop them from leaving and avoid the resultant project delays and confusion if new team members must be added.

Communications Management

Overview

Chapter ten of the PMBOK® Guide is dedicated to the communications management knowledge area. There are three processes found in the communications management knowledge area. These processes include the following:

- ⇒ Plan communications management
- ⇒ Manage communications
- ⇒ Monitor communications

Before we can examine these processes it is important to understand some basic terminology and the basic communications model. The key terms to study for the PMP® exam include the following:

- ⇒ **Communication** — The exchange of information, intended or involuntary. The exchange can be in the form of ideas, instructions, or emotions. This exchange can make use of a variety of mechanisms such as written or verbal, formal or informal, gestures, media, or the choice of words.

- ⇒ **Communication dimensions** — PMI® uses a number of terms to describe the dimensions of communication these include:

- ◇ **Internal** — Communications is said to be internal if the focus is on the stakeholders within the project and within the organization.
- ◇ **External** — Communications is said to be external if the focus is on stakeholders such as customers, vendors, other projects, other organizations, the government, the public, or environmental advocates.
- ◇ **Formal** — Formal communication uses reports, formal meetings (both regular and ad hoc), meeting agendas and minutes, stakeholder briefings, and presentations.
- ◇ **Informal** — Informal communication represents general communication activities using emails, social media, websites, and informal ad hoc discussions.

Planning Process Group

10. Project Communications Management

10.1 Plan Communications Management

Executing Process Group

10. Project Communications Management

10.2 Manage Communications

Monitoring and Controlling Process Group

10. Project Communications Management

10.3 Monitor Communications

Image 106: The Communications Management Processes



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- ◇ **Hierarchical focus** — When discussing communication, hierarchical focus refers to the position of the stakeholder or group with respect to the project team. This positioning affect the format and content of the message in a number of ways. It is important that you think about the direction of your communication.
 - ⇒ **Upward** — Communication to senior management stakeholders tends to be more formal and structured.
 - ⇒ **Downward** — Downward communication represents communication directed to the team and other resources who contribute work to the project.
 - ⇒ **Horizontal** — Horizontal communication refers to communication done to peers of the project manager or team.
 - ◇ **Official** — Official communication typically uses a formal structure and is exemplified by annual reports or reports to regulators or other government bodies.
 - ◇ **Unofficial** — Unofficial communication is focused on establishing and maintaining the profile and recognition of the project and building strong relationships between the project team and its stakeholders using flexible and often informal means.
 - ◇ **Written and oral** — The words and voice inflections we use (verbal) and body language and actions (non-verbal) represent our oral communication. Written communication is represented by anything written on paper or with social media, websites and media releases or any other print means.
- ⇒ **Response** — The response is the reaction a receiver provides to a message sent by the sender. It includes communications using both verbal and nonverbal means.
 - ⇒ **Channel** — The channel represents the mechanism used to communicate. E-mail, the telephone, and face-to-face are all examples of channels of communication.
 - ⇒ **Nonverbal** — Nonverbal communication is the communication that happens without spoken words. It can be in written form or can take the form of facial expressions and gestures.
 - ⇒ **Para Lingual** — Para lingual describes the pitch, tone, and inflections in the speaker's voice that affect the message.
 - ⇒ **Active Listening** — Active listening is a communication technique that requires the listener to understand, interpret, and evaluate what he hears. The ability to listen actively can improve personal relationships through reducing conflicts, strengthening cooperation, and fostering understanding.



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- ⇒ **Effective Listening** — Listening is difficult. There is an old saying, “we have one mouth and two ears because one is twice as hard as the other.” To be an effective listener, one must focus on the communication, provide feedback, and work to interpret the message without preconceptions.
- ⇒ **Feedback** — Feedback is the information provided by the receiver to the sender of the communication about how the message was received and its meaning.

The basic model of communication used by PMI® has four parts, as follows:

- ⇒ **The sender** — The sender is the person who initiates the communication and has information to transmit.
- ⇒ **The message** — The message represents the information that needs to be conveyed.
- ⇒ **The receiver** — The receiver is the person or group for whom the message is intended.
- ⇒ **The response** — The response or feedback, is the information returned to the sender and originated by the receiver which tells the sender how the message was received and interpreted. *Image 101* shows an example of this model.

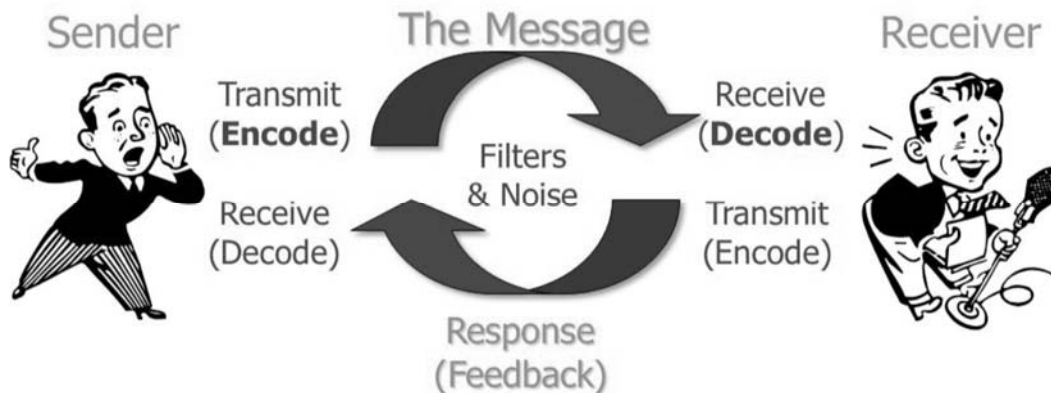



Image 107: The Basic Communication Model

An important element of the basic communication model is understanding the number of channels or lines of communication on any project. Project managers must determine the number of lines of communication that exist using the formula for Didactic (one-on-one) Communication. This formula is as follows:

$$\frac{N(N-1)}{2}$$

Where N = The Number of Participants

A common exam question asks you how many additional channels of communication are there if the number of participants changes from one number to another such as in a case where you start with five participants

 **Know the PMI® communications model.**

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 **Didactic Communications**

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and add two more. To answer this question you must first determine the channels for each population (7 and 9) and then determine the difference as shown below.

$$\begin{aligned}(7(7-1))/2 &= (7*6)/2 = 42/2 = 21 \\ (9(9-1))/2 &= (9*8)/2 = 72/2 = 36 \\ 36 - 21 &= 15\end{aligned}$$

The correct answer is 15.

For the exam it is also important that you learn the communication styles that may be used to convey information. These styles are as much about how stakeholders perceive the project manager as they are about how the project manager is trying to sound. The styles may be combined to create an individual style. These styles include the following:

- ⇒ **Authoritarian** — When using an authoritarian style the sender gives expectations and specific guidance. The sender is the person in authority.
- ⇒ **Promotional** — A sender using a promotional style attempts to cultivate team spirit and excitement around the information being conveyed.
- ⇒ **Facilitating** — A sender using a facilitating style gives guidance as required, but acts only in a non-interfering manner. They are the keepers of the process, but do not take a position on the issue.
- ⇒ **Conciliatory** — A sender who uses a conciliatory style is friendly and agreeable with the goal of building a compatible team.
- ⇒ **Judicial** — A sender who uses a judicial style wants to be perceived as using sound judgment or being logical.
- ⇒ **Ethical** — A sender who is ethical is seen as being honest, fair, or “by the book.”
- ⇒ **Secretive** — A sender who is perceived as secretive is not open or outgoing. They do not share information with the team or stakeholders. This is usually to the project’s detriment.
- ⇒ **Disruptive** — A sender who is disruptive works to break apart the unity of the group, and is often perceived as an agitator. This is usually seen as a negative impact on the group, but is not seen as threatening to anyone.
- ⇒ **Intimidating** — A sender using an intimidating style is perceived as a “tough guy,” who is attempting to influence the group through fear. This can lower morale.
- ⇒ **Combative** — A sender who is combative is seen as eager to fight or be disagreeable with others. This is usually to the detriment of the team.

10.1 Plan Communications Management

The first process in the communications management knowledge area is plan communications. This is the process of determining the project stakeholder



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communication needs and defining how the project intends to meet those needs. The primary output of this process is the communications management plan. Like all the plans created in the 49 defined processes, this one is to be updated throughout the project.

The inputs to the plan communications management process include the following:

- ⇒ **.1 Project charter** — The project charter is always an input to processes found in the planning process group. It is important to this process because it informs the team about the business need and reasoning for the project along with the success criteria, any constraints and assumptions, and project prioritization.
- ⇒ **.2 Project management plan** — The project management plan provides a large amount of the information used to define the stakeholders as well as what must be communicated. There are two specific components called out by PMI® within the project management plan: The resource management plan that describes how the team will categorize, allocate, manage and release resources on the project; And the stakeholder engagement plan which identifies the management strategies required to effectively engage stakeholders.
- ⇒ **.3 Project documents** — Although examining the project documents adds a lot of potential paper to the inputs for planning communications management, the important ones are your requirements documentation so the team understands specifically what they are supposed to deliver, and the stakeholder register which is the primary output from the identify stakeholders process. It contains the details about the defined stakeholders such as who they are, their positions, major concerns and desires for the project and a classification. It is a critical input to the communications management plan because it defines with whom you must communicate and what they want.
- ⇒ **.4 Enterprise environmental factors** — Although you may be used to seeing enterprise environmental factors as an input to most processes, this one is a little different in that the PMBOK® Guide does not specify any factors. It simply says all environmental factors are in play.
- ⇒ **.5 Organizational process assets** — Similar to the enterprise environmental factors, the organizational process assets does not specify which ones and simply says they all should be used.

The tools and techniques used in the plan communications management process provide most of the ground that must be studied in the knowledge area and include the following:

- ⇒ **.1 Expert judgment** — Expert judgement is important when planning communications management because the project leader must know about the power and political structures within the organizations. Many



Image 108: Plan Communications Management



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organizations also have specific communication requirements because of their industry or because of culture or geography. Expert judgment provides that knowledge.

- ⇒ **.2 Communication requirements analysis** — This is the process of determining the information needs of the project stakeholders. This is done by combining the type and format of information needed with an analysis of the value of that information. This is a prioritization process to ensure the things that add the most to project success are done first.
- ⇒ **.3 Communication technology** — Communication technology deals with the methods used to transfer information amongst the stakeholders. Several factors can impact the decision on the best technology. These include urgency of the information, availability of the technology, expected staffing requirements to support the technology, duration of the project in conjunction with the time required to use the technology, and the project environment.
- ⇒ **.4 Communication models** — The communication model used on the exam was described previously at the beginning of this chapter.
- ⇒ **.5 Communication methods** — There are three primary classifications of communication methods you need to know for the exam, as follows:
 - ◇ **Interactive communications** — This is communication between two or more parties using a multidirectional exchange of ideas. It is the back and forth seen in a group or one-on-one setting. It allows for confirmation of understanding.
 - ◇ **Push Communication** — This is communication sent to a specific recipient or group of recipients. However, this classification does not confirm receipt of the message. It simply makes it available. Items such as letters, memos or reports are examples.
 - ◇ **Pull Communication** — This classification is used for very large volumes of information; websites, data warehouses or e-learning are examples.
- ⇒ **.6 Interpersonal and team skills** — There are a lot of different skills and techniques involved with communication. Discovering the best style of communication for your team begins with a communication styles assessment. This tool evaluates your preferred style, method, format and content of communication. This tool often follows a stakeholder engagement assessment to identify gaps in stakeholder engagement that require additional communication tailoring. A big part of this tailoring is political and cultural awareness.
 - ◇ **Political awareness** is focused on being able to recognize the power relationships, both formal and informal within a group and having a willingness to operate within those structures. Such ability requires an understanding of the strategies of the organization, knowing who wields power and influence, and focuses on the development of communication with these stakeholders.

- ◇ **Cultural awareness** is an understanding of the differences between individuals, groups, and organizations and adapting the project's communication strategy within a framework of those differences

⇒ **.7 Data representation** — A core tool used to present data is the stakeholder engagement assessment matrix such as the one below. In the table, the C represents the stakeholder's current level of support for the project and the D represents the level of support the team believes they need from the stakeholder for the project to succeed.

Stakeholder	Unaware	Resistant	Neutral	Supportive	Leading
Bob	C			D	
Sally		C	D		
Joan			CD		
Frank				C	D

Image 109: A Sample Stakeholder Engagement Assessment Matrix

⇒ **.8 Meetings** — The plan communications management process requires the project leader to hold discussions with the team about the most appropriate way to update and communicate project information, and to respond to the information requests from various stakeholders. We call those discussions meetings.

The outputs from the plan communications management process include the communications management plan, project management plan updates, and project document updates. The primary output however is the communications management plan. This plan is a subsidiary plan contained in the project management plan and can be formal or informal, usually including the following:

- ⇒ Stakeholder communication requirements
- ⇒ Format, content, and level of detail of the communication
- ⇒ Person responsible for communicating
- ⇒ Receivers of the communication
- ⇒ Methods or technologies used to communicate
- ⇒ Frequency of communication
- ⇒ Escalation process if receivers have questions, concerns, or dissatisfaction
- ⇒ Updating process
- ⇒ Glossary

10.2 Manage Communications

The second process found in the communications management knowledge area is manage communications. This is the process of making all the relevant information available to the project stakeholders as defined in the communications



Image 110: The Manage Communication Process



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management plan. This process is performed throughout the entire project and in all its management processes. This process also includes responding to unplanned requests for information concerning the project.

The inputs to the manage communications process include the following:

- ⇒ **.1 Project management plan** — The project management plan includes a lot of information. To successfully manage communications the team must examine the resource, communications, and stakeholder engagement plans to understand the communications needs and expectations.
- ⇒ **.2 Project documents** — If the project management plan provides a lot of documents, the project documents package provides a huge number. Specific to the manage communication process is the change log, the issue log, the lessons learned register, the quality report, risk report, and the stakeholder register.
- ⇒ **.3 Work performance reports** — Work performance reports are used to show project performance and status information. According to the PMBOK® Guide, these should be made available prior to project meetings. A key element of any performance report is the forecasting information indicating when the project is expected to finish. These reports are discussed in more detail in the Report Performance Process section that follows.
- ⇒ **.4 Enterprise environmental factors**— What is happening around the project has a great deal to do with what is communicated.
- ⇒ **.5 Organizational process assets** — Any policies, procedures or guidelines held by the organization that may aid in the distribution of information.

The tools and techniques used in the manage communications process include the following:

- ⇒ **.1 Communication technology** — The 21st century has added a wealth of technology-based tools for project managers to use towards improved communication. Examples include SharePoint, VersionOne, or EPM.
- ⇒ **.2 Communications methods** — Communication methods are generally broken into two types and two categories: they are verbal and written, and formal or informal.
- ⇒ **.2 Communication skills** — There are a number of key skills that are used in managing communication. These include:
 - ◇ **Communication competence** — A combination of tailored communication skills that considers factors such as clarity of purpose in key messages, effective relationships and information sharing and leadership behaviors.
 - ◇ **Feedback** — Feedback represents the returned information about communication in terms of a reaction, a deliverable, or a situation. It is a key element of interactive communication.



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- ◇ **Nonverbal** — Nonverbal communication represents communication that is provided with gestures, vocal tones, and facial expression.
 - ◇ **Presentations** — A presentation is the formal delivery of information and/or documentation.
- ⇒ **.4 Project management information systems** — How the team chooses to manage all the information they intend to share with their stakeholders is represented by the information management system.
- ⇒ **.5 Project reporting** — Updating all parties on project progress is done through performance reporting. These include the specific details about resource accomplishments, hours worked, schedule and cost performance.
- ⇒ **.6 Interpersonal and team skills** — PMI® lists a large list of potential interpersonal and team skills that can be used to manage communications. This list includes active listening, conflict management, cultural awareness, meeting management, networking and political awareness.
- ⇒ **.7 Meetings** — Meetings are a tool used in most of the defined PMI® processes.

The outputs from the manage communications process are as follows:

- ⇒ **Project communications** — Direct communication with people is the objective of the manage communications process. It's focus is to assure all stakeholders have the necessary information to make decisions which benefit the organization.
- ⇒ **Project management plan updates** — As the team communicates with stakeholders, changes might be required of the project.
- ⇒ **Project document updates** — Almost every time the project management plan is updated the project documents are as well. Don't forget them.
- ⇒ **Organizational process assets updates** — Every time the team produces real outputs there is an opportunity to also need to update other tools, techniques and processes throughout the organization.

10.3 Monitor Communications

The final process found in the communications management knowledge area is the monitor communications process. This process is where the project manager and team work to ensure the right communications happens and that any changes to the communications processes result in positive outcomes. This process is part of integrated change control and is there to ensure the information



Image 111: The Monitor Communications Process



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needs of the project and its stakeholders are met.

The inputs to the monitor communications process include the following:

- ⇒ **.1 Project management plan** — The project management plan includes the resource management plan, the communications management plan, and the stakeholder engagement plan. These plans define how communications is managed on the project and the expectations held by stakeholders.
- ⇒ **.2 Project documents** — Project documents provide access to the issue log, the lessons learned register, and project communications.
- ⇒ **.3 Work performance data** — Work performance data includes the deliverable status, schedule status and information about any costs incurred. These are just raw numbers and qualitative information at this point.
- ⇒ **.4 Enterprise environmental factors** — The organizations culture, political climate, and governance can significantly impact project communications. These factors along with any area trends or geography must be considered as the team works to monitor the organization's communications.
- ⇒ **.5 Organizational process assets** — Many organizations have standardized reporting templates, policies and procedures for reporting and predefining variance limits. These should all be used as inputs to the Report Performance Process.

The tools and techniques focus on several of our old friends, including the following:

- ⇒ **.1 Expert judgment** — Expert judgment is the single most important tool available to any project manager.
- ⇒ **.2 Project management information system** — The PMIS contain and focus all the information that has been or will be communicated.
- ⇒ **.3 Data presentation** — One of the methods used to present data is the previously describe stakeholder engagement assessment matrix. This and other tools provide information about the effectiveness of project communications.
- ⇒ **.4 Interpersonal and team skills** — Project leaders must engage in observation and conversation to effectively monitor project communications. The often leads to dialogue and discussions with the team and stakeholders.
- ⇒ **.5 Meeting** — Meetings are another common tool used by the project manager. Meetings are especially important for communications.

The last piece of the monitor communications process is to understand the outputs of the process. They are as follows:



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- ⇒ **.1 Work performance information** — For the exam it is important that you understand what PMI[®] means when they talk about a performance report. shows a sample performance report. Notice the columns are all values you have seen before in the Cost Management Knowledge Area during the EVMS discussion.
 - ⇒ **.2 Change requests** — As with many of the processes, the Report Performance Process can bring about new learning in stakeholders, who then request changes.
 - ⇒ **.3 Project management plan updates** — Controlling the communications will often cause new information to be discovered requiring changes to the Project Management Plan.
 - ⇒ **.4 Project document updates** — If you have to update the project management plan you will likely have to update other documents as well.

Communications Management Summary

The communications management knowledge area is one of the easiest on the PMP[®] exam. It is largely common sense with a small amount of memorization. As you study for the exam make sure to focus on the following:

- ⇒ **Three processes** — Make sure you can name the three processes, their inputs, tools and techniques, and the outputs. Do not worry too much if you cannot memorize the inputs, tools and techniques, and outputs. Just know them in general terms.
- ⇒ **Performance reporting** — Performance reporting often centers on earned value and the variance analysis done by comparing the baselines to the actual results. This is followed by determining why there are variances.
- ⇒ **Formula for channels of communication** — Make sure you know and can use the formula for didactic communication $((N(N-1)/2)$.
- ⇒ **Importance/role of project communication** — Above all else, remember no project succeeds without strong communication, and you cannot over-communicate.



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Exercise 18 — Communications Management

1. How many additional channels of communication are there if the number of stakeholders increases from 11 to 13?
 - A. 55
 - B. 23
 - C. 78
 - D. 133
2. How many additional channels of communication are there if the number of stakeholders increases from 7 to 9?
 - A. 15
 - B. 36
 - C. 21
 - D. 19
3. How many channels of communication exist if your project has 8 stakeholders?
 - A. 31
 - B. 56
 - C. 28
 - D. 48
4. How many channels of communication exist if your project has 15 stakeholders?
 - A. 125
 - B. 78
 - C. 64
 - D. 105
5. How many additional channels of communication are there if the number of stakeholders increases from 15 to 17?
 - A. 31
 - B. 59
 - C. 105
 - D. 136
6. How many channels of communication exist if your project has 12 stakeholders?
 - A. 54
 - B. 66
 - C. 74
 - D. 90



Exercise 18 — Communications Management

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7. How many additional channels of communication are there if the number of stakeholders increases from 9 to 12?
 - A. 24
 - B. 30
 - C. 36
 - D. 54
 8. How many channels of communication exist if your project has 18 stakeholders?
 - A. 153
 - B. 94
 - C. 136
 - D. 86
 9. Your project has run into a series of highly complex problems that must be solved. Increasing the use of what type of communication is likely to improve the odds of success?
 - A. Written
 - B. Formal
 - C. Informal
 - D. Verbal
 10. You are taking over a project for a very senior project manager who is retiring. As they leave they advise you to make extensive use of a work breakdown structure to help ensure success. Which of the following would likely explain this recommendation?
 - A. A WBS is a very effective tool within a project team
 - B. A WBS is a very effective tool within the organization
 - C. A WBS is a very effective tool with your external customer
 - D. A WBS is a very effective tool both internally and externally to the project
 11. Which of the following is the last process of the communications management knowledge area?
 - A. Plan communications management
 - B. Manage communications
 - C. Monitor communications
 - D. Manage stakeholder expectations
 12. Which of the following is not a process found in the communications management knowledge area?
 - A. Plan communications management
 - B. Define communications requirements
 - C. Monitor communications
 - D. Manage communication

-
13. Which of the following is the first process found in the communications Management Knowledge Area?
- A. Plan communications management
 - B. Identify stakeholders
 - C. Distribute information
 - D. Report performance
14. Your organization is having a difficult time managing all of its projects. You have been asked to help senior management get a better understanding of the problems. What do you do first?
- A. Meet with individual project managers to get a better sense of what is happening.
 - B. Send a formal memo to all project managers requesting their project plans.
 - C. Meet with senior managers to help them develop a new tracking system for managing projects.
 - D. Review the project charters and Gantt charts for all projects.
15. Project A has had poor project meetings since its inception. There have been complaints that information does not get to the right people, some people are talking too much during the meeting, and the right people are not there to resolve issues. What is most likely missing from this project?
- A. A scope management plan
 - B. A responsibility chart
 - C. A communications management plan
 - D. A resource matrix
16. A company asks one of the project managers to lead a project to create a substantially improved version of one of the company's best selling products. The project manager is given total freedom of decision and resources, including whether to utilize contractor services and/or the company's resource pool. Under these circumstances, which of the following would be the best way for the project manager to build the team?
- A. She should choose her team from the top developers and fabrication workers in the company.
 - B. She should create a team of company line workers and contracts the development services under a "cost reimbursable" contract with provisions to protect confidentiality.
 - C. She should contract the entire team utilizing a "cost plus incentive fee" type of contract.
 - D. She should contract selected team members on an ad hoc and as needed basis utilizing a "time and materials" type of contract.

-
17. While creating the agenda for a status meeting with the team, a project manager receives input from one team member that an item should be added. Another team member says the team is not ready to resolve the item during the meeting. After much discussion, the project manager decides to put the item on the agenda as an initial discussion item only. Which conflict resolution technique is the project manager using?
- A. Compromise
 - B. Smoothing
 - C. Forcing
 - D. Withdrawal
18. To a project manager, what is a disadvantage of progress reports over watching what is going on in a project, asking questions, and assisting team members?
- A. Progress reports include information from all the team.
 - B. Progress reports include information from stakeholders.
 - C. Progress reports generally show problems after they have occurred.
 - D. Progress reports supply information about trends.
19. A resource assigned to your project contacts you, trying to get off the team. He knows that an important project in his department is going to be approved and will take place at the same time as yours. He wants to work on the other project. Under the circumstances, what should you do?
- A. Release him from the team.
 - B. Talk to the functional manager about releasing him from the team.
 - C. Release him after he finds a suitable replacement.
 - D. Speak with the project sponsor about releasing him from the team.
20. A large, one-year telecommunications project is about halfway done when you take the place of the previous project manager. The project involves three different sellers and a project team of 30 people. You would like to see the project's communications requirements and what technology is being used to aid in project communications. Where will you find this information?
- A. Project management plan
 - B. Information distribution plan
 - C. Stakeholder management plan
 - D. Communications management plan
21. As a project manager you are dealing with a series of communication blockers. The most likely result of communication blockers is that:
- A. Conflicts will occur
 - B. The project sponsor will be unsatisfied
 - C. The project will fail to meet its schedule target
 - D. Trust will be improved

-
22. One of the key issues when dealing with didactic communication is that the sender _____ the receiver.
- A. Uses more than one channel with
 - B. Shows concern for the perspective of
 - C. Enunciates clearly to
 - D. Talks more loudly to
23. When is it most likely that formal written communication with the customer is required?
- A. Quality audits fail
 - B. Stakeholders request additional features not specified in the contract
 - C. Changes to the critical path are required to meet the deadline
 - D. The project has cost overruns
24. You are managing a large textile project and have discovered one of your resources is significantly underperforming. What is the best form of communication for addressing this problem?
- A. Informal verbal communication
 - B. Informal written communication
 - C. Formal verbal communication
 - D. Formal written communication
25. When communicating within the boundaries of a contract which communication style tends to be most prevalent?
- A. Informal verbal
 - B. Informal written
 - C. Formal verbal
 - D. Formal written
26. You are leading a U.S. \$250,000 information technology project. Your SPI is 1.04 and your CPI is 0.99. You are 70% through the deliverables of the project. When you do your weekly status updates, which type of communication does it represent?
- A. Informal verbal
 - B. Informal written
 - C. Formal verbal
 - D. Formal written
27. You are leading an effort to complete negotiations for a major new initiative for your organization. In this situation how important are nonverbal communication skills?
- A. Not important
 - B. Very important
 - C. Important only when dealing with requirements
 - D. Important to ensure you win

-
28. You are preparing to lead a large project within your organization that will require over 40 resources and likely take more than 18 months. Where will you likely define the communication requirements and technology used to support good project communication?
- A. The stakeholder management strategy
 - B. The communications management plan
 - C. The information distribution plan
 - D. The project management plan
29. You are leading a \$300,000 manufacturing project. The project has been going for six months and has another four months scheduled. Project information has consistently been delivered in accordance with the communications management plan, and all scope changes have followed the appropriate change management guidelines. One day you are approached by a key stakeholder who is very surprised to learn about a change that was approved two months ago and received by all stakeholders. What should you do?
- A. Ask the sponsor why the stakeholder did not understand their responsibilities.
 - B. Address the situation in the next steering committee meeting to ensure no one else missed the change.
 - C. Review the communications management plan to see what revisions are necessary.
 - D. Determine why the stakeholder did not receive the information and let them know when it was published.
30. You are leading a manufacturing project for your organization that started five months ago. In your latest status meeting two of your resources argue about what needs to be done to complete a work package. To best understand what is going on you should pay the most attention to what?
- A. What is being said and when.
 - B. What is being said, who is saying it, and the time of day.
 - C. Physical mannerisms and what is being said.
 - D. The pitch and tone of the voices and the physical mannerisms.
31. You have been selected to lead a major project for a large petroleum company. The project is critical to the organization's success. The project is going to consist of resources from three different continents. What type of communication should be used?
- A. Informal verbal
 - B. Informal written
 - C. Formal verbal
 - D. Formal written

-
32. It is Friday afternoon and you are conducting your normal end-of-week status meeting. Unfortunately, it is not going well. Everyone is talking over each other, some team members are not participating, and topics are being raised and discussed totally randomly. Which of the following rules for effective meeting management is not being followed?
- A. Every meeting must have a purpose and the correct participants in attendance.
 - B. Meetings should be scheduled in advance.
 - C. Create and publish an agenda with a set of rules for controlling the meeting.
 - D. Participants should demonstrate courtesy and take turns speaking.
33. You are on a business trip visiting a client site at a location that is in a time zone two hours ahead of the client site. As the project manager you are conducting your weekly status meeting with your team via telephone. Which of the following is the most important to ensure good communication with your team?
- A. Review the list of attendees and deliverables
 - B. Ask team members to repeat back what you ask them to do
 - C. Ask the team members to discuss change requests
 - D. Review work status
34. Which of the following are always stakeholders?
- A. A person who does not want the project completed
 - B. A union worker who will use the product or service
 - C. A functional manager from the finance department
 - D. A worker who might lose their job because of the project
35. Six months into a one-year project everything is going well. The project currently has an SPI of 1.05 and a CPI of .99. The stakeholder management strategy has worked well and the BCI has been steadily improving. The sponsor just left your office after expressing their gratitude for you and your team's hard work. You get a call from one of your resources saying the deliverable from the completion of their activity's predecessor is three days late. Which of the following reasons would best describe why this occurred?
- A. The project manager was focusing on the sponsor's needs.
 - B. The successor activities should have been watched, not the predecessors.
 - C. Functional management was not included in the communications management plan.
 - D. The right people were invited to the milestone party.

-
36. You are leading a small information technology project which is scheduled to take one year and is approximately halfway complete. You have just taken over as the project manager. The project involves four different external resources and a project team of 25 people. You would like to see the project's communications requirements and what technology is being used to aid in project communications. Where will you find this information?
- A. The project management plan
 - B. The information distribution plan
 - C. The bar chart
 - D. The communications management plan
37. Changes to some project deliverables have been documented in the project management plan. These changes, and other project information, have been distributed according to the communications management plan. One stakeholder expressed surprise to the project manager upon hearing of a documented change to a project deliverable. All stakeholders received the communication containing notification of the change. What should the project manager do?
- A. Determine why the stakeholder did not receive the information and let him know when it was published.
 - B. Ask the functional manager why the stakeholder did not understand his responsibility.
 - C. Review the communications management plan and make revisions if necessary.
 - D. Address the situation in the next steering committee meeting so others do not miss published changes.
38. Two people are arguing about what needs to be done to complete a work package. If the project manager wants to know what is going on, she should pay most attention to:
- A. What is being said and when
 - B. What is being said, who is saying it, and the time of day
 - C. Physical mannerisms and what is being said
 - D. The pitch and tone of the voices, and physical mannerisms
39. A project manager has a project team consisting of people in four countries. The project is very important to the company, and the project manager is concerned about its success. The length of the project schedule is acceptable. What type of communication should he use?
- A. Informal verbal communication
 - B. Formal written communication
 - C. Formal verbal communication
 - D. Informal written communication

-
40. The project status meeting is not going well. Many attendees are talking at the same time, there are people who are not participating, and any topics are being discussed at random. Which of the following rules for effective meetings is not being adhered to?
- A. Demonstrate courtesy and consideration of each other, and control who is allowed to speak.
 - B. Schedule meetings in advance.
 - C. Have a purpose for the meeting, with the right people in attendance.
 - D. Create and publish an agenda and a set of rules for controlling the meeting.
41. A project manager overhears a conversation between two stakeholders who are discussing how unhappy they are with the impacts of the project on their own departments. Stakeholder A asks if the project is on time, and stakeholder B replies that the SPI is 1.05. Stakeholder A asks if the project manager for the project knows of stakeholder B's concern. Stakeholder B responds that he is not sure. What is the best thing for the project manager to do?
- A. Make sure the stakeholders see that the project manager overheard. Then ask them to direct any questions in writing to the project manager.
 - B. Make a presentation to all the stakeholders regarding the status of the project.
 - C. Send both stakeholders a copy of the issue log and ask for additional comments.
 - D. Arrange a meeting with both stakeholders to allow them to voice any concerns they may have.
42. During the middle of the project, things have been going well. The work authorization system has allowed people to know when to start work, and the issue log has helped keep track of stakeholders' needs. The sponsor has expressed appreciation for the team members' efforts by hosting a milestone party. The project manager gets a call from a team member saying the results from the completion of her activity's predecessor are two days late. Which of the following reasons would best describe why this occurred?
- A. The project manager was focusing on the sponsor's needs.
 - B. Functional management was not included in the communications management plan.
 - C. The successor activities should have been watched, not the predecessors.
 - D. The right people were not invited to the milestone party.

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43. You are leading a project that has 20 team members and affects more than a dozen departments in the organization. Your project has been going well and you are approximately 1/3 complete and the project has been going so well that you decide to hold a party to celebrate. You invite all the key stakeholders to the party so the team can have the opportunity to communicate informally with the stakeholders about their efforts. At the party, you walk around to try to discover any relevant information that would help you make the project even more successful. You happen to hear one of the senior stakeholders talking about setting up more regular meetings on the project. Which of the following would be the best thing to do?
- A. Review the information distribution methods on the project.
 - B. Provide the executive a copy of the communications management plan and remind them that all such concerns should be brought to you, the project manager.
 - C. Record the effectiveness of the party in the lessons learned for future events.
 - D. Arrange the requested meeting with the stakeholder and team.
44. The requirements from several of your stakeholders were not approved for inclusion in your project, and you had a difficult time receiving formal approval of the project management plan. The stakeholders argued and held up the project with meeting after meeting about their requirements. The project was finally approved and work began three months ago. All of the following would be good preventive actions to implement except which:
- A. Maintain an issue log.
 - B. Ensure the change control process is not used to reintroduce the requirement back into the project.
 - C. Hold meetings with the stakeholders to go over the work that will not be added to the project.
 - D. Keep a log of the not included requirements.
45. One of your project resources calls in to a normal status meeting. During their update you cannot hear them well due to interference from their cell phone. A few weeks later you call the resource to locate a past due deliverable and the resource reminds you that they had told you previously that the deliverable would be late. You do not remember being told and question when the resource informed you of the delay. They tell you it was during the meeting where they were on the phone. What could have been done to avoid this problem?
- A. Para-lingual communication
 - B. Feedback during the communication
 - C. Better attention to determining communication requirements
 - D. Adding to the issue log after the phone call

Exercise 18 — Communications Management Answers

1. **Answer B.** To answer this question you must remember the formula for Didactic Communication: $(n * (n-1)) / 2$ where n represents the number of people in question. This question is asking the difference so you must calculate the number of channels for each situation and then calculate the difference between the two.
2. **Answer A.** To answer this question you must remember the formula for Didactic Communication: $(n * (n-1)) / 2$ where n represents the number of people in question. This question is asking the difference so you must calculate the number of channels for each situation and then calculate the difference between the two.
3. **Answer C.** To answer this question you must remember the formula for Didactic Communication: $(n * (n-1)) / 2$ where n represents the number of people in question.
4. **Answer D.** To answer this question you must remember the formula for Didactic Communication: $(n * (n-1)) / 2$ where n represents the number of people in question.
5. **Answer A.** To answer this question you must remember the formula for Didactic Communication: $(n * (n-1)) / 2$ where n represents the number of people in question. This question is asking the difference so you must calculate the number of channels for each situation and then calculate the difference between the two.
6. **Answer B.** To answer this question you must remember the formula for Didactic Communication: $(n * (n-1)) / 2$ where n represents the number of people in question.
7. **Answer B.** To answer this question you must remember the formula for Didactic Communication: $(n * (n-1)) / 2$ where n represents the number of people in question. This question is asking the difference so you must calculate the number of channels for each situation and then calculate the difference between the two.
8. **Answer A.** To answer this question you must remember the formula for Didactic Communication: $(n * (n-1)) / 2$ where n represents the number of people in question.
9. **Answer A.** PMI[®] breaks down the types of communication as formal vs. informal and verbal vs. written. The more complex the situation the more written, formal communication is beneficial.
10. **Answer D.** According to PMI[®], the WBS is one of the most effective tools possible for communicating what deliverables must be produced to anyone involved in the project. Remember, according to PMI[®] WBSs rule!

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11. **Answer C.** PMBOK® Guide p. 360 – The processes found in the communication management knowledge area include:
- ⇒ Plan communications management
 - ⇒ Manage communications
 - ⇒ Monitor communications
12. **Answer B.** PMBOK® Guide p. 360 – The processes found in the communication management knowledge area include:
- ⇒ Plan communications management
 - ⇒ Manage communications
 - ⇒ Monitor communications
13. **Answer A.** PMBOK® Guide p. 360 – The processes found in the communication management knowledge area include:
- ⇒ Plan communications management
 - ⇒ Manage communications
 - ⇒ Monitor communications
14. **Answer A.** Always remember, the first step is to analyze the situation to see what is happening. If this is a choice take it!
15. **Answer C.** A common cause of project failure is not having a communication management plan. It is a simple document that provides significant help managing expectations.
16. **Answer A.** Hopefully, this was an easy one. The key here is remembering to always take the best resources you can. Most of the question is a ruse designed to distract you.
17. **Answer A.** This question moves back into the resource management knowledge area. Of the choices given, compromise is the lesser of four evils.
18. **Answer C.** This question is driving at the important distinction between being reactive and proactive. As a project manager your goal is to always be proactive.
19. **Answer B.** There are two issues here. First, a resource that does not want to be on your project is likely not going to be that committed to the effort. Secondly, if you are willing to try to help the resource out you can build trust with them for the next project.
20. **Answer D.** This is a simple definitional question. The communication management plan defines all aspects of communication for the project.
21. **Answer A.** The single most common result of blocked or poor communication is conflict. Remember, conflict is not necessarily bad. How we choose to handle it will define whether it is good or bad.
22. **Answer B.** Didactic communication, or one-on-one communication, is most successful when the sender displays empathy for the receiver's perspective.

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23. **Answer B.** The introduction of the word contract creates a level of formality that does not exist in the other options. It is therefore the best option.
 24. **Answer A.** This question is about communication between two parties. The first thing you need to do is let the resource know you are not happy with their performance and only when that does not work go to more formal styles of communication. Note that this does not mean you do not keep a record of the communication.
 25. **Answer D.** Whenever a contract becomes involved communication tends toward the formal and written style.
 26. **Answer D.** Weekly status reports are assumed to be a formal written part of the project management process unless specifically defined otherwise.
 27. **Answer B.** Remember that nonverbal communication accounts for 55% of understanding in any communication scenario.
 28. **Answer B.** Although the communications management plan is part of the project management plan, the communications management plan is the best answer as it directly answers the question.
 29. **Answer C.** This is a trick question of sorts. The question states that all stakeholders received the information about the change so option D is out. The next best option is reviewing the communications management plan and determining what changes need to be made.
 30. **Answer D.** The question amounts to asking you where do we get most of our understanding. We get 55% from nonverbal communication. We get 38% from tone and the remaining 7% from the actual words being said.
 31. **Answer D.** Distance, the potential for language barriers, time barriers and cultural barriers make formal written communication the best choice.
 32. **Answer C.** This is a problem where the meeting participants lack any structure and are therefore not achieving the desired results. Meetings should always have an agenda, and the team needs to have a standard set of rules by which it will operate.
 33. **Answer B.** This question is taking you back to the didactic communication model. That model describes the importance of two loops. The initial communication loop goes from the sender to the receiver and the second loop (required to ensure good communication) goes from the receiver back to the sender.
 34. **Answer B.** The user of the result of a project is always a stakeholder. The others might or might not be stakeholders.

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35. **Answer C.** Since the question does not provide any information about the sponsor, focusing on their needs cannot be the answer. A good project manager watches both predecessors and successors, and notifying different people about the achievement of milestones would not impact the call you received. Often we forget the bosses of team members in the communication management plan. If the functional manager of the team member assigned to the predecessor activity had been included, he or she would have known when the team member was needed to do work and the impact of any delay.
36. **Answer D.** Although the information is found within the project management plan, the communications management plan is the best answer because it directly answers the question.
37. **Answer C.** The question states that all stakeholders received the information, so the issue is not that this stakeholder did not receive it. The problem presented here illustrates that there is something missing in the communications management plan. The best answer is to review the communications management plan in order to prevent future problems and find any instances of similar problems.
38. **Answer D.** Remember that nonverbal communication represents 55% of all communication. The choice including para-lingual communication (pitch and tone), as well as physical mannerisms, is the best choice.
39. **Answer B.** Because of the differences in culture and the distance between team members, formal written communication is needed.
40. **Answer D.** Courtesy and consideration is not a “rule” for effective meetings. Since there is no indication that the meeting was not scheduled in advance or that there isn’t a purpose, these cannot be the best answers. “Discussed at random” implies no agenda. If an agenda is issued beforehand, people will follow the outline and should not need random discussions.
41. **Answer D.** This is another question with more than one right answer. Would asking for something in writing be the best way to communicate? In this particular situation, asking for the concern to be in writing might alienate the stakeholders. The issue log is where the issue should be listed, but the situation does not say if the project manager knows what the stakeholders’ concern is. Therefore, using the issue log cannot be the best choice. This problem would likely require informal verbal communication to discover the real problem. Arranging a meeting with the concerned stakeholders is therefore the best choice.

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42. **Answer B.** Since there is no information about the sponsor or his needs in this situation, focusing on his needs cannot be best. The statement that successor activities should have been watched, rather than predecessors, is not a correct statement. A good project manager always watches both. Often forgotten in communications management plans are the bosses of team members. In addition, it helps the functional managers to manage their resources effectively. If the functional manager of the team member assigned to the predecessor activity had been included in the project planning processes, he would have known when the team member was needed to do the work for the project and the impact of any delay. The communications management plan should have also included a method to communicate potential delays.
43. **Answer A.** This is another example of a question where you might want to do several of the items listed. The real question is what would you do first? In this case you must realize that the fact that one of your key stakeholders is asking for more meetings means they are not getting the information they need. Adding more meetings will not solve the problem and often too many meetings is a key problem for project managers. The correct answer is figure out why the stakeholder is not getting the information they require which requires a review of the information distribution methods of the project.
44. **Answer C.** You have already held a lot of meetings which added little value. Holding more meetings will not help to convince the stakeholders about something they feel passionate about. The best you can hope for is establishing parameters to protect the project.
45. **Answer B.** Giving and requesting feedback is always the best way to ensure understanding. Para-lingual is simply dealing with the pitch and tone of communication and adds no value. The issue log would not have prevented the problem as the project manager did not know what to write.

Risk Management

Overview

Chapter eleven of the PMBOK® Guide is dedicated to the risk management knowledge area. There are seven processes found in the risk management knowledge area. These processes include:

- ⇒ 11.1 Plan risk management
- ⇒ 11.2 Identify risks
- ⇒ 11.3 Perform qualitative risk analysis
- ⇒ 11.4 Perform quantitative risk analysis
- ⇒ 11.5 Plan risk responses
- ⇒ 11.6 Implement risk responses
- ⇒ 11.7 Monitor risks

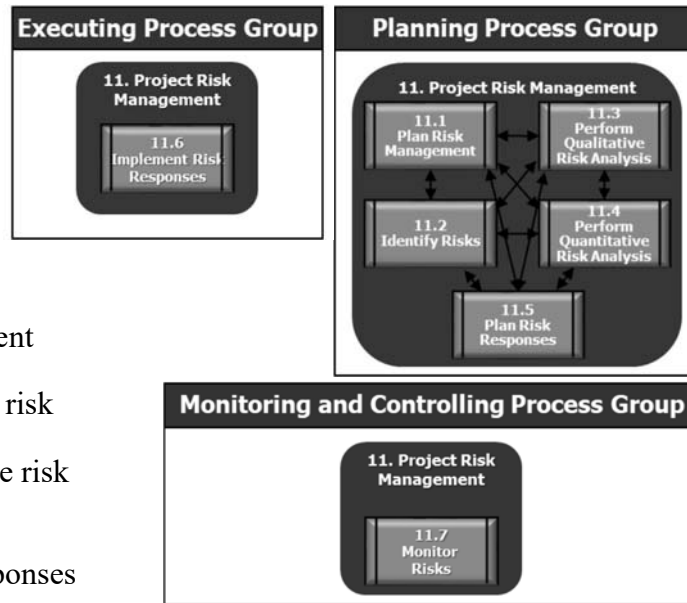


Image 112: Plan Risk Management

The risk management knowledge area includes the processes concerned with conducting risk management planning, identification, analysis, responses and monitoring and control on a project. It is typically one of the most difficult knowledge areas on the exam for three reasons. First, risk management requires you to memorize and understand the six processes exactly in order without variation. This includes having a very strong understanding of the inputs, tools and techniques, and the outputs of each process. Second, PMI's understanding of risk is likely very different from the one you are used to. Finally, the risk management knowledge area provides the last major set of calculation and modeling techniques that must be learned in this course. As we progress through this chapter, several techniques will be provided to help you memorize the processes involved in risk management.

So what is risk? Risks are simply unknown events which might happen. According to PMI®, risks exist at two levels for every project. The first level is the individual project risk. This level addresses an uncertain event or condition that, if it occurs, has a positive or negative effect on one or more project objectives. The second level of project risk is overall project risk. This is the effect of uncertainty on the project as a whole, arising from all sources of uncertainty including individual risks, representing the exposure of stakeholders to the implications of variations in project outcome, both positive and negative. [PMBOK® Guide 6th Ed. p. 397]

The goal of risk management is to increase the probability and impact of positive risks and decrease the probability and impact of negative risks, realizing that

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Risk Management is the most difficult knowledge area on the exam. Dedicate extra time to learning it.

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Risks can be positive or negative.



Image 113: Risks impact all other knowledge areas

risks often have more than one cause and more than one impact. Project risk management is absolutely critical to project success because it impacts every other knowledge area. Risks can occur any where at any time and successful project managers know they must effectively manage the risks to deliver results.

The definition of a risk gets more complicated. Not only are there two types of risks, good and bad risk, there are also two further categories within each of these: known unknowns and unknown unknowns. Are you confused yet?

An unknown is just something that might happen. Its result could be good or bad. The real question is do you know whether it is a possibility or not? If the possible future event is visible to you, i.e. you know it might happen, we say that is a known unknown. If the risk is something which is not visible to you or you do not know about it, we call it an unknown unknown. Why the distinction? Known unknowns can be planned for and become the responsibility of the project manager. Unknown unknowns cannot be planned for and require management reserves or general contingency. Unknown unknowns can only be recognized once they have occurred. Up to 90% of the risks on a project fall into the known unknown category and can be identified, investigated, and planned for.

Before discussing the processes involved with the risk management knowledge area, a few terms must be defined.

⇒ **Risk Tolerance** — Risk tolerance is the amount of risk a person or group of people is willing to accept. It is the project manager's responsibility to ensure that the project operates within the risk tolerance of the sponsor and key stakeholders.

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- ⇒ **Risk Averse** — Someone who is risk adverse has a low risk tolerance. A sponsor or key stakeholder who is risk adverse can significantly impact the delivery of a project by limiting the choices the project manager and team may make to achieve desired project results.
 - ⇒ **Risk Factors** — Risk factors are drivers or descriptors of a project risk. The key risk factors are largely common sense and are listed below.
 - ◇ **Probability & Impact** — Probability defines how likely the risk is to occur. Impact defines the result of the risk. Typically, project risks are scored using a probability and impact (or PI) score which will be described later in this chapter.
 - ◇ **The range of possible outcomes** — Many risks have more than one possible outcome. Understanding that range can be an important element in successfully managing the project risk and delivering the project.
 - ◇ **Expected timing in the project life-cycle** — When a risk occurs, it can have a significant impact on the overall success of the project. For example, many risks that occur early in the project are easier to overcome than those which occur late in the timeline.
 - ⇒ **Variability risk** — This is a non-event risk. Uncertainty exists about some key characteristics of a planned event, activity, or decision. Variability risks include things such as productivity being above or below a target, the error count found during testing being higher or lower than expected, or weather conditions impacting construction.
 - ⇒ **Ambiguity risk** — Uncertainty exists about what might happen in the future. This risk deals with the fact that there are areas of imperfect knowledge that might impact the team's ability to achieve the project's objective. Examples changes in regulation or law, or inherent systemic complexity.
 - ⇒ **Project resilience** — Resilience is the ability to overcome unknown risks when they occur. Resilient projects have a much higher probability of success.
 - ⇒ **Integrated risk management** — Integrated risk management provides a coordinated approach to enterprise-wide risk management to ensure alignment and coherence to ensure risks are managed across all levels of the organization. Using an integrated approach to risk management build risk efficiency into the structure of the performing organization.

11.1 Plan Risk Management

The first process in the risk management knowledge area is plan risk management. The plan risk management process is focused on deciding how to approach and conduct risk management activities for a project. Like the other planning processes within the PMBOK® Guide, the primary output of the plan risk management process is the risk management plan. As the project manager



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and team develop this plan, it is important that they ensure the level, type, and visibility of risk management activities are commensurate with both the risk and importance of the project. The objective is to maximize the return while minimizing required costs. It is important that the Project Management Plan provides sufficient resources and time for risk management activities. In other words, don't short-change risk management! As part of this plan it is important to establish an agreed-upon basis for evaluating risks and clearly document this basis.

The inputs to the plan risk management process include the following:

- ⇒ **.1 Project charter** — The project charter defines the overall business need and justification, along with the constraints, assumptions, and success criteria used on the project.
- ⇒ **.2 Project management plan** — The project management plan provides the team with all the subsidiary plans and baselines necessary to gain a basic understanding of which risks are likely to be experienced during the project.
- ⇒ **.3 Project documents** — For most projects the greatest single risk is people. They have a tendency to do the darnedest things! Understanding your stakeholders, their expectations, and how they fit into the organization, can provide critical information to successfully managing project risks. To provide this information, the project leader must look at the stakeholder register.
- ⇒ **.4 Enterprise environmental factors** — The environment can have a significant impact on project risks. Items like the labor market, technology, the economy or other factors specific to the organization can greatly influence project risks and must be considered.
- ⇒ **.5 Organizational process assets** — Many organizations have standardized risk management practices, templates, policies and/or tools which must be used or that may aid the team.

The tool and technique used in the plan risk management process are the following:

- ⇒ **.1 Expert judgment** — Nowhere is expert judgment more valuable than in the management of risks. Sometimes, you just have to have been there and done that.
- ⇒ **.2 Data analysis** — In this first risk process, the most important type of data analysis is stakeholder analysis.
- ⇒ **.3 Meetings** — In many situations it is important to get the expert judgment



Image 114: Plan Risk Management



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of others. This requires getting together and actually talking to each other. The most important meeting is the project kick-off meeting because it is the first meeting of the project.

The entire purpose of this process is to develop a single output, the risk management plan. This plan has a number of components that you must know for the exam. These include the following:

- ⇒ **Methodology** — Methodology defines the processes and practices the team intends to use to manage the project risks. It answers the question *how?*
- ⇒ **Roles and Responsibilities** — The roles and responsibilities define who will do what to manage the various project risks using the defined methodology.
- ⇒ **Budgeting** — Budgeting defines how much money is available for the various risk management activities and when that money will be available.
- ⇒ **Timing** — A key question in risk management is: when do the various risk management activities need to occur? We are not referring here to the risks themselves, which will later be defined.
- ⇒ **Risk Categories (RBS)** — Establishing the categories which will be used can be an important tool to manage project risks. The most common form of categorization is a risk breakdown structure, or RBS. This is one of two definitions for the acronym RBS. The other is a resource breakdown structure, which is used in project resources management to define the organization of the project team. A risk breakdown structure shows the risks organized into groups or categories without any prioritization or other measure. It is a visual representation of the statement, these risks go together. *Image 115* shows a sample risk breakdown structure.

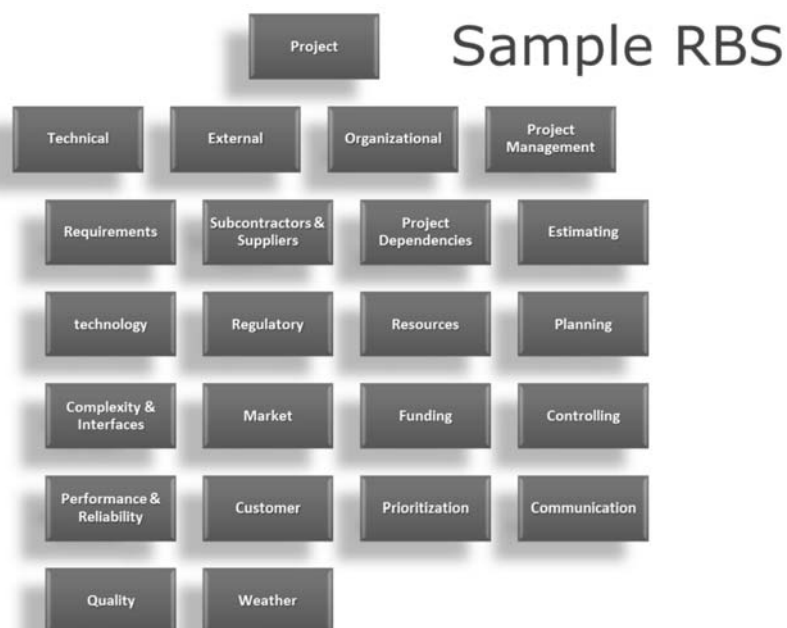


Image 115: A sample Risk Breakdown Structure (RBS)



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Make sure to know what is included in a Risk Management Plan.



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- ⇒ **Revised stakeholder tolerances** — The tolerance data tells the team how much risk the various stakeholders feel comfortable accepting. Keeping this information updated is critical to managing stakeholder expectations.
- ⇒ **Reporting formats** — Reporting formats define how the outcomes of the risk management processes will be documented, analyzed and communicated. It defines both the content and format of the risk register.
- ⇒ **Tracking** — Tracking documents are how the various risk activities will be recorded for both the current project and lessons learned.
- ⇒ **Definitions of probability and impact** — Risks are typically prioritized according to their potential implications for having an effect on project objectives. There are a number of scales which may be used to represent both the probability and impact of a project risk. The most common measures use linear, non-linear, or relative scales to represent the data. The most common risk categories to be represented using these scales are cost, time, scope, and/or quality.
 - ◇ **Linear Scale** — A linear scale increments a consistent amount as values climb the scale. The most common example of a linear scale occurs in measuring the probability of a project risk occurring and often uses values of 1, .3, .5, .7, .9.
 - ◇ **Non-linear Scale** — A non-linear scale climbs the scale using some factor that is not linear. A common example is an impact scale where the scores double at each interval such as with the values .05, .10, .20, .40, .80.
 - ◇ **Relative** — A relative scale is one where the distance between one measure and the next may not be measured or interpreted. A simple example is seen with the values very low, low, medium, high, very high.

Matrices — The purpose of the matrices during planning is to define impact and probability ratings. These will be used to evaluate risks that will be identified later. *Image 116* shows a sample impact matrix which could be used to score potential project risks. Think of it as the rules for scoring project risks.

Defined Conditions for Impact Scale of a Risk on Major Project Objectives					
<i>(Examples are shown for Negative Risks Only)</i>					
Project Objectives	Relative or Numerical Scales are Shown				
	Very Low / .05	Low / .10	Medium / .20	High / .40	Very High / .80
Cost	Insignificant cost increase	<10% cost increase	10%-20% cost increase	20%-40% cost increase	>40% cost increase
Time	Insignificant time increase	<5% Time increase	5%-10% time increase	10%-20% time increase	>20% time increase
Scope	Scope decrease barely noticeable	Minor areas of scope affected	Major areas of scope affected	Scope reduction unacceptable to sponsor	Product of project is effectively unusable
Quality	Quality degradation barely noticeable	Only very demanding applications are affected	Quality reduction requires sponsor's approval	Quality reduction unacceptable to sponsor	Product of project is effectively unusable

Image 116: A Sample Impact Matrix



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11.2 Identify Risks

The second process found in the risk management knowledge area is identify Risks. This process is concerned with determining which risks might affect the project and documenting their characteristics. This process is managed by the project manager and project team but may involve any project stakeholders or designated resources necessary for success. The identify risks process produces one of the largest processes found in the PMBOK® Guide in terms of the number of inputs, tools and techniques, and outputs. Do not be intimidated by the list. It is largely common sense. Recognize the standard PMI® process model and it becomes very easy. The first step is always to plan. The second step is to always do what the plan says. The third step is to examine the work to ensure the appropriate results, and the final step is to make corrections where necessary. This is a fancy way to say the PDCA process!



Image 117: Identify Risks Process

The inputs to the identify risks process include:

- ⇒ **.1 Project management plan** — The project management plan provides the primary project documents. In this case you need to examine the requirements management plan, the schedule management plan, the cost management plan, the quality management plan, the resource management plan, the risk management plan, the scope baseline, schedule baseline, and the cost baseline. Risks can come from anywhere so each of the primary plans is an important potential risk source.
- ⇒ **.2 Project documents** — In addition to looking at the primary documents for potential risks, the team also needs to examine the secondary project documents for potential risks. This list includes: the assumption log, the cost and duration estimates, the issues log, lessons learned register, requirements documentation, resource requirements, and the stakeholder register.
- ⇒ **.3 Agreements** — If the team must procure resources outside the project team, and remember this is often things other than people, they need to look at information within these agreements for information such as milestone dates, contract types, acceptance criteria, and awards and penalties that can present threats and/or opportunities to the team.
- ⇒ **.4 Procurement documentation** — The team already has the contracts and other agreements for the items being purchased outside the organization, so why is there a need for this input? It represents the original procurement documents where the team defined the need to purchase goods and services outside the team. This decision and the reasoning behind it can increase or decrease the risks to the project and therefore must be examined.



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- ⇒ **.5 Enterprise environmental factors** — The enterprise environmental factors which can influence the identification of risks include published information, academic databases, published checklists, benchmarking, industry studies, or risk attitudes.
 - ⇒ **.6 Organizational process assets** — The organizational process assets that can influence the identification of risks include project files, including actual data, organizational and project process controls, and risk statement templates.

The tools and techniques used in the identify risks process are as follows:

- ⇒ **.1 Expert judgment** — The most powerful tool at any project manager’s disposal is his or her team. Trusting the knowledge of the team is critical to project success. Agile development makes this point by establishing a rule, “take it to the team,” as a core mindset. Every project manager needs to learn to trust this rule.
- ⇒ **.2 Data gathering** — There are a number of information gathering techniques that may be used. However, three techniques are dominant. These techniques include the following:
 - ◇ **Brainstorming** — There are many situations that require the team to discuss various ideas or options for addressing issues within the project. Many of these situations warrant the use of some form of brain storming. The term brain storming was first popularized by Faickney Osborn in the 1953 book Applied Imagination. This book defines brainstorming as a group creativity technique by which efforts are made to find a conclusion for a specific problem by gathering a list of ideas spontaneously contributed by its members. For the PMI-ACP Exam, there are a number of these techniques with which you must be familiar.
 - ⇒ **Quiet Writing** — This is a brain storming technique where the individual team members are given time to generate an individual list of ideas before sharing them with the team. This technique has the advantage of limiting peer influence in the initial creation of ideas which often results in a larger initial list.
 - ⇒ **Round-Robin Brainstorming** — This brain storming technique requires the team to take turns suggesting one or more ideas to address specific project needs. It is often used in conjunction with the Quiet Writing technique and it continues to the bias towards ensuring each team member actively participates in the process.



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- ⇒ **Free-For-All** — This is the most common brain storming technique. However, many do not even think about it when deciding how to conduct a brain storming session it just happens. A free-for-all occurs whenever team members shout out ideas without any rules or constructs. In many cases team members shout out over each other making it difficult for team members to hear each other.
- ⇒ **Green Zone / Red Zone** — This is a model first described by Lyssa Adkins. It represents more than a simple brain storming technique, but a way of establishing organizational guidelines for positive performance. In the model, Atkins describes two states of being in which we all exist, a red zone and a green zone. The red zone is a space where we become defensive and act in a rigid way. When we become rigid, we typically stop thinking and turn to using most of our abilities to protect ourselves from the others members of our team. Our need for self preservation is important, but we must learn to control it and turn it towards a positive direction. To do this we must learn to recognize when we are entering the Red Zone. The defensive response pattern can take many forms but it most commonly highlighted by a response to fight, flee, or freeze. Physically, emotionally, and intellectually team members are in a heightened state that focuses on self-protection and defending. When in the Red Zone there are a number of possible tendencies:
- ◇ Blaming others for the circumstances of their life.
 - ◇ Feeling threatened or wronged.
 - ◇ Our actions trigger defensiveness in others.
 - ◇ We do not seek or value feedback from others.
 - ◇ We regularly communicate a high level of disapproval and contempt for our teammates.

The Red Zone is not likely to be a place of collaboration, trust building, mutual problem solving, or deeper self-reflection and shared accountability. According to the most Agile thought leaders, each of these are critical for project and team success.

The alternative to the Red Zone is the Green Zone. When we are in the Green Zone we feel relaxed, safe, alive, and emotionally significant, competent and likable. Being in the Green Zone allows team members to be intellectually open and honest. They can consciously operate in a non-defensive, cooperative, problem-solving, accountable state. When we are in the Green Zone we do not see conflict situations as a threatening. When a team member is in the Green Zone the exhibit the following qualities:



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- ◇ They take responsibility for the circumstances of their life.
 - ◇ They seek to respond to the actions and words of others in a non-defensive manner.
 - ◇ Team members seek solutions rather than blame.
 - ◇ They welcome feedback.
 - ◇ They communicate a caring attitude to the other members and to stakeholders.
 - ◇ **Checklists** — Checklists are often used as reminders of things the team needs to examine or consider. Most, are based on historical information. The team begins with a list of items they believe needs to be considered. As other projects are completed the team gains experience and finds things they believe the checklist missed. These items are then added to the checklist for future use. Additionally, many industries have standardized checklists that provide an excellent starting point for the team. However, be careful. The danger of a checklist is that often users believe it to be a complete list. It is important that the team looks beyond the checklist for potential risks.
 - ◇ **Delphi Technique** — The Delphi Technique is a survey methodology that targets subject matter experts in a three step process.
 1. Survey the subject matter experts about the subject in question.
 2. Aggregate the survey results and feed them back to the experts for review.
 3. Have the experts consolidate the responses to a consensus opinion.

When using the Delphi Technique, this process is repeated until a single position is established. This technique is useful because it reduces bias.
 - ◇ **Interviews** — Interviewing is a less structured process than the Delphi Technique, but is more structured than the brainstorming techniques.
- ⇒ **.3 Data analysis** — Once the team has collected data about potential risks they must sit down and decide what the information means for the project. There are a number tools the team can use to aid this process.
- ◇ **Root cause analysis** — Root cause analysis is often completed using a fishbone or Ishikawa diagram as part of a brainstorming session. We have discussed this process at length earlier in our course.
 - ◇ **Assumption and constraint analysis** — Every project uses a large number of assumptions. Many risks can be discovered by examining these assumptions and testing them against reality.



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- ◇ **SWOT analysis** — SWOT stands for Strengths, Weaknesses, Opportunities, and Threats. This is a brainstorming technique that makes use of a four square grid to direct the group discussion. The group discusses each area in order before moving to the next area, noting key phrases or elements for each quadrant.
 - ◇ **Document analysis** — In addition to generating ideas about potential risks as a group, the team should also spend time examining the various project documents for potential risks.
- ⇒ **.4 Interpersonal and team skills** — This process places a heavy emphasis on collaborative work. Therefore, there is a strong need for the project leader to engage as a facilitator to help the team identify potential project risks.
- ⇒ **.5 Prompt lists** — Prompt lists are predetermined lists of risk categories. They provide the team with a head start on the process of brainstorming as they generate ideas about potential risks. Usually, the lists are based on lessons learned from previous projects, but other are more generic such as:
- ◇ **PESTLE** — Political, economic, social, technological, legal, environmental.
 - ◇ **TECOP** — Technical, environmental, commercial, operational, political.
 - ◇ **VUCA** — Volatility, uncertainty, complexity, ambiguity.
- ⇒ **Meetings** — If expert judgment is the project manager's primary tool, then meetings are his or her primary technique. Meetings allow the team to make use of many of the practices discussed in this section. By getting the team and stakeholders together the group becomes stronger and can share information.

There are three outputs to the identify risks process, and there definitely is an order of importance to them.

- ⇒ **.1 Risk register** — The primary output of the identify risks process is the list of identified risks. This list appears in a document called the **risk register**. In addition to the list of risks, the Risk Register includes the following:
- ◇ A description of the risks.
 - ◇ Potential responses for each risk, if known.
 - ◇ Owners for each risk.
 - ◇ Root causes of each risk.
 - ◇ Categories for each risk.
- ⇒ **.2 Risk report** — The risk report is a new document added in the 6th edition of the PMBOK® Guide. It is a report that presents information on sources of overall project risks, and it is developed progressively throughout the entire project. The results from each of the risk processes are included in this report. Many people look at this report as redundant with the risk register, but a better way to think about it is similar to the relationship between the WBS and WBS dictionary.



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- ⇒ **.3 Project document updates** — As the team goes through the process of identifying potential project risks they likely acquired additional understanding and information about other aspects of the project. This might require them to update the assumption log, the issue log or the lessons learned register.

11.3 Perform Qualitative Risk Analysis

The perform qualitative risk analysis process is where most exam candidates begin to have problems. As has been stated before, and will be stated again, it is very important you get these risk processes in order. Additionally, the qualitative and quantitative risk analysis processes are very close together. You cannot confuse them. The perform qualitative risk analysis process is about prioritizing the identified risks for further action. It uses the probability and impact scoring defined earlier in the plan risk management process. This process only analyzes the defined risks enough to produce an ordered list of risks. The people completing this process only need to know the subject matter enough to compare the risks to order the list.



Image 118: Perform Qualitative Risk Analysis

The inputs to the perform qualitative risk analysis process are as follows:

- ⇒ **.1 Project management plan** — Within the project management plan the team specifically needs to know about project risks this means looking at the risk management plan defines the processes used to prioritize the project risks and is therefore an input.
- ⇒ **.2 Project documents** — The project documents outside the project management plan the team must examine include the assumption log, the risk register, and the stakeholder register. The assumption log provide information about why the team thought what they did. The risk register defines the known risks, and the stakeholder register informs the team on who the players are on the project.
- ⇒ **.3 Enterprise environmental factors**—What is going on around the project and team can significantly influence the prioritization of project risks.
- ⇒ **.4 Organizational process assets** — Information from similar or prior projects or risk databases can inform the team of important qualitative risk information.

The tools and techniques used in the perform qualitative risk analysis process include the following:

- ⇒ **.1 Expert judgment** — Often the most common and powerful qualitative risk assessment tool is expert judgment because subject matter experts have the best understanding of potential risks.



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- ⇒ **.2 Data gathering** — There are a lot of different data gathering techniques we have already discussed in this course. All of those techniques are available here.
 - ⇒ **.3 Data analysis** — After the data is collected, it must be examined and there are a lot of different ways to do it. Potential methods for qualitative data analysis.
 - ◇ **Risk data quality assessment** — The risk data quality assessment answers the question: how accurate and credible is the data? If the data does not represent the real situation or cannot be trusted for some reason, acting upon the conclusions drawn from it could cause significant harm to the project. Therefore, it is important the project team examine the data's accuracy and credibility.
 - ◇ **Risk probability and impact assessment** — The risk probability and impact assessment is done for each identified risk. These assessments examine the likelihood of the risk occurring and how significant the risk would be should it occur.
 - ◇ **Assessment of other risk parameters** — There are a lot of other characteristics of project risk that the team must consider when prioritizing project risks. PMI® lists a number of factors in this category. Make sure you spend some time examining these factors. [PMBOK® Guide 6th ed. p. 424]
 - ⇒ **Urgency** — The period of time within which a response to the risk is to be implemented in order to be effective. A short period of time indicates high urgency.
 - ⇒ **Proximity** — The period of time before the risk might have an impact on one or more project objectives. A short period indicates high proximity.
 - ⇒ **Dormancy** — The period of time that may elapse after a risk has occurred before its impact is discovered. A short period indicates low dormancy.
 - ⇒ **Manageability** — The ease with which the risk owner (or owning organization) can manage the occurrence or impact of a risk. Where management is easy, manageability is high.
 - ⇒ **Controllability** — The degree to which the risk owner (or owning organization) is able to control the risk's outcome. Where the outcome can be easily controlled, controllability is high.
 - ⇒ **Detectability** — The ease with which the results of the risk occurring, or being about to occur, can be detected and recognized. Where the risk occurrence can be detected easily, detectability is high.



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- ⇒ **Connectivity** — The extent to which the risk is related to other individual project risks. Where a risk is connected to many other risks, connectivity is high.
- ⇒ **Strategic impact** — The potential for the risk to have a positive or negative effect on the organization’s strategic goals. Where the risk has a major effect on strategic goals, strategic impact is high.
- ⇒ **Propinquity** — The degree to which a risk is perceived to matter by one or more stakeholders. Where a risk is perceived as very significant, propinquity is high.
- ⇒ **.4 Interpersonal and team skills** — Great project managers know they must engage with both their stakeholders and the team. Nowhere is this more important than with the management of project risks.
- ⇒ **.5 Risk categorization** — Risk categorization is the process of examining the potential risks to break them into groupings or categories. Like risks often have like responses. A visual tool often used for this process is the risk breakdown structure shown earlier in the course.
- ⇒ **.6 Data representation** — Once the team has collected all that information about the various project risks they must somehow present that information in a way that can quickly and easily be interpreted and used. There are a number of techniques possible here including:

- ◇ **Probability and impact matrix** — A probability and impact matrix is a two axis grid using the probability of the risk occurring as the y axis and the impact should the risk occur as the x axis. Each axis has score values associated with it based upon the previously defined scales. *Image 119* shows a probability and impact matrix.

A Risk Score Defined By Formula P x I					
	Impact				
Probability	0.05	0.10	0.20	0.40	0.80
0.90	0.045	0.09	0.18	0.36	0.72
0.70	0.035	0.07	0.14	0.28	0.56
0.50	0.025	0.05	0.10	0.20	0.40
0.30	0.015	0.03	0.06	0.12	0.24
0.10	0.005	0.01	0.02	0.04	0.08

Image 119: A Probability & Impact Matrix

- ◇ **Hierarchical charts** — In situations where risks are categorized or grouped using more than just two parameters such as probability and impact, some other visual representation must be used. That is where



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hierarchical charts come into play. Bubble charts are one example of this multi-dimensional visual tool.

⇒ **.7 Meetings** — Most of the processes you have seen have involved meetings because they involve the project leader using their facilitation skills to gain information from stakeholders to benefit the project. Meetings are used here as well.

The only output from the perform risk qualitative analysis process are project document updates, primarily in the form of updates to the risk register and risk report. Think back for a moment to the beginning of the risk management knowledge area. The first step was to create the risk management plan. Then the risk register was created based upon the rules and processes established in the plan. The risk register at this point contains an unordered listing of all the potential risks for the project. In the third step we took that list and ordered the list so the most significant risk was at the top and the least significant risk is at the bottom. The best way to accomplish this ordering is to add a column to the risk register — called the PI score — for probability and impact. Now you have an ordered risk register and are ready to move onto the next step. You also may have updates to the assumption and issue logs.

11.4 Perform Quantitative Risk Analysis

In the perform quantitative risk analysis process the risks found in the newly ordered risk register are more carefully examined to understand in detail the significance of each risk. This is done starting at the top of the list with the highest scoring risk and working down. At some point the team reaches a risk that requires more effort and expense to analyze than the risk is worth in terms of its potential impact. At this point analysis is ended.

The inputs to the perform quantitative risk analysis process include the following:

- ⇒ **.1 Project Management Plan** — The project management plan establishes the rules, tools, and processes that are used to manage the project. To understand the significance of each risk the team needs to exam the risk management plan, the scope baseline, the schedule baseline, and the cost baseline.
- ⇒ **.2 Project documents** — To understand the significance of the defined project risks the team also must examine a large number of the documents defined outside the project management plan. These include the assumption log, the basis of estimates, the cost estimates and forecasts, the duration estimates, the milestone list, the resource requirements, the risk register and risk report, and the schedule forecast. Remember the goal of this process is to understand each risk enough to answer the question, how significant is the risk really?



Image 120: The Quantitative Risk Analysis Process



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This analysis is much more robust than the one done for qualitative analysis.

- ⇒ **.3 Enterprise environmental factors** — Often the organization has access to industry studies from similar projects or other published commercial information that can aid in the quantitative analytical process.
- ⇒ **.4 Organizational process assets** — The organizational process assets that apply to the perform quantitative risk analysis process include any information from prior, similar projects.

The tools and techniques used in the perform quantitative risk analysis process include the following:

- ⇒ **.1 Expert judgment** — The use of expert judgment has been consistent throughout the course. It is used here because the team hopefully has experience with similar projects and can evaluate the significance of the identified risks.
- ⇒ **.2 Data gathering** — Data gathering can represent a wide range of techniques and tools. They can be as simple as interviewing and analyzing historical data from past projects.
- ⇒ **.3 Interpersonal and team skills** — The team must come together to discuss the information collected about the types and impacts of project risks discovered. The project leader must add their facilitation skills to this process for success.
- ⇒ **.4 Representations of uncertainty** — How likely is any risk to occur, and how confident is the team in both that likelihood and the analysis of the project impact? Until the risk actually occurs, the answers to these questions is some form of a guess, often based on some kind of a belief in an understanding of the type of data. Teams regularly use curves to represent this data such as the various distributions we discussed earlier in this course (normal, triangular, beta, etc.)
- ⇒ **.5 Data analysis** — There are a number of data analysis techniques used in this process that are important for test takers to understand. These include:
 - ◇ **Sensitivity Analysis** — Sensitivity Analysis examines the extent to which uncertainty affects the objective being examined when all else is equal. A common display for sensitivity analysis is a tornado diagram.
 - ◇ **Simulations** — The common form of simulations are Monte Carlo simulations. Monte Carlo simulations are advanced computer models that have only been available for the last five to ten years. They allow the project team to pretend to execute the project 1,000 different times to determine the likelihood of a particular outcome or risk. For the exam you must remember that Monte Carlo simulations require a significant amount of expertise and also provide the greatest accuracy. The most common Monte Carlo simulations use the WBS

or similar breakdowns to examine costs, or PDM to examine the schedule.

- ◇ **Influence diagrams** — Influence diagrams are also called relevance diagrams, decision diagrams, or decision networks. They represent project decisions using compact graphical and mathematical representations. They are actually generalizations of a Bayesian network that are specifically designed to solve decision making and probabilistic inference problems. Influence diagrams were first developed in the 1970s and are widely accepted as an alternative to decision trees which have problems from the exponential growth of branches as variables are added to the model.



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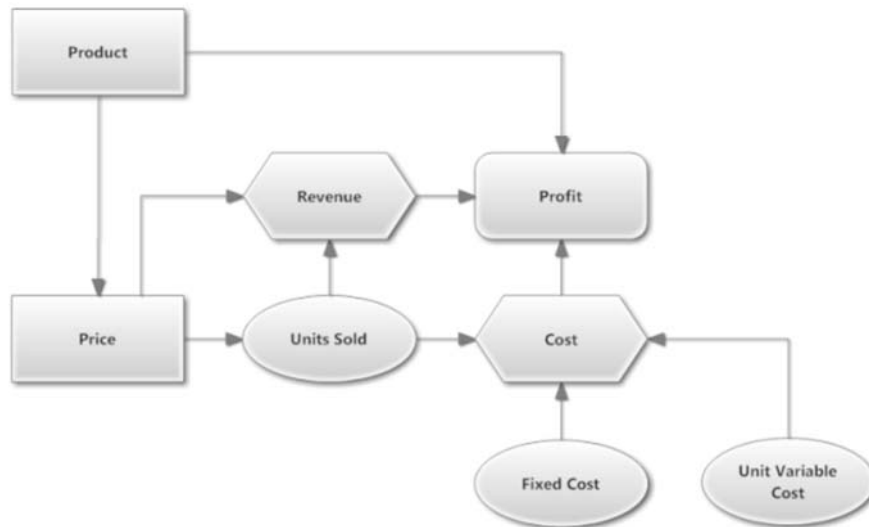


Image 121: Sample Influence Diagram

- ◇ **Expected Monetary Value (EMV)** — EMV provides a modeling technique to forecast future events that are uncertain based upon probabilities. EMV is often associated with decision trees, which provide a visual representation of the probabilities for the purpose of decision making. To better understand EMV, let's examine a simple scenario. Imagine you have a project that based upon your subject matter expert's judgment has a pessimistic cost of \$300,000, a likely cost of \$225,000, and an optimistic cost of \$150,000. Your subject matter expert also informs you that they believe the project has a 30% chance of achieving the pessimistic result, a 50% chance of achieving the likely cost, and a 20% chance of achieving the optimistic cost result. How much should you plan on the project costing? The answer is \$232,500, as the table in *Image 122* shows. But, how did we come up with that answer?

First, the probabilities for a series of mutually exclusive options must sum to 100%. What does this mean? In our example, it is impossible to have both the optimistic and pessimistic options at the same time. It is a case of one or the other, and if you add the probabilities you

Outcome	Cost	Probability	Product
Optimistic Outcome	\$150,000	.20	\$30,000
Likely Outcome	\$225,000	.50	\$112,500
Pessimistic Outcome	\$300,000	.30	<u>\$90,000</u>
			\$232,500

Image 122: An Expected Monetary Value Example

will see they sum to 100%. To illustrate further, imagine having three tasks on a project (A, B, and C). A has a 36% chance of costing X. B has a 49% chance of costing Y, and C has a 68% chance of costing Z. Why don't the percentages sum to 100%? The answer is that A, B, and C are not mutually exclusive options. You have to do all three tasks on the project. To calculate the EMV for each row, simply multiply the variable—in this case cost—by the probability to achieve the product column, then add the results together. This provides the cumulative result.

- ◇ **Decision Trees** — Decision trees provide a visual methodology to calculate outcomes that involve a chance event and the implications of each of the available choices. Decision Trees incorporate cost, probability, and results. Imagine that you are leading a project and have a choice to make. In the choice you can either be conservative or aggressive, but regardless of your decision there is some chance event which might impact the project. Image 123 shows this simple example.

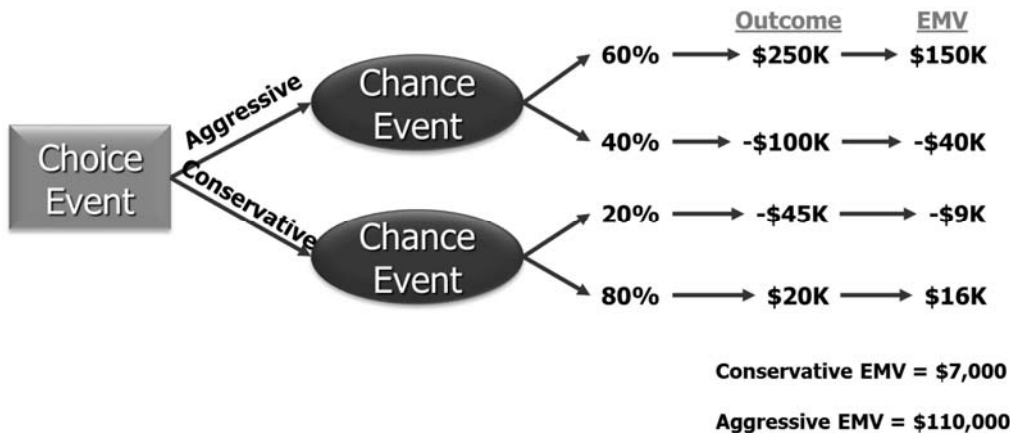


Image 123: A Sample Decision Tree

If you choose to be aggressive and the chance event happens, there is a 60% chance you will profit significantly from the decision and make \$250,000. However, if you are aggressive and the chance event happens, there is a 40% chance you will loose \$100,000.

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Alternatively, if you choose to be conservative and the chance event happens, there is an 80% chance you will gain \$20,000 and a 20% chance you will lose \$45,000. What should you do? The answer is found by calculating the expected monetary value exactly as before. The only difference here is the fact that you have two trees—or sets of options—that each sum to 100%. Notice how the two branches within the aggressive choice sum to 100%, and the two options within the conservative choice also sum to 100%. Each branch is complete. Therefore you must multiply the rows as before but only add the results within each choice. This causes you to get a result of \$110,000 for the aggressive choice and \$7,000 for the conservative choice. The concept of decision trees can be extended one step further by including the costs of the initiative as when examining a build-versus-buy decision.

Imagine you have been asked to lead a project to give your organization a new capability. To deliver the project you must either build a new software application or buy an existing one. If you build it internally it is significantly more likely to meet the organization’s needs. If you buy an off-the-shelf (OTS) package it will cost less. No matter what decision you make there is a chance people will love it and there is a chance people will hate it. What do you do?

A great way to solve this problem is to use Decision Tree Modeling in conjunction with Expected Monetary Value. Examine *Image 124* to see a scenario using these techniques.

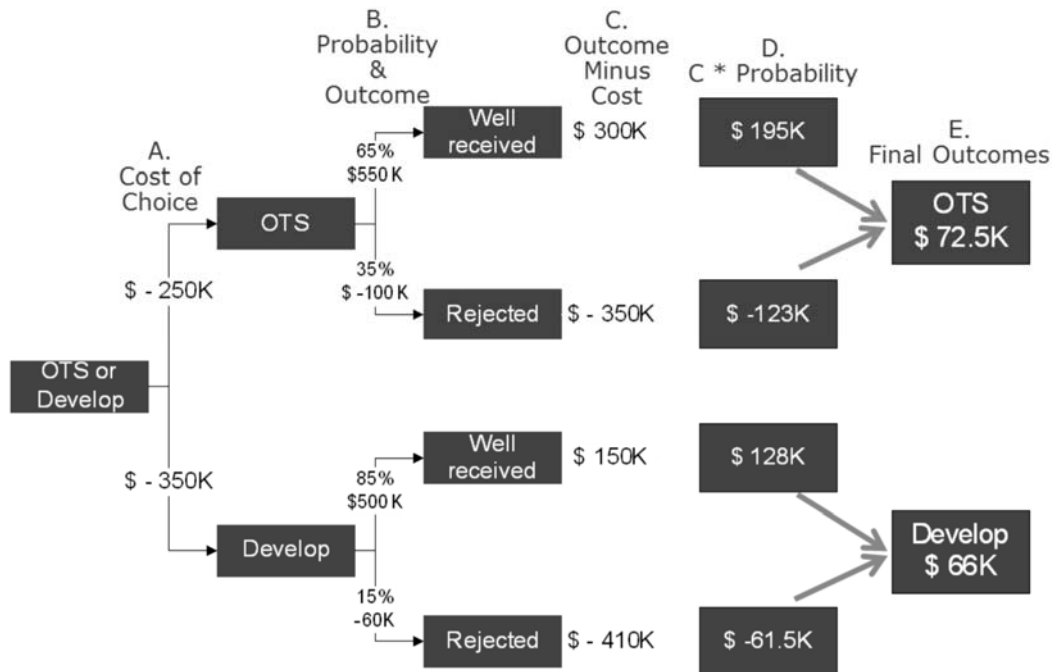


Image 124: A Sample Decision Tree with Costs



The image is broken into columns. The first column is the pre-decision point and should be ignored. Column A shows the costs of the two choices. Because they are expenses, or outflows of capital for the organization, the values are both negative (\$-250K and \$-350K). Column B shows the probability of getting the outcome should the choice (either OTS or Develop) be made and the result, or payout, from making that choice. Column C shows the net outcome which is the outcome from column B minus the cost of making that choice (Column A). Column D takes the net outcome from Column C and multiplies it by the probability to have that outcome found in Column B. The final outcome for each choice is derived by summing the two possible outcomes for each branch. In *Image 124* the best choice is the OTS Option because it has a payout of \$72.5K versus the Develop Option which only has a value of \$66K.

Exercise 19 — Expected Monetary Value



Exercise 19 — EMV

1. You have been asked to establish an estimated project cost using Expected Monetary Value (EMV). If the project has a best case estimate of \$10,000 with a probability of 20%, a most likely case estimate of \$12,000 with a probability of 50%, and a worst case estimate of \$14,400 with a probability of 30% what is the EMV for the project?
 - A. \$12,320
 - B. \$12,400
 - C. \$13,010
 - D. \$13,260
2. You have been asked to establish an estimated project cost using Expected Monetary Value (EMV). If the project has a best case estimate of \$15,000 with a probability of 30%, a most likely case estimate of \$19,500 with a probability of 50%, and a worst case estimate of \$26,325 with a probability of 20% what is the EMV for the project?
 - A. \$19,190
 - B. \$19,515
 - C. \$20,110
 - D. \$20,350
3. You have been asked to establish an estimated project cost using Expected Monetary Value (EMV). If the project has a best case estimate of \$25,000 with a probability of 22%, a most likely case estimate of \$31,250 with a probability of 53%, and a worst case estimate of \$40,625 with a probability of 25% what is the EMV for the project?
 - A. \$30,190
 - B. \$31,560
 - C. \$32,219
 - D. \$33,350
4. You have been asked to establish an estimated project cost using Expected Monetary Value (EMV). If the project has a best case estimate of \$50,000 with a probability of 25%, a most likely case estimate of \$55,000 with a probability of 45%, and a worst case estimate of \$68,750 with a probability of 30% what is the EMV for the project?
 - A. \$55,975
 - B. \$56,550
 - C. \$57,125
 - D. \$57,875

-
5. You have been asked to establish an estimated project cost using Expected Monetary Value (EMV). If the project has a best case estimate of \$75,000 with a probability of 30%, a most likely case estimate of \$86,250 with a probability of 40%, and a worst case estimate of \$99,188 with a probability of 30% what is the EMV for the project?
- A. \$86,756
 - B. \$87,247
 - C. \$87,691
 - D. \$88,121
6. You have been asked to establish an estimated project cost using Expected Monetary Value (EMV). If the project has a best case estimate of \$30,000 with a probability of 24%, a most likely case estimate of \$34,500 with a probability of 56%, and a worst case estimate of \$45,540 with a probability of 20% what is the EMV for the project?
- A. \$35,121
 - B. \$35,628
 - C. \$36,222
 - D. \$36,92
7. You have been asked to establish an estimated project cost using Expected Monetary Value (EMV). If the project has a best case estimate of \$35,000 with a probability of 15%, a most likely case estimate of \$40,250 with a probability of 60%, and a worst case estimate of \$54,338 with a probability of 25% what is the EMV for the project?
- A. \$41,652
 - B. \$42,111
 - C. \$42,984
 - D. \$43,596
8. You have been asked to establish an estimated project cost using Expected Monetary Value (EMV). If the project has a best case estimate of \$20,000 with a probability of 10%, a most likely case estimate of \$23,200 with a probability of 65%, and a worst case estimate of \$32,480 with a probability of 25% what is the EMV for the project?
- A. \$23,950
 - B. \$24,220
 - C. \$24,880
 - D. \$25,200

-
9. You have been asked to establish an estimated project cost using Expected Monetary Value (EMV). If the project has a best case estimate of \$5,000 with a probability of 30%, a most likely case estimate of \$5,900 with a probability of 45%, and a worst case estimate of \$8,024 with a probability of 25% what is the EMV for the project?
- A. \$6,161
 - B. \$6,437
 - C. \$6,918
 - D. \$7,020
10. You have been asked to establish an estimated project cost using Expected Monetary Value (EMV). If the project has a best case estimate of \$7,500 with a probability of 20%, a most likely case estimate of \$9,150 with a probability of 55%, and a worst case estimate of \$11,529 with a probability of 25% what is the EMV for the project?
- A. \$8,919
 - B. \$9,126
 - C. \$9,415
 - D. \$9,783

Exercise 19 — Expected Monetary Value Answers

1. **Answer A.** The formula to get the correct answer is:

$$(\$10,000 * 20\%) + (\$12,000 * 50\%) + (\$14,400 * 30\%) = \mathbf{\$12,320}$$

2. **Answer B.** The formula to get the correct answer is:

$$(\$25,000 * 22\%) + (\$31,250 * 53\%) + (\$40,625 * 25\%) = \mathbf{\$19,515}$$

3. **Answer C.** The formula to get the correct answer is:

$$(\$15,000 * 30\%) + (\$19,500 * 50\%) + (\$26,325 * 20\%) = \mathbf{\$32,219}$$

4. **Answer D.** The formula to get the correct answer is:

$$(\$50,000 * 25\%) + (\$55,000 * 45\%) + (\$68,750 * 30\%) = \mathbf{\$57,875}$$

5. **Answer A.** The formula to get the correct answer is:

$$(\$75,000 * 30\%) + (\$86,250 * 40\%) + (\$99,188 * 30\%) = \mathbf{\$86,756}$$

6. **Answer B.** The formula to get the correct answer is:

$$(\$30,000 * 24\%) + (\$34,500 * 56\%) + (\$45,540 * 20\%) = \mathbf{\$35,628}$$

7. **Answer C.** The formula to get the correct answer is:

$$(\$35,000 * 15\%) + (\$40,250 * 60\%) + (\$54,338 * 25\%) = \mathbf{\$42,984}$$

8. **Answer D.** The formula to get the correct answer is:

$$(\$20,000 * 10\%) + (\$23,200 * 65\%) + (\$32,480 * 25\%) = \mathbf{\$25,200}$$

9. **Answer A.** The formula to get the correct answer is:

$$(\$5,000 * 30\%) + (\$5,900 * 45\%) + (\$8,024 * 25\%) = \mathbf{\$6,161}$$

10. **Answer C.** The formula to get the correct answer is:

$$(\$7,500 * 20\%) + (\$9,150 * 55\%) + (\$11,529 * 25\%) = \mathbf{\$9,415}$$

Exercise 20 — Decision Trees



Exercise 20 — Decision Trees

1. You are asked to choose between two projects, A or B, based on the highest gain (or the lowest loss). Project A will cost \$650,000 and B will cost \$467,000. There is a 56% chance that project A will be successful, which will result in a gain of \$1,800,000. If project A fails there will be a loss of \$900,000. There is a 67% chance project B will be successful, and that will result in a \$950,000 gain. If Project B fails there will be a loss of \$670,000. Based on this information, what is the value of the best alternative?
 - A. \$-38,000
 - B. \$38,000
 - C. \$-51,600
 - D. \$51,600
2. You are asked to choose between two projects, A or B, based on the highest gain (or the lowest loss). Project A will cost \$300,000 and B will cost \$255,000. There is a 67% chance that project A will be successful, which will result in a gain of \$650,000. If project A fails there will be a loss of \$310,000. There is a 58% chance project B will be successful, and that will result in a \$650,000 gain. If Project B fails there will be a loss of \$225,000. Based on this information, what is the value of the best alternative?
 - A. \$60,700
 - B. \$27,500
 - C. \$33,200
 - D. \$51,600
3. You are asked to choose between two projects, A or B, based on the highest gain (or the lowest loss). Project A will cost \$288,000 and B will cost \$225,500. There is a 61% chance that project A will be successful, which will result in a gain of \$650,000. If project A fails there will be a loss of \$287,000. There is a 57% chance project B will be successful, and that will result in a \$560,000 gain. If Project B fails there will be a loss of \$225,000. Based on this information, what is the value of the best alternative?
 - A. \$6,480
 - B. \$-3,050
 - C. \$3,200
 - D. \$-3,430

-
4. You are asked to choose between two projects, A or B, based on the highest gain (or the lowest loss). Project A will cost \$663,500 and B will cost \$589,000. There is a 66% chance that project A will be successful, which will result in a gain of \$1,399,000. If project A fails there will be a loss of \$663,500. There is a 69% chance project B will be successful, and that will result in a \$1,005,000 gain. If Project B fails there will be a loss of \$225,000. Based on this information, what is the value of the best alternative?
- A. \$34,250
 - B. \$34,700
 - C. \$68,950
 - D. \$68,525
5. You are asked to choose between two projects, A or B, based on the highest gain (or the lowest loss). Project A will cost \$79,250 and B will cost \$75,500. There is a 71% chance that project A will be successful, which will result in a gain of \$690,000. If project A fails there will be a loss of \$309,500. There is a 75% chance project B will be successful, and that will result in a \$570,500 gain. If Project B fails there will be a loss of \$219,500. Based on this information, what is the value of the best alternative?
- A. \$320,895
 - B. \$618,395
 - C. \$297,500
 - D. \$648,716
6. You are asked to choose between two projects, A or B, based on the highest gain (or the lowest loss). Project A will cost \$40,000 and B will cost \$55,000. There is a 59% chance that project A will be successful, which will result in a gain of \$151,000. If project A fails there will be a loss of \$94,000. There is a 55% chance project B will be successful, and that will result in a \$168,500 gain. If Project B fails there will be a loss of \$72,500. Based on this information, what is the value of the best alternative?
- A. \$5,500
 - B. \$15,600
 - C. \$10,550
 - D. \$21,525

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7. You are asked to choose between two projects, A or B, based on the highest gain (or the lowest loss). Project A will cost \$77,230 and B will cost \$91,980. There is a 63% chance that project A will be successful, which will result in a gain of \$740,000. If project A fails there will be a loss of \$300,000. There is a 77% chance project B will be successful, and that will result in a \$500,000 gain. If Project B fails there will be a loss of \$225,000. Based on this information, what is the value of the best alternative?
- A. \$703,200
 - B. \$425,230
 - C. \$277,970
 - D. \$256,990
8. You are asked to choose between two projects, A or B, based on the highest gain (or the lowest loss). Project A will cost \$210,000 and B will cost \$255,000. There is a 60% chance that project A will be successful, which will result in a gain of \$650,000. If project A fails there will be a loss of \$325,000. There is a 65% chance project B will be successful, and that will result in a \$550,000 gain. If Project B fails there will be a loss of \$207,750. Based on this information, what is the value of the best alternative?
- A. \$79,788
 - B. \$29,788
 - C. \$27,970
 - D. \$50,000
9. You are asked to choose between two projects, A or B, based on the highest gain (or the lowest loss). Project A will cost \$12,500 and B will cost \$15,250. There is a 72% chance that project A will be successful, which will result in a gain of \$65,000. If project A fails there will be a loss of \$31,000. There is a 66% chance project B will be successful, and that will result in a \$56,500 gain. If Project B fails there will be a loss of \$22,500. Based on this information, what is the value of the best alternative?
- A. \$14,390
 - B. \$19,780
 - C. \$25,620
 - D. \$40,010
10. You are asked to choose between two projects, A or B, based on the highest gain (or the lowest loss). Project A will cost \$241,250 and B will cost \$225,500. There is a 65% chance that project A will be successful, which will result in a gain of \$550,500. If project A fails there will be a loss of \$310,000. There is a 60% chance project B will be successful, and that will result in a \$568,000 gain. If Project B fails there will be a loss of \$270,000. Based on this information, what is the value of the best alternative?
- A. \$7,300
 - B. \$8,075
 - C. \$11,650
 - D. \$15,375

-
11. You are asked to choose between two projects, A or B, based on the highest gain (or the lowest loss). Project A will cost \$500 and B will cost \$750. There is a 65% chance that project A will be successful, which will result in a gain of \$2,500. If project A fails there will be a loss of \$1,650. There is a 59% chance project B will be successful, and that will result in a \$3,000 gain. If Project B fails there will be a loss of \$1,750. Based on this information, what is the value of the best alternative?
- A. \$303
 - B. \$548
 - C. \$641
 - D. \$850
12. You are asked to choose between two projects, A or B, based on the highest gain (or the lowest loss). Project A will cost \$194,500 and B will cost \$175,000. There is a 66% chance that project A will be successful, which will result in a gain of \$645,000. If project A fails there will be a loss of \$315,500. There is a 55% chance project B will be successful, and that will result in a \$715,500 gain. If Project B fails there will be a loss of \$220,500. Based on this information, what is the value of the best alternative?
- A. \$115,960
 - B. \$119,300
 - C. \$123,930
 - D. \$243,230

Exercise 20 — Decision Trees Answers

1. **Answer A.** To answer this question you must calculate the expected monetary value of each choice using the decision tree model found in your LGd training guide and then compare the options. Whichever option has the greatest value is the one you should choose.

	Cost	Probability	Profit / Loss	Net	Outcome	Total
Build vs. Buy	\$ (650,000)	56%	\$ 1,800,000	\$ 1,150,000	\$ 644,000	\$ (38,000)
		44%	\$ (900,000)	\$ (1,550,000)	\$ (682,000)	
	\$ (467,000)	67%	\$ 950,000	\$ 483,000	\$ 323,610	\$ (51,600)
		33%	\$ (670,000)	\$ (1,137,000)	\$ (375,210)	

2. **Answer C.** To answer this question you must calculate the expected monetary value of each choice using the decision tree model found in your LGd training guide and then compare the options. Whichever option has the greatest value is the one you should choose.

	Cost	Probability	Profit / Loss	Net	Outcome	Total
Build vs. Buy	\$ (300,000)	67%	\$ 650,000	\$ 350,000	\$ 234,500	\$ 33,200
		33%	\$ (310,000)	\$ (610,000)	\$ (201,300)	
	\$ (255,000)	58%	\$ 650,000	\$ 395,000	\$ 229,100	\$ 27,500
		42%	\$ (225,000)	\$ (480,000)	\$ (201,600)	

3. **Answer B.** To answer this question you must calculate the expected monetary value of each choice using the decision tree model found in your LGd training guide and then compare the options. Whichever option has the greatest value is the one you should choose.

	Cost	Probability	Profit / Loss	Net	Outcome	Total
Build vs. Buy	\$ (288,000)	61%	\$ 650,000	\$ 362,000	\$ 220,820	\$ (3,430)
		39%	\$ (287,000)	\$ (575,000)	\$ (224,250)	
	\$ (225,500)	57%	\$ 560,000	\$ 334,500	\$ 190,665	\$ (3,050)
		43%	\$ (225,000)	\$ (450,500)	\$ (193,715)	

4. **Answer B.** To answer this question you must calculate the expected monetary value of each choice using the decision tree model found in your LGd training guide and then compare the options. Whichever option has the greatest value is the one you should choose.

	Cost	Probability	Profit / Loss	Net	Outcome	Total
Build vs. Buy	\$ (663,500)	66%	\$ 1,399,000	\$ 735,500	\$ 485,430	\$ 34,250
		34%	\$ (663,500)	\$ (1,327,000)	\$ (451,180)	
	\$ (589,000)	69%	\$ 1,005,000	\$ 416,000	\$ 287,040	\$ 34,700
		31%	\$ (225,000)	\$ (814,000)	\$ (252,340)	

5. **Answer A.** To answer this question you must calculate the expected monetary value of each choice using the decision tree model found in your LGd training guide and then compare the options. Whichever option has the greatest value is the one you should choose.

	Cost	Probability	Profit / Loss	Net	Outcome	Total
		71%	\$ 690,000	\$ 610,750	\$ 433,633	
	\$ (79,250)					\$ 320,895
Build vs. Buy		29%	\$ (309,500)	\$ (388,750)	\$ (112,738)	
		75%	\$ 570,500	\$ 495,000	\$ 371,250	
	\$ (75,500)					\$ 297,500
		25%	\$ (219,500)	\$ (295,000)	\$ (73,750)	

6. **Answer C.** To answer this question you must calculate the expected monetary value of each choice using the decision tree model found in your LGd training guide and then compare the options. Whichever option has the greatest value is the one you should choose.

	Cost	Probability	Profit / Loss	Net	Outcome	Total
		59%	\$ 151,000	\$ 111,000	\$ 65,490	
	\$ (40,000)					\$ 10,550
Build vs. Buy		41%	\$ (94,000)	\$ (134,000)	\$ (54,940)	
		55%	\$ 168,500	\$ 113,500	\$ 62,425	
	\$ (55,000)					\$ 5,050
		45%	\$ (72,500)	\$ (127,500)	\$ (57,375)	

7. **Answer B.** To answer this question you must calculate the expected monetary value of each choice using the decision tree model found in your LGd training guide and then compare the options. Whichever option has the greatest value is the one you should choose.

	Cost	Probability	Profit / Loss	Net	Outcome	Total
		63%	\$ 740,000	\$ 662,770	\$ 417,545	
	\$ (77,230)					\$ 277,970
Build vs. Buy		37%	\$ (300,000)	\$ (377,230)	\$ (139,575)	
		77%	\$ 500,000	\$ 591,980	\$ 455,825	
	\$ 91,980					\$ 425,230
		23%	\$ (225,000)	\$ (133,020)	\$ (30,595)	

8. **Answer D.** To answer this question you must calculate the expected monetary value of each choice using the decision tree model found in your LGd training guide and then compare the options. Whichever option has the greatest value is the one you should choose.

	Cost	Probability	Profit / Loss	Net	Outcome	Total
		60%	\$ 650,000	\$ 440,000	\$ 264,000	
	\$ (210,000)					\$ 50,000
Build vs. Buy		40%	\$ (325,000)	\$ (535,000)	\$ (214,000)	
		65%	\$ 550,000	\$ 295,000	\$ 191,750	
	\$ (255,000)					\$ 29,788
		35%	\$ (207,750)	\$ (482,750)	\$ (181,983)	

9. **Answer C.** To answer this question you must calculate the expected monetary value of each choice using the decision tree model found in your LGd training guide and then compare the options. Whichever option has the greatest value is the one you should choose.

	Cost	Probability	Profit / Loss	Net	Outcome	Total
Build vs. Buy		72%	\$ 65,000	\$ 52,500	\$ 37,800	\$ 25,620
	\$ (12,500)					
		28%	\$ (31,000)	\$ (43,500)	\$ (12,180)	
	\$ (15,250)					\$ 14,390
		66%	\$ 56,500	\$ 41,250	\$ 27,225	
		34%	\$ (22,500)	\$ (37,750)	\$ (12,835)	

10. **Answer B.** To answer this question you must calculate the expected monetary value of each choice using the decision tree model found in your LGd training guide and then compare the options. Whichever option has the greatest value is the one you should choose.

	Cost	Probability	Profit / Loss	Net	Outcome	Total
Build vs. Buy		65%	\$ 550,500	\$ 309,250	\$ 201,013	\$ 8,075
	\$ (241,250)					
		35%	\$ (310,000)	\$ (551,250)	\$ (192,938)	
	\$ (225,500)					\$ 7,300
		60%	\$ 568,000	\$ 342,500	\$ 205,500	
		40%	\$ (270,000)	\$ (495,500)	\$ (198,200)	

11. **Answer B.** To answer this question you must calculate the expected monetary value of each choice using the decision tree model found in your LGd training guide and then compare the options. Whichever option has the greatest value is the one you should choose.

	Cost	Probability	Profit / Loss	Net	Outcome	Total
Build vs. Buy		65%	\$ 2,500	\$ 2,000	\$ 1,300	\$ 548
	\$ (500)					
		35%	\$ (1,650)	\$ (2,150)	\$ (753)	
	\$ (750)					\$ 303
		59%	\$ 3,000	\$ 2,250	\$ 1,328	
		41%	\$ (1,750)	\$ (2,500)	\$ (1,025)	

12. **Answer C.** To answer this question you must calculate the expected monetary value of each choice using the decision tree model found in your LGd training guide and then compare the options. Whichever option has the greatest value is the one you should choose.

	Cost	Probability	Profit / Loss	Net	Outcome	Total
Build vs. Buy		66%	\$ 645,000	\$ 450,500	\$ 297,330	\$ 123,930
	\$ (194,500)					
		34%	\$ (315,500)	\$ (510,000)	\$ (173,400)	
	\$ (175,000)					\$ 119,300
		55%	\$ 715,500	\$ 540,500	\$ 297,275	
		45%	\$ (220,500)	\$ (395,500)	\$ (177,975)	

The only output from the perform quantitative risk analysis process are updates to project documents, again primarily in the form of information being added to the risk register. These updates add a number of columns to the register such as:

- ⇒ **An assessment of overall project risk exposure** — This assessment looks at two key areas. First, it looks at the chances of overall project success. Second, it looks at the degree of inherent variability remaining within the project at the time the analysis was conducted, or in other words, how much confidence do we have in the analysis.
- ⇒ **Probabilistic analysis of the project** — This analysis answers the question how likely is the project to hit its product targets which allow for the development of contingency reserves.
- ⇒ **Probability of achieving cost and time objectives** — These probabilities also aid in the development of contingency reserves.
- ⇒ **A prioritized list of quantified risks** — This is a listing of the risks which pose the greatest threat or opportunity. A tornado diagram can be an effective tool to visualize the prioritized list.
- ⇒ **Trends** — Any trends noticed through the analysis process should be documented in the Risk Register.

For the exam it is important you can compare and contrast the qualitative and quantitative risk analysis processes on four different levels. In each of these the amount of effort, accuracy, expertise and precision is greater when doing the quantitative analysis than when doing the qualitative analysis. The four categories are as follows:

- ⇒ Level of detail
- ⇒ Time for analysis
- ⇒ Cost and schedule implications
- ⇒ Expertise of analysis

11.5 Plan Risk Responses

The next risk process is found in the planning process group for the risk management knowledge area is plan risk responses. The plan risk responses process is about developing options and determining actions to enhance opportunities and reduce threats to the project's objectives. It also addresses the risks by their priority, inserting resources and activities into the budget, schedule, and project management plan, as needed.

The inputs to the plan risk responses process include the following:

- ⇒ **.1 Project management plan** — There are



Image 125: Plan Risk Responses



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three key components the team must examine within the project management plan. The first is the risk management plan that defines the roles, responsibilities, processes, and procedures used to plan and manage the project risks. The team must also examine the resource management plan so they understand the resources available to them to build their risk responses and finally, they must look to the cost baseline so they understand the cost expectations for the project.

- ⇒ **.2 Project documents** — If the task is determining the best way to respond to various project risks then the team needs to examine all the documents that could potentially influence how the team intends to respond to the risks. Within the project documents, the team must examine the lessons learned register, the project schedule, the project team assignments, resource calendars, the risk register, the risk report, and the stakeholder register.
- ⇒ **.3 Enterprise environmental factors** — The biggest enterprise environmental factor is the organization’s willingness to accept risks. This is called the organization’s risk tolerance.
- ⇒ **.4 Organizational process assets** — Often organizations have standardized processes, templates and responses in place for project risks.

The tools and techniques for the plan risk responses process are the most important part of this process for the exam. They include the following:

- ⇒ **.1 Expert judgment** — Expert judgment is a critical input to planning risk responses as the subject matter experts know the risks best.
- ⇒ **.2 Data gathering** — The project leader must go to the team to determine the best response to various project risks. This is the process of conducting interviews.
- ⇒ **.3 Interpersonal and team skills** — This is another situation where the leader must draw on basic skills to succeed. Here we are talking about your facilitation skills as you bring team members and stakeholders together to discuss the best way to respond to project risks.
- ⇒ **.4 Strategies for negative risk or threats** — There are three strategies which are exclusive to negative risks or the potential bad things which might happen on the project. These include the following:
 - ◇ **Avoid** — Risk avoidance involves changing the project to make the risk impossible.
 - ◇ **Transfer** — Risk transference occurs when the risk is moved from the project to make it someone else’s problem. The most common form of risk transfer is insurance.
 - ◇ **Mitigate** — Mitigation is the process of reducing the probability and/or the impact of the risk occurring.



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STOP! You must know the risk response strategies.

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- ⇒ **.5 Strategies of positive risks or opportunities** — There are also three strategies specifically for positive risks or the good things that are unknown on the project. These include:
- ◇ **Exploit** — This strategy attempts to ensure the risk happens. A common example of exploitation is assigning the organization's best resources to a project to ensure it gets done.
 - ◇ **Share** — Sharing a risk involves bringing in a third party who is best able to capture the opportunity for the benefit of the project. A simple example would be a special consultant.
 - ◇ **Enhance** — Enhancing a risk increases the probability and/or positive impacts of an opportunity. An example is adding more resources to a task to have it completed early.

There are two strategies that applies to both positive and negative risks. They are **acceptance** and **escalation**.

- ◇ **Escalate** — Escalation is the process of taking the issue to a leader above the project sponsor, manager, and team. Escalation is considered appropriate when the team and sponsor agree that the threat is outside the scope of the project or that the proposed response would exceed the project manager's authority.
 - ◇ The most common form of acceptance is simply ignoring a risk.
- ⇒ **.6 Contingent response strategy** — Contingent response strategies are the plans which are used should a risk occur. Often called contingencies, they are under the control of the project manager.
- ⇒ **.7 Strategies for overall project risk** — There are also situations that require the team to address project-wide risks rather than risks that are single drivers. PMI® lists the same responses we have already discussed: avoidance, exploitation, transference, mitigation or enhancement, and acceptance.
- ⇒ **.8 Data analysis** — The team often needs to consider a number of potential responses to risks and therefore needs to conduct an analysis of the data to decide the best potential response.
- ⇒ **.9 Decision making** — The team must make decisions about various aspects of project risks. Multi-criteria decision analysis is a big part of this tool.

The outputs to the plan risk responses process include the following:

- ⇒ **.1 Change requests** — Planned risk responses may result in change requests to almost any other area in the project.
- ⇒ **.2 Project management plan updates** — Risk responses can cause updates to any of the Project Management Plan's subsidiary plans as risks can occur anywhere on the project. However, most important in this section are updates to the risk register. These updates include the following:

- ◇ Impacts to the project
- ◇ Owner
- ◇ Analysis data
- ◇ Selected strategy
- ◇ Action items
- ◇ Fallback plans—What to do if the contingency plan doesn't work.
- ◇ Symptoms/warning signs (triggers)
- ◇ Budget and schedule updates to be made
- ◇ Contingency requests, requirements, plans

⇒ **.3 Project document updates** — Documents such as assumption logs or technical documents may require updating based upon the specific responses selected by the project team. Additionally, many potential risk responses require the project manager to enter the organization into contractual relationships to deliver the desired results. These relationships might include purchasing insurance, or acquiring consultants with specialized skills.

11.6 Implement Risk Responses

The only risk process found in executing process group is implement risk responses. This process takes the strategies defined in the last process and puts them into action with its major output being change requests that are run through the integrated change control process.

The inputs to the implement risk responses process include”

- ⇒ **.1 Project management plan**—Within the project management plan the team needs to focus on the risk management plan which provide the core information about how the team intends to manage project risks.
- ⇒ **.2 Project documents** — The key project documents used as inputs to the implementation of risk responses are the lessons learned register, the risk register and the risk reports.
- ⇒ **.3 Organizational process assets** — The team needs to pay particular attention to the lessons learned register to successfully implement their risk responses.

The tools and techniques used to implement risk responses include:

- ⇒ **.1 Expert judgment** — This has been the first tool or technique is almost every process defined in the PMBOK® Guide. Remember, take it to the team!
- ⇒ **.2 Interpersonal and team skills** — Right after expert judgment, the most common tool you have seen is the use of team and interpersonal skills. In most cases, we have talked about a project leader's facilitation skills.



Image 126: Implement Risk Responses



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- ⇒ **.3 Project management information system** — The PMIS is a great tool for the team to use to track, monitor and maintain risk information.

There are two primary outputs to the implement risk responses process. These include changes requests focused on the cost or schedule baseline, but possibly impacting any other aspect of the project management plan and project document updates. These updates can apply to the issue log, lessons learned register, project team assignments, risk register, the risk report or any other document contained in the project.

11.7 Monitor Risks

The last process found in the risk management knowledge area is the monitor risks process. The primary purpose of this process is to watch the project for trigger events so appropriate risk response strategies are employed in a timely fashion, and monitor the project for previously undefined risks as they occur so that appropriate plans may be put into place. Other functions of the monitor risks process include the following:



Image 127: Monitor Risks

- ⇒ **Keeping track of identified risks and those on the watch list** — This is a simple monitoring process to see if the risks still matter to the project.
- ⇒ **Reviewing the execution of risk responses while evaluating their effectiveness** — This process answers the question, did our risk response have the desired affect?
- ⇒ **Reanalyzing existing risks** — Project risks must constantly be reviewed to ensure they are still appropriate.
- ⇒ **Monitoring residual risks** — Residual risks are those risks which remain after the risk response strategy is employed. Think of these as the crumbs in a meal that must be cleaned up.

The inputs to the monitor risks process include the following:

- ⇒ **.1 Project management plan** — The specific document of concern from the project management plan is the risk management plan which defines the processes and procedures being used throughout risk management.
- ⇒ **.2 Project documents** — There are a number of project documents important to the monitoring of project risks. This includes, the issue log, lessons learned register, risk register and the risk reports.
- ⇒ **.3 Work performance data** — The work performance information defines what is happening on the project such as cost, schedule and deliverable performance.



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- ⇒ **.4 Work performance reports** — Whenever a reference is made to performance reports remember it means Earned Value data, variance analysis and project forecasts.

The tools and techniques used in the monitor risks process include the following:

- ⇒ **.1 Data analysis** — This is the process of looking for new risks, examining current ones, and closing outdated risks as the project progresses. This can take the form of examining the technical aspects of project performance such as when using earned value, and/or it can be in the form of reserve analysis to ensure the project has enough safety in place to meet expectations.
- ⇒ **.2 Audits** — Risk audits examine the effectiveness of the risk responses and the overall risk management process.
- ⇒ **.3 Meetings** — Regular status meetings are a critical tool for project success. They provide the face-to-face opportunity for the team to capture information about where the project currently stands.

The outputs from the monitor risks process include the following:

- ⇒ **.1 Work performance information** — These updates can include things such as the results from risk reassessments, risk audits, or periodic risk reviews as well as the work results, hours completed, or scheduling information.
- ⇒ **.2 Change requests** — When various risk management strategies or workarounds are implemented they can cause significant changes to the project. A workaround is an unplanned response used to deal with unanticipated events or problems on a project.
- ⇒ **.3 Project management plan updates** — If the approved change requests have an effect on the risk management processes, the corresponding component documents of the project management plan are revised and reissued to reflect the approved changes.
- ⇒ **.4 Project document updates** — The updates seen here are the same items from the plan risk responses process.
- ⇒ **.5 Organizational process assets updates** — The various risk processes produce a huge amount of lessons learned that may be used on future projects.

Risk Management Summary

To prepare for the risk management knowledge area for the PMP® exam make sure to study the following:

- ⇒ **Seven (7) processes** — The risk management knowledge area is the single most important knowledge area for learning the processes in exactly the correct order. Pay special attention to the qualitative and quantitative processes.



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- ⇒ **Activities of monitoring risks** — Study the tools and techniques which create the activities in the monitor risks process.
 - ⇒ **Seven types of risk responses** — Memorize the eight risk response strategies and what impacts they have.
 - ⇒ **Risk register** — This is a critical document for any project. Make sure you understand all its components and how it is used and updated throughout the risk management processes.
 - ⇒ **Definition of risk, positive and negative** — Many test candidates struggle with the PMI® definition of risk. Remember, a risk is just an unknown event. It can have either positive or negative impacts.
 - ⇒ **Solving and interpreting decision trees and EMV** — Spend time studying and practicing decision tree models and expected monetary value.
 - ⇒ **Delphi technique** — You do not need to know how to implement the Delphi technique, but you should know what it is and its three basic steps.
 - ⇒ **SWOT analysis** — Make sure you are comfortable with the brainstorming technique SWOT analysis (strengths, weaknesses, opportunities and threats).
 - ⇒ **Risk data quality assessment** — Memorize the value and purpose of a risk data quality assessment.
 - ⇒ **Sensitivity analysis** — Memorize the value and purpose of a sensitivity analysis.
 - ⇒ **Qualitative vs. quantitative analysis** — Know the differences and roles of both the perform qualitative risk analysis and perform quantitative risk analysis processes. This is absolutely key for the exam.
 - ⇒ **Interpret quantitative probability and outcome data chart** — Know the different scales, how to calculate a PI score, and how to use the score table, matrix, or data chart.

Exercise 21 — Risk Management

1. Which of the following is an input to the identify risks process?
 - A. Project management plan
 - B. SWOT analysis
 - C. Risk related contracts
 - D. Technical performance measurements
2. Which of the following is NOT a tool or technique used in the identify risks process?
 - A. Data gathering
 - B. Data analysis
 - C. Risk categorization
 - D. Prompt list
3. Which of the following is a tool or technique used in the perform qualitative risk analysis process?
 - A. Risk response analysis
 - B. Risk prioritization
 - C. Project management information system
 - D. Risk categorization
4. Which of the following is NOT an input to the perform quantitative risk analysis process?
 - A. Organizational process assets
 - B. Agreements
 - C. Project management plan
 - D. Project documents
5. Which of the following is NOT a tool or technique used in the perform quantitative risk analysis process?
 - A. Prompt lists
 - B. Representations of uncertainty
 - C. Interpersonal and team skills
 - D. Expert judgment
6. Which of the following is a tool or technique used in the perform quantitative risk analysis process?
 - A. Representations of uncertainty
 - B. Risk categorization
 - C. Meetings
 - D. Project management information system



Exercise 21 — Risk Management

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7. Which of the following is a tool or technique used in the plan risk responses process?
 - A. Risk response analysis
 - B. Risk response planning
 - C. Contingent response strategies
 - D. Strategic risk response planning
 8. Which of the following is NOT a tool or technique used in the plan risk response process?
 - A. Strategies for negative risks or threats
 - B. Strategies for positive risks or opportunities
 - C. Expert judgment
 - D. Contingency reserve analysis
 9. Which of the following is NOT an tool and technique to the monitor risks process?
 - A. Risk urgency assessment
 - B. Risk audits
 - C. Status meetings
 - D. Technical performance measurement
 10. Which of the following is a tool or technique used in the monitor risks process?
 - A. audits
 - B. Interpersonal and team skills
 - C. Expert judgment
 - D. Decision making
 11. Which of the following is NOT a tool or technique used in the implement risk responses process?
 - A. Expert judgment
 - B. Interpersonal and team skills
 - C. Technical performance measurements
 - D. Project management information system
 12. Which of the following is a tool or technique used in the implement risk responses process?
 - A. Data gathering and representation techniques
 - B. Project management information systems
 - C. Risk data quality assessment
 - D. Planning meetings and analysis

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13. You are acting as the portfolio manager and must select a project to execute from a pool of three choices. Each of the choices has an expected payout of \$20,000 and an equal 75% chance of succeeding. In this situation what does \$15,000 represent?
- A. Net present value
 - B. Risk value
 - C. Expected monetary value
 - D. Simple interest
14. You are leading a large complex project within your organization that is forecast to continue for ten more months. The project has an 18% chance of being impacted in a given month by a particular risk. What is the probability that the project will be impacted by the risk in the 3rd month?
- A. 18%
 - B. 36%
 - C. 54%
 - D. 72%
15. You are acting as an outside project management expert consultant for a struggling project. The project is important to the chief executive officer who is concerned the project is not going to hit its schedule date. Which of the following is most likely to impact achieving the schedule target?
- A. Significant increases in component costs.
 - B. Delays in obtaining required sponsor approvals.
 - C. Date slippages as stakeholders fail to attend sprint reviews.
 - D. Disputes with contractors over increase costs.
16. You have been asked to select one of four projects for your organization to execute. The organization is very risk adverse. If you assume the ends of a range of estimates are +/- 3 sigma from the mean, which of the following range estimates involves the least risk?
- A. Mean of 33 days.
 - B. 40 days plus or minus 8 days.
 - C. 32 – 46 days.
 - D. Optimistic = 33 days, most likely 40 days, pessimistic 46 days.
17. You have been asked to select one of four projects for your organization to execute. The organization is very risk adverse. If you assume the ends of a range of estimates are +/- 3 sigma from the mean, which of the following range estimates involves the least risk?
- A. Optimistic = 21 days, most likely 27 days, pessimistic = 32 days.
 - B. 26 days plus or minus 5 days.
 - C. 20 – 33 days.
 - D. Mean of 26 days.

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18. Which of the following is not a factor in the assessment of project risk?
- A. Transference costs
 - B. Risk probability
 - C. Value at stake
 - D. Risk event
19. You take over a project from a previous project manager. As part of the turn over process they hand you a risk watch list. What should be done with the risks on the watch list?
- A. Add the information to your takeover report.
 - B. Add them to the lessons learned for future projects.
 - C. Read over the watch list as they are already covered in the properly completed contingency plans.
 - D. Read over the watch list then revisit during monitoring and controlling.
20. Which of the following is not always an input to the risk management process?
- A. Work breakdown structure
 - B. Lessons learned
 - C. Project status reports
 - D. Historical information
21. It is very important that the project manager determine risk tolerances in order to help:
- A. The sponsor understand how the resource managers will act.
 - B. Schedule the project.
 - C. Rank the project risks.
 - D. Estimate the project duration.
22. Which of the following is not a common result of risk management?
- A. The communications management plan is changed.
 - B. The project charter is changed.
 - C. The schedule management plan is changed.
 - D. The project management plan is changed.
23. Which of the following risk strategies is represented by insurance?
- A. Avoidance
 - B. Acceptance
 - C. Transfer
 - D. Mitigation

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24. It is your first day at a new job and you are asked to evaluate the risks on a large project managed by the PMO. Unfortunately, you cannot evaluate the exact cost impacts of the risks you are analyzing. Based on this situation you should evaluate the risks on a:
- A. Statistical basis
 - B. Qualitative basis
 - C. Quantitative basis
 - D. Mathematical basis
25. In which of the following risk management processes are you most likely to be required to find workarounds?
- A. Monitor risks
 - B. Plan risk responses
 - C. Identify risks
 - D. Quantitative risk analysis
26. You have just determined that you need to transfer a risk. In which of the following risk management processes are you?
- A. Identify risks
 - B. Plan risk responses
 - C. Monitor and control risks
 - D. Perform quantitative risk analysis
27. You are acting as the project manager for a large project \$1,500,000 within your organization. You have just finished the risk response plan for your project. Which of the following should you probably do next?
- A. Begin a project risk reassessment.
 - B. Begin to analyze the risks that appear in major project documents.
 - C. Complete the work breakdown structure.
 - D. Determine the overall risk rating for the project.
28. You are in the process of quantifying risks on a project you are leading. Several of your key resources are non-located and have needed input. How can this be done?
- A. Make use of the Delphi technique.
 - B. Make use of Monte Carlo analysis.
 - C. Make use collaboration software.
 - D. Apply critical chain modeling.

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29. During the plan risk management process the project team you are leading discovers 387 risks and 32 major causes of those risks. The project is part of a major program within the organization and must be completed. Your team is very experienced and has worked together for several years. You have also worked with the sponsor for several years as well, and they are very supportive of your efforts. Significant time has been spent to ensure the project scope and WBS is complete and it has been signed off by all the key stakeholders. Unfortunately, your team has not been able to determine an effective way to mitigate or insure against the one of those major risks. It is something that must be done by the internal team and cannot be outsourced. It also cannot be deleted from the project. What would be the best solution?
- A. Determine a way to transfer the risk
 - B. Determine a way to avoid the risk
 - C. Continue to investigate ways to mitigate the risk
 - D. Accept the risk
30. You are the project manager on a large IT project. You have assembled your team, identified the major risks on the project, determined what would trigger those risks, rated the risks on a rating matrix, tested the major risk assumptions, and assessed the quality of the data used. The team is continuing to move through the risk management process. What have you forgotten to do?
- A. Involve other stakeholders.
 - B. Use a Monte Carlo simulation.
 - C. Mitigate the risks.
 - D. The overall risk ranking for the project.
31. You have worked with different stakeholders to determine the probability and impact of a project's risks. You have also analyzed the assumptions. Before you move on to the next step in the risk management process, what do you need to do?
- A. Identify and evaluate triggers.
 - B. Develop your risk rating matrix.
 - C. Evaluate the trends in risk analysis.
 - D. Create a contingency plan.
32. You apply for a job with a large consulting company. As part of the interview process you are provided with a sample project charter and asked to provide an analysis of the project risks. Which of the following would best help you complete the exercise?
- A. The PMBOK® Guide.
 - B. A discussion with several team members within the organization from a similar project that failed in the past.
 - C. The scope statement from the project planning process.
 - D. The resource plan from the project planning process.

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33. You are working as a project manager on a large new product development project. While preparing your risk responses your team identifies additional risks. What should you do?
- A. Get management to allocate another 5% to the project budget to cover the risks.
 - B. Determine the risk events and the associated cost, then add the cost to the project budget as a reserve.
 - C. Document the risks, and calculate the expected monetary value based on the PI score that result from the risk occurrence.
 - D. Add reserves to the project to accommodate the new risks and notify management.
34. You are leading a project that has an SPI of 0.69 and a CPI of .71. The project has more than 1,000 work packages, and it is being completed over three years. The team has not worked together before, and the project has not been well supported. Which of the following is the best thing to do?
- A. Update the risk register with any new risks and analysis.
 - B. Examine the WBS for unnecessary work packages.
 - C. Examine the RAM for necessary changes.
 - D. Examine the budget for necessary changes.
35. Your project is very close to completion when an unidentified risk occurs. This risk could affect the project's overall ability to deliver. What should you do first?
- A. Develop a risk response plan.
 - B. Develop a workaround.
 - C. Alert the project sponsor to the potential impacts to the schedule, costs, and scope of the project.
 - D. Qualify the risk.
36. You are the project manager on a multi-year facilities development project. Significant spring rains caused major flooding that caused power outages and the loss of all project records not stored on your laptop. What should have been done to prevent this problem?
- A. Approve a larger contingency reserve.
 - B. Plan for a larger management reserve.
 - C. Maintain the records outside a flood plain.
 - D. Monitor the weather and have a contingency plan.

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37. You have been asked to lead a mission-critical project for your organization. The project is very large, will take approximately 3 years, and will be highly visible to the senior leadership of the organization. Unfortunately, your company does not have a very good track record at handling risks and rarely seems to follow its risk management policies and procedures. You have less than a month until your first major milestone. If senior management is expecting to see an analysis of the project's risks and response strategies which of the following groups or individuals is least important?
- A. The sponsor.
 - B. The project team members.
 - C. The individuals responsible for the risk policies and procedures.
 - D. Key stakeholders.
38. You are leading a high technology product development project that was originally scheduled to take 18 months. The project has faced significant problems and has had to use all its reserves. You currently have an SPI of 0.68 and a CPI of 0.73. There are only six deliverables left and three of them are on the critical path. The project sponsor has just told you that you only have four weeks to finish the project or risk losing all funding and support. This is three weeks faster than your current ETC. In response, you send out an RFP to four vendors for some of the work that the internal team was going to perform hoping an external organization could get the work done faster. This can best be described as an effort on the part of the project manager to work with:
- A. Contingencies
 - B. Threats
 - C. Opportunities
 - D. Reserves
39. Which of the following is a primary characteristic of the Delphi Technique?
- A. Expert opinion.
 - B. Simulation modeling in a hierarchical process.
 - C. Use of heuristic analysis.
 - D. Extrapolation from historical documents.
40. You are leading a large IT project that is nearing completion. Your sponsor requests a change to the project that would increase the project risk. What should you do first?
- A. Update the risk register.
 - B. Gain an understanding of why the sponsor wants the change.
 - C. Analyze the impacts of making the change with the project team.
 - D. Calculated the EMV of the risk and create a new cost estimate.

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41. You are leading a major construction project. During project execution a major problem occurs that does not appear in the risk register. What should you do first?
- A. Inform the project stakeholders.
 - B. Look for secondary risks.
 - C. Exam the identify risks process for flaws.
 - D. Create a workaround.
42. You are leading a research and development project. You are in the executing process group when one of your senior resources identifies a risk that is not listed in the risk register. What should you do?
- A. Determine how the team member identified the risk.
 - B. Analyze the risk.
 - C. Inform the sponsor and key stakeholders of the risk.
 - D. Place the risk in the risk register.
43. You are taking over a \$50,000 IT project for your organization. The project is entering its third phase. Although there appear to be many risks on the project, no one has evaluated them to assess the range of possible impacts. What needs to be done?
- A. Perform qualitative risk analysis
 - B. Plan risk management
 - C. Plan risk responses
 - D. Monitor risks
44. Which of the following best describes a heuristic?
- A. An advanced statistical calculation used to model risks.
 - B. A simulation used to model risks.
 - C. A rule of thumb.
 - D. A calculation used to produce a weighted measure of risk.
45. Monte Carlo analysis is used to:
- A. Get an indication of the risk involved in a project.
 - B. Simulate the order in which activities occur.
 - C. Estimate an activity's length.
 - D. Measure project risk level.
46. You are working with your team to complete the risk response plan. However, every time the team develops a risk response, another risk is identified as being caused by the suggested response. Which of the following is the best thing for the project manager to do?
- A. Return to the identify risks process as something is amiss.
 - B. Document the new risks and continue the plan risk responses process.
 - C. Return to the define scope process to determine what is missing.
 - D. Get more stakeholders involved in the identify risks process as so many were missed.

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47. From which of the following processes would you expect to generate a watch list?
- A. Plan risk management
 - B. Identify risks
 - C. Perform qualitative risk analysis
 - D. Plan risk responses
48. Which of the following must be an agenda item at all team meetings?
- A. Review of project issues
 - B. Identification of new assignments
 - C. Status of all activities
 - D. Discussion of project risks
49. Which of the following is not always an input to the risk management process?
- A. Project status reports
 - B. Historical information
 - C. Lessons learned
 - D. The work breakdown structure
50. You are struggling to evaluate the exact cost impact of risks on your project. You would be advised to evaluate on a:
- A. Qualitative basis
 - B. Quantitative basis
 - C. Numeric basis
 - D. Cost basis
51. You have just finished the risk response plan for your US \$250,000 information technology project. Which of the following should you probably do next?
- A. Determine the overall risk rating for the project.
 - B. Add needed work packages to the work breakdown structure.
 - C. Hold a project risk reassessment.
 - D. Begin to analyze the risks that appeared in the technical design.
52. You have just completed the determination of probability and impact of your defined project risks. You have also analyzed the assumptions and are ready to move on to the next step of risk management, but based upon the information what have you forgotten to do?
- A. Identify triggers.
 - B. Evaluate trends in the risk analysis.
 - C. Create a fallback plan.
 - D. Provide a standardized risk rating matrix.

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53. As the project manager you have assembled your team and identified more than 100 risks on your project. You and the team have rated them on a risk rating matrix, tested their assumptions, and assessed the quality of the data used. The team is continuing to move through the risk management process, but what have you forgotten to do?
- A. Risk mitigation.
 - B. Overall risk ranking for the project.
 - C. Involve other stakeholders.
 - D. Monte Carlo analysis.
54. Your team has come up with 521 risks and 42 major causes of those risks. Your team has worked on several projects together and your project sponsor is both influential and supportive. You and your team have invested significant time to make sure the project work was completed and signed off by all key stakeholders. However, during the planning phase, the team was unable to come up with an effective way to mitigate or ensure against a particular risk. The work cannot be outsourced or deleted from the project. Which of the following represents the best solution?
- A. Accept the risk.
 - B. Look for ways to transfer the risk.
 - C. Look for ways to avoid the risk.
 - D. Continue to look for ways to mitigate the risk.
55. You are leading a large, multi-year engineering project designed to impact multiple locations within your company. A tornado destroys the headquarters location and all the project records including all project reporting and historical information with no way of recovering the information. What should have been done to prevent this problem?
- A. Purchase insurance.
 - B. Monitor the weather and have a contingency plan.
 - C. Plan a reserve fund.
 - D. Schedule the installation outside of tornado season.
56. During the project execution phase of a project you are leading one of your subject matter experts identifies a risk that is not in the risk register. What should you do?
- A. Disregard the risk because it was not identified in risk identification.
 - B. Inform the sponsor of the risk.
 - C. Analyze the risk.
 - D. Discuss with the resource how they identified the risk to ensure others were not missed.

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57. Which of the following is a chief characteristic of the Delphi Technique?
- A. A bottoms up approach
 - B. Analytical heuristic analysis
 - C. Expert opinion
 - D. Extrapolation from historical records of previous projects
58. You are leading a multi-year project that is almost complete. You have five deliverables left and have used up almost all the reserves. You sponsor informs you that the project must be completed two weeks earlier than previously forecasted. In response you send out an RFP to several potential vendors to outsource three of the remaining deliverables. This is an example of the project manager attempting to work with what?
- A. Reserves
 - B. Opportunities
 - C. Threats
 - D. Strengths
59. During the identify risks process, a project manager made a long list of risks identified by all the stakeholders using various methods. She then made sure all the risks were understood and that triggers had been identified. Later, in the plan risk responses process, she took all the risks that had been identified and determined ways to mitigate them. What has she done wrong?
- A. The project manager should have waited until the perform qualitative risk analysis process to get the stakeholders involved.
 - B. The project manager should have created workarounds.
 - C. More people should be involved in the plan risk response process.
 - D. Triggers are not identified until the identify risks process.

Exercise 21 — Risk Management Answers

1. **Answer A.** PMBOK® Guide p. 396 – The inputs to the identify risks process includes:
 - ⇒ Project management plan
 - ⇒ Project documents
 - ⇒ Agreements
 - ⇒ Procurement documentation
 - ⇒ Enterprise environmental factors
 - ⇒ Organizational process assets
2. **Answer C.** PMBOK® Guide p. 396 – The tools and techniques of the identify risks process include:
 - ⇒ Expert judgment
 - ⇒ Data gathering
 - ⇒ Data analysis
 - ⇒ Interpersonal and team skills
 - ⇒ Prompt lists
 - ⇒ Meetings
3. **Answer D.** PMBOK® Guide p. 396 – The tools and techniques used in the perform qualitative risk analysis include:
 - ⇒ Expert judgment
 - ⇒ Data gathering
 - ⇒ Data analysis
 - ⇒ Interpersonal and team skills
 - ⇒ Risk categorization
 - ⇒ Data representation
 - ⇒ Meetings
4. **Answer B.** PMBOK® Guide p. 396 – The inputs to the perform quantitative risk analysis process include:
 - ⇒ Risk management plan
 - ⇒ Cost management plan
 - ⇒ Schedule Management Plan
 - ⇒ Risk register
 - ⇒ Enterprise environmental factors
 - ⇒ Organizational process assets
5. **Answer A.** PMBOK® Guide p. 396 – The tools and techniques used in the perform quantitative risk analysis process include:
 - ⇒ Expert judgment
 - ⇒ Data gathering
 - ⇒ Interpersonal and team skills
 - ⇒ Representations of uncertainty
 - ⇒ Data analysis

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6. **Answer A.** PMBOK® Guide p. 396 – The tools and techniques used in the perform quantitative risk analysis process include:
- ⇒ Expert judgment
 - ⇒ Data gathering
 - ⇒ Interpersonal and team skills
 - ⇒ Representations of uncertainty
 - ⇒ Data analysis
7. **Answer C.** PMBOK® Guide p. 396 – The tools and techniques used in the plan risk responses process include:
- ⇒ Expert judgment
 - ⇒ Data gathering
 - ⇒ Interpersonal and team skills
 - ⇒ Strategies for negative risks or threats
 - ⇒ Strategies for positive risks or opportunities
 - ⇒ Contingent response strategies
 - ⇒ Strategies for overall project risks
 - ⇒ Data analysis
 - ⇒ Decision making
8. **Answer D.** PMBOK® Guide p. 396 – The tools and techniques used in the plan risk responses process include:
- ⇒ Expert judgment
 - ⇒ Data gathering
 - ⇒ Interpersonal and team skills
 - ⇒ Strategies for negative risks or threats
 - ⇒ Strategies for positive risks or opportunities
 - ⇒ Contingent response strategies
 - ⇒ Strategies for overall project risks
 - ⇒ Data analysis
 - ⇒ Decision making
9. **Answer A.** PMBOK® Guide p. 396 – The tools and techniques used in the monitor risks process include:
- ⇒ Data analysis
 - ⇒ Audits
 - ⇒ Meetings
10. **Answer B.** PMBOK® Guide p. 396 – The tools and techniques used in the monitor risks process include:
- ⇒ Data analysis
 - ⇒ Audits
 - ⇒ Meetings

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11. **Answer C.** PMBOK® Guide p. 396 – The tools and techniques used in the implement risk responses process include:
- ⇒ Expert judgment
 - ⇒ Interpersonal and team skills
 - ⇒ Project management information system
12. **Answer B.** PMBOK® Guide – The tools and techniques used in the implement risk responses process include:
- ⇒ Expert judgment
 - ⇒ Interpersonal and team skills
 - ⇒ Project management information system
13. **Answer C.** The expected monetary value is calculated by multiplying the probability times the impact of any event.
14. **Answer A.** Many people miss this question. Remember, each month in the scenario is independent. So if the probability is 18% in one month and the probability is equal, it is 18% in all months.
15. **Answer B.** Only delays in obtaining sponsor approvals are guaranteed to cause delays. The other alternatives might cause a delay (except the post-implementation review meeting).
16. **Answer D.** This question is actually much easier than it first appears. Because we are assuming a range of estimates that is +/- 3 sigma, meaning it is a normal distribution, all you have to do is determine which range estimate has the smallest difference or variance. The 3 point estimate has a range of 13, the 33-46 days is a range of 13, and 40 +/- 8 days is 16.
17. **Answer B.** This question is actually much easier than it first appears. Because we are assuming a range of estimates that is +/- 3 sigma, meaning it is a normal distribution, all you have to do is determine which range estimate has the smallest difference or variance. The 3 point estimate has a range of 11 days. The plus or minus 5 days is a range of 10 and 20-33 days is 13.
18. **Answer A.** “Transference costs” is a fancy way of saying insurance premiums. These do not come into play until you are evaluating the risk responses.
19. **Answer B.** A good project manager is constantly monitoring the identified risks on a project. In this question you do not know where the watch list came from.
20. **Answer C.** Although project status reports can be a vital input to the risk management process, they are usually not available during the risk planning process and are therefore not always an input to the risk management process.

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21. **Answer C.** Risk tolerances, or how much risk various stakeholders are willing to accept. This is a critical piece of information used to rank the project risks.
 22. **Answer B.** Of the choices the project charter is the least likely to be changed because of the risk management process. Remember, the charter authorizes the project.
 23. **Answer C.** Insurance is the most common type of risk transfer. It is making the risk someone else's problem.
 24. **Answer B.** The question tells you that you cannot find the exact impacts. This excludes statistical, quantitative and mathematical basis of measure. You are left with qualitative such as high, medium and low.
 25. **Answer A.** Workarounds—by definition—are responses created for risks not included in the risk register.
 26. **Answer B.** Be careful here. The question states you have just determined that you NEED to transfer a risk. This is done in the plan risk response process.
 27. **Answer C.** Finishing the risk response plan is done in the planning process group. The only of the options that is also in the planning process group is the completion of the work breakdown structure.
 28. **Answer A.** The Delphi Technique is specifically designed to survey your experts, aggregate their responses and then feed the aggregated result back to them for confirmation. This is the best option in a situation where the resources are not all together.
 29. **Answer D.** There are two important aspects to this question. Firstly, did you notice that everything but the last four sentences is unnecessary? Secondly, this question really reflects the real world. The question excludes everything but acceptance. Sometimes in the real world all you can do is accept a risk.
 30. **Answer A.** There is nothing wrong with this process. It simply needs to be continued. The best answer in this case is to involve other stakeholders
 31. **Answer B.** Before you can move on to the next step in the process you need a definition for how you will be rating the risks.
 32. **Answer B** This question centers on imagining where you are in the project. The question gives you a charter and nothing else. Therefore, you must assume you are in the initiating process. Two of the other choices say they are from the planning process and therefore not available. The PMBOK® Guide is a nice framework, but remember PMI® suggests the situation is critical.

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33. **Answer C.** Before you can determine the appropriate response you have to determine the value or cost of the risk as well as the impacts. Only then can you determine if you or management needs to add reserves or another response is needed.
34. **Answer A.** To answer this question correctly you had to notice the project is already significantly over budget and behind schedule. Changing the WBS, RAM, or budget should only happen in response to risks that occur. So you should start there.
35. **Answer D.** The first thing you always do is analyze the situation and develop alternatives. Only then do you proceed.
36. **Answer D.** With the information provided you do not know what the best solution would have been. The only thing you can say for sure is that you should have had a contingency plan—oh, and watching the weather probably wasn't a bad idea either...
37. **Answer A.** Although sponsors are often involved in the identification of risks, they are usually not as involved in the development of response plans. All the other answers are key resources in the development of response plans.
38. **Answer C.** This is a bad situation, but that does not impact the answer. Only the last three sentences matter. You are trying to gain an opportunity to do the project more quickly.
39. **Answer A.** The Delphi Technique is a process where you survey your subject matter expert, aggregate their responses, and then feed back the aggregation for confirmation.
40. **Answer C.** According to PMI[®], the first thing you must do in any situation is understand the impacts. Only then can you devise the correct response.
41. **Answer D.** This is a risk that has already happened. The first thing you need to do is deal with the problem and then take the workaround to the sponsor and key stakeholders.
42. **Answer B.** The first thing you always do is analyze the risk. Only then can you determine what should be done next.
43. **Answer B.** The project has started, and it should complete the risk management process. That process begins by planning risk management. Since that step has not already occurred it needs to be completed first.
44. **Answer C.** A heuristic is simply a rule of thumb. There is no calculations involved.

-
45. **Answer A.** Several of these answers are partially correct. The Monte Carlo Analysis could help you know that an activity needs to change, but not what the estimate should be. The Monte Carlo analysis is a simulation tool, but it typically is used to simulate time or cost and not ordering of the activities. It can also be used to measure the probabilities of risk or the likelihood of being on the critical path. However, the best answer is getting an overall analysis of the project risk.
46. **Answer B.** Don't get misled by the fact that the process generated so many new risks. The key is that you follow your process. In this case it is working as it should. You should expect the identify risk responses process to generate new risks.
47. **Answer C.** A watch list is made up of low priority risks that, in the perform qualitative risk analysis process, were determined to be too low priority or low impact to move further in the risk process.
48. **Answer D.** According to PMI®, risks are a critical area that impacts all other areas of project management. It is so important it should be discussed at every meeting.
49. **Answer A.** Although project status reports can be an important input to the risk management process, when you are first completing the process you likely will not have any status reports yet.
50. **Answer A.** If you cannot determine the exact costs of a risk you should use qualitative estimates such as low, medium and high.
51. **Answer B.** Based upon the description, this situation is in the planning process group. You must complete the planning before moving on. The only process in planning is adding work packages to the WBS.
52. **Answer D.** In this case you are in the Perform Qualitative Risk Analysis process. There are two key activities in this process: assumption testing and probability and impact matrix development. The matrix is missing. All the other options will occur later in risk management.
53. **Answer C.** You might look at this question as a trick of sorts. The process described is fine. The only issue is you have not involved other stakeholders to identify more risks.
54. **Answer A.** Most of this question is useless. You cannot remove the work nor can you insure or outsource it to transfer the risk. The only option left is acceptance.
55. **Answer B.** The risk is the loss of the data due to the weather. Purchasing insurance does nothing to mitigate the problem. Creating a reserve fund is a form of risk acceptance. Avoiding the tornado by scheduling the project when it wasn't tornado season could negatively impact the project. The best choice is to monitor the weather and know when to implement the contingency plan.

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56. **Answer C.** This is another example of those “what would you do first?” questions. As always, the right answer is analyze the situation.
 57. **Answer C.** The Delphi Technique uses expert judgment to build a consensus opinion. The expert judgment is its key feature.
 58. **Answer B.** The ability to potentially outsource some of the deliverables is an example of taking advantage of an opportunity.
 59. **Answer C.** The plan risk responses processes should include the involvement of all the risk response owners and possibly other stakeholders.

Procurement Management

Overview

Chapter 12 of the PMBOK® Guide is dedicated to the procurement management knowledge area. There are three processes found in the procurement management knowledge area. These processes include the following:

- ⇒ 12.1 Plan procurement management
- ⇒ 12.2 Conduct procurements
- ⇒ 12.3 Control procurements

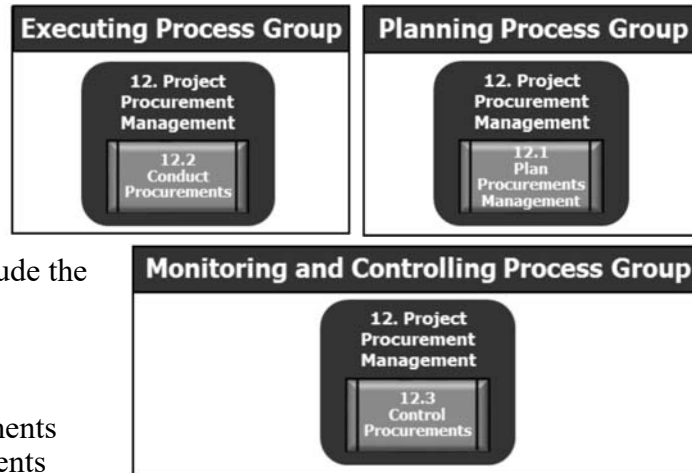


Image 128: The Procurement Management Processes

The procurement management knowledge area includes the processes necessary to purchase or acquire the products, services, or results needed from outside the project team to perform project work. A few exam prep writers believe the procurement management knowledge area is difficult. I do not. Compared to areas such as risk, scheduling or cost, procurement is relatively simple. However, there are three important aspects of procurement management you must remember for the PMP® exam.

First, PMI's view of procurement management is likely much more inclusive than what you are used to. For the exam, it is important to remember the type of project you are leading (a large, multi-national project for a manufacturing or engineering concern, involving millions of dollars and hundreds of resources, across multiple time zones). As part of this project you are responsible for the selection criteria of the sellers, managing them, and managing their payments.

Secondly, unless an exam question says something to the contrary, and we have never heard of one, you are always the **BUYER** in a procurement situation. Remember, for the exam you are always acting in the role of the project manager trying to get your project completed. In this situation you might need to purchase goods, services or consultants to help you complete the project. However, there are a lot of different terms questions can use to reference you in the role of the buyer. You might be called the client, customer, requestor or purchaser. When PMI® references the seller the exam could use terms such as seller, contractor, prime contractor, sub-contractor, bidder, selected source, or vendor. Do not be fooled by the term used. Always remember your role.

The third key to passing the procurement management portion of the exam is to learn the type of contracts which may be used by the project manager. These contract types are discussed in detail in the first process below.



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You are always the BUYER!

It is also a good idea to learn several PMIisms which can be used to prepare for the exam. These PMIisms include the following:

- ⇒ All product and project management requirements for the procurement work should be specifically stated in the contract.
- ⇒ If it is not in the contract, it can only be done if a formal change order to the contract is issued.
- ⇒ If it is in the contract, it must be done or a formal change order to the contract must be issued cancelling it.
- ⇒ Changes must be submitted and approved in writing.
- ⇒ Contracts are legally binding; both parties are obligated to perform per the terms of the contract.
- ⇒ Contracts should diminish project risks.

There are also a number terms you must know to be successful with the exam. Many of these terms deal with the legalities of procurement management which are another difference from other knowledge areas. PMI® does NOT expect the project manager to be a trained expert in all the laws and regulations dealing with procurement management, but does expect you to have enough familiarity with the topics to make intelligent decisions regarding contracts and contractual relationships [PMBOK® Guide 6th ed. p. 460]. PMI® also does NOT assume the PM has authority to sign any legal agreements binding the organization. Remember, PMI® is trying to reflect what is generally happening in the real world. The terms you should still know include:

- ⇒ **Force majeure** — This is a situation which may be considered an act of God, and is an allowable excuse for either party not meeting contractual requirements. Usually the risk is covered by the seller for which they will often carry insurance.
- ⇒ **Liquidated damages** — These are estimated damages for specific defaults, described in advance.
- ⇒ **Retainage** — This is an amount of money—usually 5% to 10%—withheld from each payment. This money is paid when all the final work is complete. Its purpose is to help ensure proper completion.
- ⇒ **Time is of the essence** — This phrase means delivery dates are strictly binding and will be stringently enforced. The seller is placed on immediate notice that any delay is considered a material breach.
- ⇒ **Material breach** — The breach is so large that it may not be possible to complete the work under contract.
- ⇒ **Work for hire** — The work provided will be owned by the buyer.
- ⇒ **Privity** — Simply means a contractual relationship.



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- ⇒ **Price** — The amount charged to the customer. It is defined as the cost plus profit.
- ⇒ **Profit** — The amount of money given to the seller above and beyond the costs incurred to produce a product. Typically, the seller has a target margin desired to sell a product.
- ⇒ **Cost** — This is how much an item costs the seller to create, develop, or purchase a product. A buyer's cost includes both the seller's cost plus profit and is the same as the price.
- ⇒ **Target price** — This is another way of saying planned or expected price. It is used as a point of comparison with the final actual price paid.
- ⇒ **Sharing ratio** — The sharing ratio describes how cost overruns will be split between the buyer and seller.
- ⇒ **Ceiling price** — This is the highest price the buyer will pay for a product or service.
- ⇒ **Master services agreement** — An MSA is a governing agreement that is used for the overall engagement. MSAs are often used on large projects where parts of the project is managed using an agile method and other parts use a more traditional method. Any adaptive work is placed in an appendix or supplement which allows changes to occur on any adaptive scope without impacting the overall contract.
- ⇒ **Point of Total Assumption** — This only relates to fixed price incentive fee contracts and refers to the amount above which the seller bears all the loss of a cost overrun. Costs that go above the PTA are assumed to be due to mismanagement. Sellers will sometimes monitor their actual costs against the PTA to make sure they are still receiving a profit for completing the project. It is defined with the following formula:

$$\text{PTA} = \frac{(\text{Ceiling Price} - \text{Target Price})}{\text{Buyer's Share Ratio}} + \text{Total Cost}$$



PTA
Formula

12.1 Plan Procurement Management

The first process found in the procurement management knowledge area is the plan procurements process. This process is about identifying which project needs can best be met by purchasing or acquiring products, services or results from outside the project organization. To accomplish this goal the project manager must consider potential sellers, permits, and licenses in addition to the project needs. The plan procurements process also requires the project manager to have a strong understanding of the



Image 129: Plan Procurements



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contracting process (not a formal process in the PMBOK® Guide) and the contract types.

The inputs to the plan procurements process include the following:

- ⇒ **.1 Project charter** — The project charter provides the overview of the project. Keep in mind the previously discussed project five-line.
- ⇒ **.2 Business documents** — The two specific documents described are the business case which describes why the organization needs the project, and the benefits management plan which explains the benefits the organization expects to receive by completing the project.
- ⇒ **.3 Project Management Plan** — The project management plan contains all the other plans that are a big part of procurements. The scope, quality and resource management plans along with the scope baseline each describe key aspects of the project that may need to be purchased from outside the organization.
- ⇒ **.4 Project documents** — Information not contained in the project management plan, but still critical to determining what the team intends to obtain from outside the organization are found in the project documents such as the milestone list, project team assignments, requirements documentation, requirements traceability matrix, resource requirements, risk register, and stakeholder register. Remember, when looking at procurements we might also be talking about bringing contractors in to complete work which the team lacks the expertise to complete.
- ⇒ **.5 Enterprise environmental factors** — The key enterprise factors that can influence the plan procurements process include items such as marketplace conditions, the items that are available in the market, supplier information such as past performance or reputation, typical terms and conditions for products, services and results, and unique local conditions.
- ⇒ **.6 Organizational process assets** — The organizational process assets which can influence the plan procurements process include things such as: formal processes, procedures and templates concerning procurement, standard organizational contracts, non-disclosure agreements, or prequalified seller lists.

The tools and techniques used in the plan procurements process are as follows:

- ⇒ **.1 Expert judgment** — A project's subject matter experts can, and should, be a critical resource in determining which items on the project should be procured externally and which processes should be used. Examples of applicable subject matter experts include lawyers, contracting officers, or industry experts.
- ⇒ **.2 Data gathering** — The process of data gathering when planning procurements largely centers on market research to understand industries and specific seller capabilities.



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- ⇒ **.3 Data analysis** — The specific analysis done in planning procurements is what is called a make-or-buy analysis. The make-or-buy analysis is a critical tool for any project. However, it does not have to be complicated. This is simply the process of determining whether it is in the best interest of the project and the organization to do the work internally or have an external resource complete the task or provide the deliverable. A common tool to complete this process was seen in the risk management chapter when decision trees were discussed. Make sure you are comfortable with decision trees and their use in the plan procurements process.
- ⇒ **.4 Source selection analysis** — The source selection analysis process involves the team determining how they will pick a provider for those items or resources needed from outside the team. Common methods include least cost, qualifications only, quality-based/highest technical proposal score, quality and cost-based, sole source and/or fixed budget.
- ◇ **In least cost**, the lowest cost provider wins. While this often leads to lower initial costs, often these providers fail to provide what the team really needed. Lowest cost criteria is typically only recommended in situations where the team is dealing with a commoditized product.
 - ◇ **Qualifications only** looks for the provider who best meets the defined need regardless of cost. This criteria often leads to providers who can truly meet the business need, but often runs the risk of exceeding the project budget.
 - ◇ **Quality-based/highest technical proposal score** asks the providers to submit a proposal with both technical and cost details. Each proposal is then evaluated against a predefined weighted scoring mechanism. The highest scored provider is then invited to negotiate the contract.
 - ◇ **Quality and cost-based** selection allows cost to be included as a factor or variable in the process. It is often similar to the a scored proposal, but cost is one of the variables.
 - ◇ In a **sole source** selection the buyer asks a specific seller to prepare technical and financial proposals which are then negotiated. This process involves only one buyer and one seller.
 - ◇ The **fixed budget** method requires the purchasing organization (you) to disclose your available budget to the sellers who are then invited to provide proposals that meet that budget. Selection is based on the RFP that provide the best value for the limit cost. This can be based on most scope, quality or other defined criteria. This method is best when the scope is precisely defined.
- ⇒ **.5 Meetings** — Meetings are a very powerful tool for every area where planning is required.

The outputs from the plan procurements process include the following:



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- ⇒ **.1 Procurement management plan** — The procurement management plan describes how the project team intends to manage the procurement process. It includes things such as the following:
- ◇ Descriptions of managing procurement from developing procurement documentation through contract closure
 - ◇ Types of contracts
 - ◇ Roles and responsibilities, authority
 - ◇ Coordination
 - ◇ Constraints and assumptions
 - ◇ Timeframes
 - ◇ Pre-qualified sellers
 - ◇ Metrics
- ⇒ **.2 Procurement strategy** — The procurement strategy is defined once the make-or-buy decision has been made using the data analysis technique defined in this process. The procurement strategy defines the project delivery method, the type of legally binding agreement(s), and how the procurement will advance through the procurement phases [PMBOK® Guide 6th ed. 476].
- ⇒ **.3 Bid documents** — Bid documents are used to solicit proposals from prospective sellers. You might see terms such as bid, tender, or quotation used. Make sure you also know:
- ◇ **Request for information** — An RFI is used when more information on the goods and services to be acquired is needed from the sellers. It does not commit the buyer or seller in any way, and will typically be followed by an RFQ or RFP.
 - ◇ **Request for quotation** — An RFQ is used when more information is needed from the vendor about how the seller would satisfy the requirements and how much it would cost. An RFQ can commit the seller to a price in many situations.
 - ◇ **Request for proposal** — An RFP is the most open ended of the choices. It simply states the buyer has a problem or need and asks the potential seller to provide information about how they would solve this problem, typically with included cost information. This is also the most formal of the “request for” documents. It often contains specific procurement rules for content, timeliness and response form.
- ⇒ **.4 Procurement statement of work** — The SOW for each procurement comes from the project scope baseline. Recognize that a single project could have multiple SOWs with each defining only their limited portion of the project scope that is included within their specific related contract. Be aware that sometimes the term “terms of reference” or TOR is included. A TOR typically includes tasks the contractor is required to perform as well as any required coordination requirements, standards with which the contractor will have to comply, any data the contractor must submit for approval, a detailed list of all data and services that will be provided to the contractor by the buyer and the schedule for the procurement. There are three primary types of



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procurement statements of work including the following:

- ◇ **Performance** — This type conveys what the final product should be able to do rather than how it is built or what the design characteristics are.
 - ◇ **Functional** — This type conveys the end purpose or result, rather than the specific procedures or approach. Functional procurement statements of work may include a statement of the minimum essential characteristics of the product.
 - ◇ **Design** — This type conveys precisely what work is to be done.
- ⇒ **.5 Source selection criteria** — The source selection criteria is an evaluation criteria for choosing a seller. It is important that this criteria be created before the sellers are selected and the potential sellers are notified of how they are to be selected. This is an ethics issue for PMI®.
- ⇒ **.6 Make-or-buy decision** — Is the team going to do it themselves or rely on outside resources? This is the critical decision in procurement.
- ⇒ **.7 Independent cost estimates** — It is not unusual for extremely large and/or government funded projects to require an independent estimate of the potential costs of a specific procurement. These estimates serve as a benchmark as the organization examines the received proposals.
- ⇒ **.8 Change requests** — The process of examining potential external sourcing of goods and services on the project can often cause the team to rethink their methods. This leads to potential changes that must go through the approved change management process.
- ⇒ **.9 Project document updates** — In addition to causing changes to the project, going through the procurement planning process can cause a number of project documents to be updated. This includes the lessons learned register, milestone lists, requirements documentation, the requirements traceability matrix, the risk register, and the stakeholder register. Stop and think about it for a moment and imagine managing that project at the Acme Widget Factory. You have just gone through a process of deciding what things you are going to do in-house and the things you need to purchase from others. As you have talked to your suppliers you have learned about their timelines and processes. Doesn't it seem reasonable that that process could change a lot of other documents as well?
- ⇒ **.10 Organizational process assets updates** — Your team likely used the knowledge from past projects to establish a potential sellers list and gain a basic understanding of those sellers capabilities. The information you gained from going through the process should be added to the repository of knowledge for future projects as well.

So far in this process we have thrown a lot of terms and legalistic documents at you. If you feel a little bewildered don't You are really only dealing with four groups of items here and PMI® provides a great comparison of them within the Guide. Examine the table below for help on understanding the major components of planning procurements:



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Procurement Management Plan	Procurement Strategy	Statement of Work	Bid Documents
How procurement work will be coordinated and integrated with other project work, particularly with resources, schedule, and budget	Procurement delivery methods	Description of the procurement item	Request for information (RFI) Request for quote (RFQ) Request for proposal
Timetable for key procurement activities	Type of agreements	Specifications, quality requirements and performance metrics	
Procurement metrics to manage the contract	Procurement phases	Description of collateral services required	
Responsibilities of all stakeholders		Acceptance methods and criteria	
Procurement assumptions and constraints		Performance data and other reports required	
Legal jurisdiction and currency used for payment		Quality	
Information on independent estimates		Period and place of performance	
Risk management issues		Currency; payment schedule	
Prequalified sellers, if applicable		Warranty	

Image 130: Comparison of Procurement Documents PMBOK® Guide 6th ed. p.481

As you prepare for the PMP® exam there are a number of processes presented that are likely very different from what you are used to. PMI's view of the project manager's role in contracting is of much greater influence than many real-world PM's experience. To prepare for the exam you must understand what PMI® means by a contract: a contract is a legally binding agreement between two parties for the exchange of value. One party agrees to provide a product, service or result in exchange for some form of remuneration. A contract is usually written, but does not have to be. They can be simple or complex. A contract is subject to remedy in the courts. Contracts are typically subject to an approval process. Contracts also have their own life cycle. In addition to understanding the basic definition of a contract you must also be familiar with the types of contracts.

The best way to understand the various types of contracts is to think of a continuum that begins with cost plus percentage of cost contracts and ends with a firm fixed price or lump sum contract. Setting the continuum is the risk relationship between the buyer and the seller. As the risk for one goes up the risk for the other goes down. This relationship defines the major decision criteria for selecting a contract type. Selecting a contract type is about dealing with unknowns. The more well understood a need, the more the project aligns to a firm-fixed price contract. The more risk involved with the need, the more a cost plus percentage of costs contract makes sense. *Image 131* shows the contract type continuum. The types of contracts are as follows:



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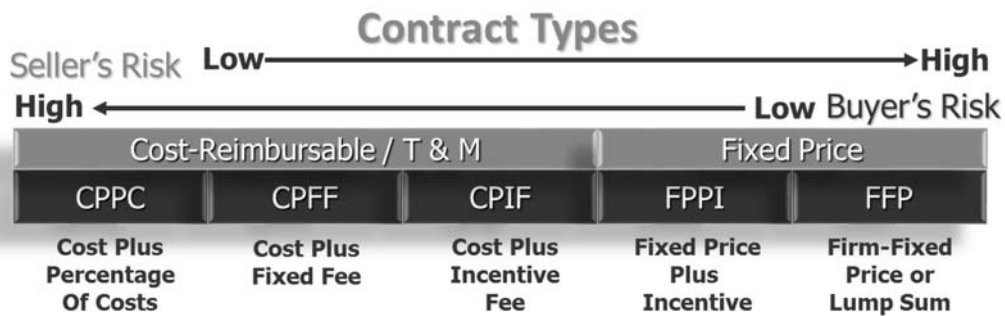


Image 131: Contract Types

- ⇒ **Cost Plus Percentage of Cost** — In a cost plus percentage of cost contract the buyer has the greatest risk because there is no incentive for the seller to keep costs low. In fact, the incentive is for the seller to spend as much as possible because they will also receive a percentage of the costs in addition to the real costs as their profit. This contract type is most common when the project scope is not well understood.
- ⇒ **Cost Plus Fixed Fee** — A cost plus fixed fee contract is similar to a cost plus percentage of cost contract in that the buyer must pay the seller for all the costs plus a pre-negotiated set fee which represents the seller's profit. This contract does not directly incent the seller to spend more, but it also does not provide any incentive to reduce costs.
- ⇒ **Cost Plus Incentive Fee** — A cost plus incentive fee contract requires the buyer to pay the seller all their expenses, but also allows the buyer to establish criteria for the seller to receive a bonus or extra fee. These incentives can be things such as hitting specific cost, quality, functional or schedule targets.
- ⇒ **Fixed Price Plus Incentive** — In a fixed price plus incentive contract the buyer pays the seller a set price regardless of the actual expenses plus the buyer establishes a criteria for the seller to receive a bonus or extra fee.
- ⇒ **Firm Fixed Price or Lump Sum** — In a firm fixed price contract the buyer pays the seller a set, pre-negotiated fee without any incentive to hit specific performance targets. This type of contract is most common when the project scope is well understood. In a fixed price contract the seller absorbs the most risk.

12.2 Conduct Procurements

The second process found in the procurement management knowledge area is the conduct procurements process. This process is part of the executing process group. The conduct procurements process focuses on obtaining seller responses, selecting a seller, and awarding a contract. In going through this process it is important to consider the following:

- ⇒ Project risks and contractual agreements



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- ⇒ Activities' resource requirements
- ⇒ Activity cost estimates
- ⇒ Cost and schedule baselines

This process may be done once or in an iterative fashion and there is no requirement that only one seller be selected. It is up to the project manager and the team to determine what is appropriate based upon the project needs.



Image 132: Conduct Procurements

The inputs to the conduct procurements process include the following:

- ⇒ **.1 Project management plan** — The project management plan is the lead document throughout the entire project. There are seven critical documents critical to the successful conducting of procurements within the plan. They include: the scope management plan, the requirements management plan, the communications management plan, the risk management plan, the procurement management plan, the configuration management plan and the cost baseline. Each of these documents has a significant role in defining what the team might need to purchase and how much money they have to get it done.
- ⇒ **.2 Project documents** — The additional project documents add key information to those found in the project management plan and include the lessons learned register, the project schedule, requirements documentation, the risk register, and the stakeholder register. These documents specifically define any pre-approved sellers, when things are needed, specific project risks and who the players are on the project.
- ⇒ **.3 Procurement documentation** — The procurement documents we defined in the plan procurements process. Remember, they include any bid documents, the procurement statement of work, any independent cost estimates that will be used as a reasonableness check against the proposals submitted and the source selection criteria that will be used to select a winning bid.
- ⇒ **.4 Seller proposals** — The seller proposals represent the seller's explanation for how they intend to deliver the desired product, service, or result.
- ⇒ **.5 Enterprise environmental factors** — When dealing with procurements a lot more legal issues come into play. Therefore, your environmental factors often deal with applicable laws or regulations with which the organization must comply. Market conditions may also drive availability and pricing or resources or deliverables. The team should also be evaluating information on past relevant experiences with the particular sellers and any existing agreements with those sellers.
- ⇒ **.6 Organizational process assets** — The particular organizational process assets of concern include listings of prospective and previously qualified sellers, and information on relevant past experience with sellers.



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The tools and techniques used in the conduct procurements process include the following:

- ⇒ **.2 Expert judgment** — Like most of the processes found in the PMBOK® Guide, expert judgment may be used to evaluate seller proposals. Commonly used expertise includes: contracting, legal finance, accounting, engineering, and specific technical disciplines for the project.
- ⇒ **.2 Advertising** — To increase the number of potential sellers, advertisements may be placed in newspapers, trade publications or on the internet.
- ⇒ **.3 Bidder conferences** — Bidder conferences have many different names. You might see contractor conferences or pre-bid conferences in addition to bidder conferences. These are meetings with all the perspective sellers, prior to the submission of bids or proposals, that allow the sellers to ask questions and receive information so all the sellers have the same information.
- ⇒ **.4 Data analysis** — Many of the processes already discussed have made extensive use of data analysis to examine key elements of process. Here, you are evaluating the proposals received by the team.
- ⇒ **.5 Interpersonal and team skills** — The key kind of interpersonal and team skill is negotiation. Negotiations are used to clarify the structure, requirements, and other terms of the purchases so that both the seller and the buyer can come to an agreement. This facilitates signing a contract so that the buyer can obtain the products or services required to complete the project. There are a number of negotiation tactics that you should know for the exam. These are as follows:
 - ◇ **Attacks** — To criticize or condemn another person or organization.
 - ◇ **Personal insults** — Making derogatory comments about another to distract from the issue or objective.
 - ◇ **Good Guy / Bad Guy** — One person is helpful to the other side and the other is difficult.
 - ◇ **Deadline** — Setting a hard deadline to complete the negotiations.
 - ◇ **Lying** — Not telling the truth to the other party.
 - ◇ **Limited Authority** — Claiming the power to negotiate only within certain boundaries.
 - ◇ **Missing Man** — Being unable to make the decision because the appropriate party is not present.
 - ◇ **Fair and Reasonable** — Asking the other party to accept the current offer as it is a fair offer to all parties.
 - ◇ **Delay** — This is a stall tactic used to push the decision to the last minute.



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- ◇ **Extreme Demands** — Using unreasonable standards to get the other party to agree to more reasonable standards.
- ◇ **Withdrawal** — This is a removal from the negotiation either physically or emotionally.
- ◇ **Fait Accompli** — It's a done deal, or assuming something is included.

The outputs from the conduct procurements process include the following:

- ⇒ **.1 Select sellers** — The listed tools and techniques will produce one or more selected sellers who have been judged to provide the best option for the project in producing the product or services required. For large, complex, or high value contracts, senior management approval might still be required.
- ⇒ **.2 Agreements** — Agreements can include contracts, statements of work or other documents. They often also include things such as the statement of work or deliverables, schedule baseline, performance reporting, period of performance, roles and responsibilities, seller's place of performance, pricing, payment terms, penalties, incentives, etc.
- ⇒ **.3 Change requests** — The conduct procurements process can generate change requests to any component of the project management plan and/or its subsidiary plans.
- ⇒ **.4 Project management plan updates** — Items which may be updated include things such as the cost baseline, scope baseline, schedule baseline, and the procurement management plan.
- ⇒ **.5 Project document updates** — Other documents which might be updated by the conduct procurements process include requirements documentation, the risk register, and/or the requirements traceability documentation.
- ⇒ **.6 Organizational process assets updates** — Because of the conduct procurement process the team may gain new information about prospective and prequalified sellers and what experience the team had with the seller.

12.3 Control Procurements

The third process found in procurement management is the control procurements process. This process is about managing the procurement relationships, monitoring contract performance, and making changes and corrections as needed. According to the PMBOK® Guide both the buyer and seller administer the contract, and both parties must meet their obligations. On some larger projects it is important that the project manager manages the interfaces among providers.



Image 133: Administer Procurements Process



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The inputs to the control procurements process include the following:

- ⇒ **.1 Project Management Plan** — The project management plan has been the dominant document collection throughout the entire project and it isn't about to change this late in the course. Within the project management plan, the team must use the requirements management plan, the risk management plan, the procurement management plan, the change management plan, and the schedule management plan.
- ⇒ **.2 Procurement documents** — The procurement documents contain all the supporting records for administration of the procurement processes. Therefore, you need to consider the assumption log, the lessons learned register, the milestone list the quality reports showing the quality of the vendor's delivery, requirements documentation showing what was to be delivered, the requirements traceability matrix so you know where requirements came from, the risk register, and the stakeholder register.
- ⇒ **.3 Agreements** — If any agreements have been negotiated and signed, these provide the basis of understanding of performance.
- ⇒ **.4 Procurement documentation** — Your procurement documentation contains all the records of the administration of the procurement agreements. Whatever you purchased for the project will have some kind of documentation here. Think of the SOWs, payment information, contractor work performance reports, plan or drawings just to name a few.
- ⇒ **.5 Approved change requests** — Notice these are not simply change requests. They are approved change requests. Items such as changes to the terms and conditions of the contract could be placed here or any changes to the work itself. The key here is that all the changes are approved.
- ⇒ **.6 Work performance data** — The work performance information in question includes any information concerning the extent to which quality standards are being met, the incurred costs, and paid seller invoices.
- ⇒ **.7 Enterprise environmental factors** — The specific enterprise environmental factors at play are your contract change control system, marketplace conditions, financial management and accounts payable system and the buying organization's code of ethics. You should also consider PMI's code of conduct as well.
- ⇒ **.8 Organizational process assets** — The team needs to specifically consider the organization's procurement policies.

The tools and techniques used in the control procurements process include the following:

- ⇒ **.1 Expert judgment** — Project teams must make use of subject matter expertise in all relevant functional areas to effectively control procurements.
- ⇒ **.2 Claims administration** — Claims administration deals with contested claims. A contested claim occurs any time the buyer and seller cannot agree



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about perspective changes or results on the project. On the exam a number of different terms can be used to reference items requiring claims administration that include: claims, disputes, appeals, conflicts or disagreements. The key is to remember that you must follow the terms of the contract which might require the buyer to pay the seller before any disputed claims are resolved.

- ⇒ **.3 Data analysis** — Monitoring and controlling project procurements requires the project team to examine and analyze a lot of information. PMI® focuses on three specific types of data analysis:
 - ◇ **Performance reviews** — A procurement performance review is a structured review of the seller's performance in delivering the desired product or service. It should examine the quality, scope, time and cost components of delivery and can also include any inspection or audit information.
 - ◇ **Earned value analysis** — EVA provides excellent tool, even for agile projects to compare actuals to forecasts and determine variances.
 - ◇ **Trend analysis** — Most of the trend analysis is done as part of earned value so make sure you are comfortable with the EAC and other forecasting variables defined in the cost chapter of this course.
- ⇒ **.4 & .5 Inspections and audits** — Inspections and audits represent examinations of the work provided by the seller and completed by the buyer. Inspections and audits may be scheduled or unscheduled and are done to ensure the seller is complying with the terms of the contract.

There are seven outputs to the control procurements process. They are as follows:

- ⇒ **.1 Closed procurements** — In the 5th edition of the PMBOK® Guide closed procurements were a process unto themselves that appeared in the closing process group. Now, PMI® has combined the process with controlling procurements and make it the first output. This is typically a formal written notice that the contract is complete. The requirements for this procedure are usually spelled out in the contract. All the deliverable should be completed and there should be no claims outstanding.
- ⇒ **.2 Work performance information** — The primary information provided in this update process is whether or not the seller performed as expected. This is a comparison of the agreed upon work with what was actually produced, the costs incurred and a comparison of the SOW budget.
- ⇒ **.3 Procurement documentation updates** — The team must update all contract information along supporting schedules, unapproved and approved change requests, technical documentation, warranties, and other financial information.

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- ⇒ **.4 Change requests** — Change requests can occur because of procurements to almost any area of the project.
 - ⇒ **.5 Project management plan updates** — Going through the process of controlling procurements can generate a lot of changes to the project management plan including changes to the risk management plan, the procurement management plan, the schedule baseline, and the cost baseline.
 - ⇒ **.6 Project document updates** — Just as controlling procurements can change the core project management plan, it can also change other project documents including the lessons learned register, resource requirements, the requirements traceability matrix, the risk register, and the stakeholder register.
 - ⇒ **.7 Organizational process assets updates** — Specific process assets which may be updated include standard communications and other correspondence, payment schedules and requests, seller performance evaluation documentation, prequalified seller list updates, the lessons learned repository, and the procurement file. The procurement file is new here. It represents a complete set of indexed contract documentation, including the closed contract for inclusion with the final project files.

Procurements Summary

As you study the procurement knowledge area for the exam make sure to study the three processes. However, this knowledge area is less important than some others in terms of pure memorization. You should be able to use common sense to determine the components in each process. Above all else remember you are always the **BUYER** unless otherwise stated. You should be able to recognize the scenarios for when to use each type of contract and the buyer/seller risk relationships for various types of contracts. Also, focus on the use and importance of evaluation criteria in selecting one or more seller.



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Exercise 22 — Procurement Management

1. Once signed, a contract is legally binding unless:
 - A. It is declared void by appropriate legal counsel.
 - B. One party fails to meet its financial obligation.
 - C. One party fails to deliver the contracted good or service.
 - D. It is in violation of applicable law.
2. You are leading a project that requires you to purchase goods and services from a third party. You negotiate and sign a contract and the contractor provides the desired product. However, you feel the product does not meet specifications. The contract is considered to be which of the following:
 - A. Closed
 - B. Null and void
 - C. Incomplete
 - D. Complete
3. Which of the following represents the primary purpose of contract negotiations?
 - A. To define objectives and stick to them.
 - B. Provide protection for the relationship.
 - C. Gain the greatest financial return.
 - D. Gain the most from the other side.
4. You are leading a large IT project for your organization. The head of the accounting department has just come to you with a problem. A routine audit of your project has found a complaint that has being made against it. The contract does not specify how to correct this situation, but you are being held accountable to do so. Which of the following would be the best course of action?
 - A. Stop payments until the problem is corrected.
 - B. Initiate legal proceedings to recover the overpayments and void the contract.
 - C. Work with the seller to alter the contract to require improved payment oversight.
 - D. Continue to make the payments.
5. Which of the following statements about change control is true and correct?
 - A. Changes rarely benefit the project.
 - B. A firm fixed price contract minimizes the need for change control.
 - C. The contract should include procedures to accommodate changes.
 - D. More detailed specifications eliminate the causes of changes.



Exercise 22 — Procurement Management

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6. Which of the following best explain the purpose of incentive clauses in contracts?
 - A. Reduce risks for the buyer by shifting them to the seller.
 - B. Synchronize objectives.
 - C. Help the seller control costs.
 - D. Help the buyer control costs.
 7. Which of the following activities is the best thing for a project manager to do when completing the conduct procurements process found in the procurement management knowledge area?
 - A. Update and evaluate risks.
 - B. Update the budget and schedule.
 - C. Answer the sellers' questions about bid documents.
 - D. Select a contract type.
 8. Which of the following activities occurs during the plan procurements process?
 - A. Advertising
 - B. Answering sellers' questions about the bid documents
 - C. Make or buy decisions
 - D. Proposal evaluation
 9. Which of the following is a key objective during contract negotiations?
 - A. Negotiate a price that meets or exceeds the buyers expectations.
 - B. Obtain a fair and reasonable price.
 - C. Ensure that an effective procurement management process is established.
 - D. Ensure that all project risks are thoroughly delineated.
 10. Which of the following best describes the role of the project manager during the procurement process?
 - A. The project manager is secondary to the contracting manager.
 - B. The project manager is the primary negotiator.
 - C. The project manager tells the contract manager how the contracting process should be handled.
 - D. The project manager supplies an understanding of the risks of the project.
 11. Which of the following is not required in a contract?
 - A. Acceptance
 - B. Procurement statement of work
 - C. Address of the buyer
 - D. Buyer's signature

-
12. In which of the following processes would you find bidder conferences?
- A. Plan procurement management
 - B. Conduct procurements
 - C. Administer procurements
 - D. Monitor procurements
13. You are leading a project that has a number of work packages that are being completed by external resources. One work package is being completed by a contractor working on a cost reimbursable contract. You have determined that the scope of the project must be expanded for this contractor. Additionally, you are concerned about cost control and would like to change the contract to a firm fixed price contract. All of the following are the seller's options except:
- A. Starting over with a new contract.
 - B. Negotiating a fixed price contract that includes all the desired work.
 - C. Completing the original work and rejecting the additional scope.
 - D. Completing the original work using the original cost reimbursable contract and then negotiating a new firm fixed price contract for the additional work.
14. Which of the following is a reason for centralized contracting?
- A. Deeping expertise.
 - B. No single location.
 - C. Increased loyalty to the project.
 - D. Easier access to expertise.
15. You are leading a large project and are attempting to negotiate a complex contract. In the middle of the meeting the selected seller informs you that "they need to finish up in the next 90 minutes so they can catch an airplane." What kind of negotiating strategy is this?
- A. Extreme demands
 - B. Delay
 - C. Good cop, bad cop
 - D. Deadline
16. You have been tasked with establishing a records management system for a large project. You are trying to make sure all the records from the procurements are properly documented and indexed. Which of the following are you not concerned about?
- A. Negotiation process
 - B. Proposal
 - C. Procurement statement of work
 - D. Terms and conditions

-
17. You have been asked to lead a mid-sized project for your organization. Your sponsor is very concerned about one particular seller that must be used on the project and wants to make sure you are minimizing the risk to your organization. You suggest using a firm fixed price contract. Which of the following explains the recommendation?
- A. Schedule risk will be fixed.
 - B. Cost risk will be lower.
 - C. The buyer owns most of the risk.
 - D. Risk is shared equally by all parties.
18. You are leading a project that has been in process for 13 months. You are nearing the completion of a major deliverable that was completed by an external resource using a cost reimbursable contract. You have entered the close procurements process. Which of the following must you remember to do?
- A. Make sure the seller is not adding work to the contract.
 - B. Make sure the seller is not adding resources.
 - C. Audit the seller's cost submittals.
 - D. Decrease the risk rating of the project.
19. You have been asked to lead a mid-sized project for your organization. Your sponsor is very concerned about one particular seller that must be used on the project and wants to make sure you are minimizing the risk to your organization. You suggest using a firm fixed price contract. In a firm fixed price contract, the fee or profit is:
- A. Specifically stated as a line item in each invoice.
 - B. Determine through negotiation at the end of the contract.
 - C. Unknown.
 - D. Part of the negotiation involved in paying every invoice.
20. You are leading a large engineering project for your organization. As part of the standard reporting process you are required to submit earned value calculations such as SPI, CPI and TCPI. One day your sponsor comes into your office concerned about your largest contractor gaining extra profit on the CPFF contract. You explain that they should not be worried about this issue. Which of the following best justifies this statement?
- A. All cost invoices are being audited.
 - B. The seller only receives their fee once the project is completed.
 - C. You are making sure the seller does not cut scope.
 - D. There can only be a maximum 10% increase if there is an unexpected overrun.

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21. You are the project manager on a project that is part of a large space program. Another project manager on the program has just come to you for advice. Their project currently has limited scope definition and she is very concerned about protecting the organization from financial risks. Which is the best contract type to choose?
- A. Firm fixed price
 - B. Cost plus fixed fee
 - C. Cost plus percentage of cost
 - D. Cost plus incentive fee
22. You are leading an especially difficult team attempting to complete a large project that has significant risk to the organization. You are in the middle of your standard Monday morning meeting where you are attempting to determine whether the team should produce a particular deliverable themselves or outsource it to an external party. In what part of the procurement process are you currently?
- A. Plan procurement management
 - B. Conduct procurements
 - C. Control procurements
 - D. Close procurements
23. Your team is meeting and discussing the proposals received to produce a large required deliverable. The team is about equally split on which provider they prefer. In what part of the procurement process are you currently?
- A. Plan procurement management
 - B. Conduct procurements
 - C. Control procurements
 - D. Close procurements
24. In what part of the procurement process are you in if you are attempting to complete procurement negotiations?
- A. Plan procurement management
 - B. Conduct procurements
 - C. Control procurements
 - D. Close procurements
25. You are leading a project and have just lost a critical internal resource due to illness and long-term disability. The work is very important and cannot be done by an internal resource. You have decided to make use of an external contractor to complete the deliverable. Time is of the essence and the deliverable must be completed quickly. Under these circumstances, which of the following would be the most helpful to add to the contract?
- A. A force majeure clause
 - B. Schedule targets
 - C. A clear procurement statement of work
 - D. Incentives

-
26. With which type of contract is the seller to be most likely concerned about project scope?
- A. Cost plus fixed fee
 - B. Cost plus incentive fee
 - C. Fixed price plus incentive fee
 - D. Firm fixed price
27. You are leading a very complex project. Part of your job required you to negotiate the contract with a large reseller. Throughout the negotiations you required minutes to be kept which you also required the reseller to sign as true and accurate. Now, several months later the seller is claiming they are not required to complete certain components of work because they appear in your notes and not the contract. In this case the seller is:
- A. Generally incorrect, because all signed agreements must be upheld.
 - B. Correct because there was a tender and agreement.
 - C. Generally correct, because both parties are only required to perform what is in the contract.
 - D. Incorrect, because both parties are required to comply with what they agreed upon.
28. You are the project manager on a large petrochemical project. You have awarded the primary contract to build the required facility to a large European engineering firm. Within the contract is specific language that requires the contract to submit a work plan to you for approval prior to initiating work. However, the seller has failed to provide one prior to commencing work. Which is the best thing for you to do?
- A. Develop the work plan and provide it to the contractor.
 - B. File a letter of intent.
 - C. Issue a default letter.
 - D. Stop the project until the contractor develops a work plan.
29. Which type of contract is best if you do not have the manpower to audit the submitted contractor invoices?
- A. Firm fixed price
 - B. Fixed price plus incentive fee
 - C. Cost plus incentive fee
 - D. Cost plus fixed fee

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30. You are leading a contracting team for a project making use of three external contractors. You submit a deliverable that the project manager believes is substandard. The project manager refuses to accept the deliverable and refers you to the technical specifications section of the contract that specifically addresses the deliverable in question. You examine the specification and agree the deliverable failed to meet the specification. What is the best thing to do?
- A. Call your team together to review the contract.
 - B. Work with the project manager to issue a change order.
 - C. Enter into negotiations with the project manager to change the contract.
 - D. Review the requirements and the WBS with your team.
31. Once signed, a contract is legally binding unless:
- A. One party is unable to perform.
 - B. Both parties are unable to perform.
 - C. It is declared null and void by counsel.
 - D. It is in violation of applicable law.
32. All of the following statements concerning procurement documents are incorrect except which one:
- A. Well-designed procurement documents can simplify comparison of responses.
 - B. Procurement documents must be rigorous with no flexibility to allow consideration of seller suggestions.
 - C. In general, procurement documents should not include selection criteria.
 - D. Well-designed procurement documents do not include a procurement statement of work.
33. A seller is working on a cost reimbursable contract when the buyer decides they would like to expand the scope of services and change to a fixed price contract. All of the following are the seller's options except which one:
- A. Completing the original work on a cost reimbursable basis and then negotiating a fixed price for the additional work.
 - B. Completing the original work and rejecting the additional work.
 - C. Starting over with a new contract.
 - D. Negotiating a fixed price contract that includes the work.

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34. The sponsor is worried about the seller deriving extra profit on the cost plus fixed fee contract. Each month he requires the project manager to submit CPI calculations and an analysis of the cost to complete. The project manager explains to the sponsor that extra profits should not be a worry on this project because:
- A. The team is making sure the seller does not cut scope.
 - B. All costs invoiced are being audited.
 - C. There can only be a maximum 10% increase if there is an unexpected cost overrun.
 - D. The fee is only received by the seller when project is completed.
35. The sponsor and the project manager are discussing what type of contract the project manager plans to use on the project. The sponsor points out that the performing organization spent a lot of money hiring a design team to come up with the design. The project manager is concerned that the risk for the buyer be as small as possible. An advantage of a fixed price contract for the buyer is:
- A. Cost risk is lower.
 - B. Cost risk is higher.
 - C. There is little risk.
 - D. Risk is shared by all parties.
36. You are in the middle of a complex negotiation when the other party says, ‘We need to finish in one hour because I have to catch my plane.’ That person is using which of the following negotiation strategies?
- A. Good guy, bad guy
 - B. Delay
 - C. Deadline
 - D. Extreme demands
37. Your company has an emergency and needs contracted work done as soon as possible. Under these circumstances, which of the following would be the most helpful to add to the contract?
- A. A clear procurement statement of work.
 - B. Requirements as to which subcontractors can be used.
 - C. Incentives.
 - D. A force majeure clause.

-
38. The project team seems to like to argue; they have argued about everything. Luckily the project set in place a reward system and team-building sessions that will help and encourage the team to cooperate more. The latest thing they are arguing about is whether they should complete a work package themselves or outsource the work to someone else. What part of the procurement process must they be in?
- A. Conduct procurements
 - B. Plan procurement management
 - C. Administer procurements
 - D. Claims administration
39. Your program manager has come to you, the project manager, for help with a bid for her newest project. You want to protect your company from financial risk, and you have limited scope definition.
- A. Firm fixed price
 - B. Cost plus percentage of cost
 - C. Time and material
 - D. Cost plus fixed fee
40. Negotiations between two parties are becoming complex, so Party A makes some notes that both parties sign. However, when the work is being done, Party B claims they are not required to provide an item they both agreed to during negotiations because it was not included in the subsequent contract. In this case, Party B is:
- A. Incorrect, because both parties must comply with what they agreed on.
 - B. Correct, because there was an offer.
 - C. Generally correct, because both parties are only required to perform what is in the contract.
 - D. Generally incorrect, because all agreements must be upheld.
41. Your project has just been fast-tracked and you are looking to quickly bring in a subcontractor to complete networking. There is no time to issue a request for proposal, so you choose to use a company you have used many times before for software development. A primary concern in this situation is:
- A. Collusion between subcontractors.
 - B. The subcontractor's qualifications.
 - C. The subcontractor's evaluation criteria.
 - D. Holding a bidder conference.

Exercise 22 — Procurement Management Answers

1. **Answer D.** A contract is not legally binding if it violates applicable law. However, contract terms typically spell out what will happen if other conditions are not met.
2. **Answer D.** If the seller completes the work specified in the procurement statement of work the contract is considered complete. That does not mean the same thing as closed. The close procurements process still must occur.
3. **Answer B.** According to PMI® you are always looking for the win/win situation. You also want to have the relationship last through the entire project. A contract will not force anyone to stick to objectives. It can only spell out the penalties if the objectives are not met.
4. **Answer D.** Remember, the question is really asking what would you do first. In this case, you would first continue the payments otherwise you would be in violation of the terms of the contract. You cannot simply void a contract. While altering the contract might be a good idea, it is not what you would do first.
5. **Answer C.** Changes will occur no matter what. It is therefore critically important that any contract outline how changes are to be made so you can best handle them. All of the other choices are myths!
6. **Answer B.** Incentives are specifically intended to help the seller and buyer synchronize objectives. Sellers are typically motivated by financial means. By providing special gains, typically financial to the seller, the buyer can motivate the seller towards specific important targets.
7. **Answer C.** During the conduct procurements process, you normally answer questions submitted by the sellers. The risk analysis processes are done before the procurement process begins, as procurement is a form of risk mitigation and transference. Selecting a particular contract type is part of plan procurements. Changes to the schedule and budget may be an output of the administer procurements process.
8. **Answer C.** PMBOK® Guide p. 466-481 – Everything other than the make or buy decision where you actually choose to procure a good or service occur in the plan procurement management process.
9. **Answer B.** Contract negotiations are about managing expectations and ensuring the relationship can be maintained throughout the project. They are also about getting a win-win situation in terms of price. This means the buyer gets a fair and reasonable price.
10. **Answer D.** This is a question where all of the options are less than perfect. However, the best or closest option is that the project manager supplies an understanding of the risks of the project.

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11. **Answer C.** The options in this question make it difficult. Acceptance is a fancy way of saying a signature from both parties, the procurement statement of work is simply what you will be purchasing. The buyer's signature is required, but not enough. The address of the buyer is not necessarily required.
 12. **Answer B.** PMBOK® p. 460 – Conduct procurements where you would find bidder conferences. Expect a number of questions where you have to know which process a tool or technique is from.
 13. **Answer A.** The seller does not have the choice to simply start over. The existing contract is binding and cannot be nullified by a single party.
 14. **Answer C.** Remember, the objective is to select the answer that is best. The best answer in this case is increase loyalty to the project. A common problem with contracting is that when it is not centralized there is very little loyalty to the project.
 15. **Answer D.** This is an example of setting a deadline where the negotiations would end.
 16. **Answer A.** To answer this question you need to know what a records management system is and that it would not be used to keep track of negotiations. The negotiations process is not a document.
 17. **Answer B.** Remember, unless otherwise specified you are always the buyer. In a firm fixed price contract the costs will theoretically be lower unless there is significant scope change.
 18. **Answer C.** There is no guarantee that the risk rating for the project has changed because of the closed project. You should have already ensured the seller is only delivering against the contract, so no additional work or resources are valid. The only thing that makes sense is that you need to audit the cost submittals because this is a cost reimbursable contract.
 19. **Answer C.** Unlike a cost plus contract, in a firm fixed price contract you have no idea how much of the firm fixed price is profit.
 20. **Answer A.** Cutting scope on a cost plus fixed fee contract will decrease profits. A CPFF contract also does not tend to limit fee increases. The fee in a CPFF contract is usually paid out on a continuous basis throughout the contract. However, one way to change the profits in a CPFF contract is to invoice for things chargeable to the project.
 21. **Answer B.** Of all the choices given only a cost plus fixed fee contract limit financial risk. A cost plus incentive fee might, but the incentives are not the best guarantee.
 22. **Answer A.** PMBOK® Guide p. 473 – This is a basic make versus buy question. Therefore you are in the plan procurement management process.
 23. **Answer B.** PMBOK® Guide p. 488 – Selected sellers is an output of the conduct procurements process.

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24. **Answer B.** PMBOK® Guide p. 488 – Procurement negotiations are part of interpersonal and team skills and a tool and technique used in the conduct procurements process.
 25. **Answer D.** PMBOK® Guide p. 477 – A clear procurement statement of work is always required but that does not ensure it will be done quickly. Incentives are best for aligning the objectives of the buyer and the seller.
 26. **Answer D.** PMBOK® Guide p. 471 – In a firm fixed price contract the seller has all the cost risk. The only way they can make a profit is if they are able to clearly define and maintain the project scope.
 27. **Answer C.** PMBOK® Guide p. 460-462 – In most situations the seller is only required to comply with what is described in the contract.
 28. **Answer C.** Any time a seller does not perform according to the contract the project manager must take action. The best action would be to simply contact the seller and find out what is happening, but that is not one of the choices.
 29. **Answer A.** PMBOK® Guide p. 471 – A firm fixed price contract does not require detailed review of invoices. Your primary concern is the deliverables as you are paying a fixed rate.
 30. **Answer D.** Calling your team together to review the contract is close, but it is not correct. The best answer is to review the requirements and the WBS as the WBS, with its included WBS dictionary, clearly describe the deliverables.
 31. **Answer D.** PMBOK® Guide p. 461 – A contract is always binding unless both sides agree to terminate it or it violates applicable law.
 32. **Answer A.** PMBOK® Guide p. 461 – Often the seller is required to inform the buyer of anything that is missing or unclear in the procurement documents. It is in the buyer's best interest to discover missing items, since it will save the buyer money and trouble to correct the problem early. Procurement documents must contain terms and conditions and selection criteria, as well as documentation of all the work that is to be done. This is so the seller can price the project and know what is most important to the buyer. Well-designed procurement documents can simplify comparison of responses. This is an important point for the real world and the best answer.
 33. **Answer C.** PMBOK® Guide p. 461 – The seller can try to negotiate changes or simply continue the original contract and refuse the request to complete additional work, but the seller cannot unilaterally decide to start over with a new contract. Both parties have to agree to this option through negotiations.

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34. **Answer B.** PMBOK® Guide p. 472 – Cutting scope decreases profits on this type of contract, so that would not be a way for the seller to generate extra profits. CPFF contracts generally do not limit fee increases and the fee in a CPFF contract is usually paid out on a continuous basis during the life of the project. One of the ways to change the profit in a cost plus fixed fee contract is to invoice for items not chargeable to the project. Therefore, all invoiced costs should be audited.
35. **Answer A.** PMBOK® Guide p. 471-472 – If you had trouble with this one, you need to remember that the questions are asked from the buyer’s perspective unless otherwise noted. The seller has the most cost risk in a fixed price contract, and the buyer’s risk is lower.
36. **Answer C.** Putting a time limit on the negotiation is an example of a deadline negotiation strategy.
37. **Answer C.** If you follow the proper project management process, you always have good definition of scope. In this situation, you are in a time crunch. Both good scope definition and incentives are required to make it happen. Which provides the better answer? Along with good scope definition, you need the seller to share your need for speed. Incentives bring the seller’s objectives in line with the buyer’s and thus would be the most helpful. Good scope definition alone does not ensure speed.
38. **Answer B.** PMBOK® Guide p. 479 – Did you notice that much of this question is irrelevant? Did you also notice that the words “make-or-buy decision” were not used in the question? Instead, the question used the definition of make-or-buy. Watch out for this on the exam. A make-or-buy decision is needed before the rest of the procurement process can occur. Therefore, the situation must be taking place in one of the early steps of the procurement process. Plan procurements is the correct choice.
39. **Answer D.** PMBOK® Guide p. 471-472 – Of those given, the only contract that limits fees for large projects with limited scope definition is the cost plus fixed fee.
40. **Answer C.** Party B is only required to deliver what is defined in the contract.
41. **Answer B.** Although you have used this contractor before, how can you be sure the company is qualified to do the new work since it is not exactly like the previous work? This is the risk you are taking.

Stakeholder Management

Overview

Chapter 13 of the PMBOK® Guide is dedicated to the stakeholder management knowledge area. There are four processes found in the stakeholder management knowledge area, which include the following processes:

- ⇒ 13.1 Identify stakeholders
- ⇒ 13.2 Plan stakeholder engagement
- ⇒ 13.3 Manage stakeholder engagement
- ⇒ 13.4 Monitor stakeholder engagement

The stakeholder management knowledge area first appeared in the 2012 5th edition of the PMBOK® Guide. In previous editions, most of the exact same information was found in the communications management knowledge area. In the 6th edition of the Guide it is still a short knowledge area that does not typically cause problems for students.

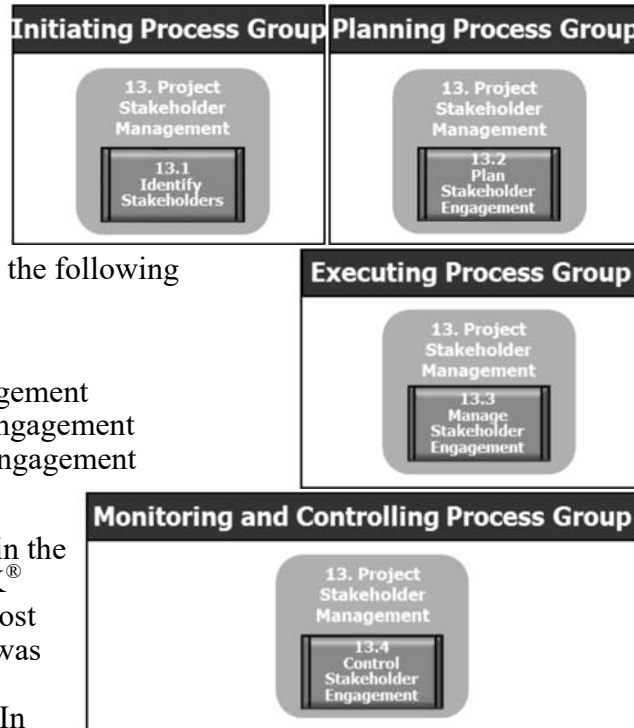


Image 133: The Stakeholder Management Processes

13.1 Identify Stakeholders

The first process found in the stakeholder management knowledge area is the identify stakeholders process. This process is one of the two processes found in the initiating process group and occurs prior to what most project managers consider the “real-world” beginning of project management. The identify stakeholder process is somewhat different than the other processes defined in the PMBOK® Guide in that it is

both a defined process that happens at a specific time in the project timeline, and it is also a process that goes on constantly throughout the project. Don’t be surprised if you see questions which seem to contradict each other. One question might ask in which specific process are you to examine the stakeholders and their needs while another might ask when should you examine the needs of the stakeholders. The answer to the first question is the identify stakeholders process while the answer to the second question is “all the time.”

The inputs to the identify stakeholders process include the following:



Image 134: 13.1 Identify Stakeholders



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- ⇒ **.1 Project charter** — The project charter may be used to obtain information about people—both internal and external to the project — who may be affected by the project.
- ⇒ **.2 Business documents** — This is one of the first two processes in any project. As such, the business documents are very important to the process. These documents include the business case and benefits management plan. These two documents explain the business need and the expected business benefits from the project.
- ⇒ **.3 Project management plan** — Don't be confused by the fact that the project management plan is listed as an input. PMI® recognizes the project management plan is not available to this process when it is first initiated. However, it is intended to be an iterative process and in later efforts the information contained in the communications management plan and the stakeholder engagement plan.
- ⇒ **.4 Project documents** — It is also unlikely that any of the additional project documents will be available when the team begins to identify stakeholders, but the change log, the issue log, and the requirements documentation will be available for future iterations of the process.
- ⇒ **.5 Agreements** — Various types of agreements might be in place before the project begins. The signors of those agreements are stakeholders for the project
- ⇒ **.6 Enterprise environmental factors** — Items such as organizational structure or governmental and industry standards can be key inputs to understand a project's stakeholders.
- ⇒ **.7 Organizational process assets** — Items such as stakeholder register templates, lessons learned from previous projects, and/or stakeholder registers from previous projects can help determine the players for your project.

The tools and techniques used in the identify stakeholders process include the following:

- ⇒ **.1 Expert judgment** — Like most of the processes found in the PMBOK® Guide, expert judgment is used in the identify stakeholder process.
- ⇒ **.2 Data gathering** — Data gathering is something we have talked about extensively in this course. Now that we are in our 13th chapter, it should be readily familiar to you. To identify stakeholders it is common to use questionnaires and surveys as well as various brainstorming techniques. On specific technique that you should add to your library is brain writing. **Brain writing** is a refinement of brainstorming that allows individual participants time to consider the question(s) individual before the group creativity session is held. The information can be gathered in face-to-face groups or using virtual environments supported by technology. [PMBOK® Guide 6th ed. p. 511].



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- ⇒ **.3 Data analysis** — A big part of data analysis is stakeholder analysis. Stakeholder analysis is the process of systematically gathering and analyzing both qualitative and quantitative data to determine what is driving the various stakeholders' participation in the project. Drivers can include interest, rights such as legal or moral, ownership, knowledge and contribution. The team should also consider document analysis.
- ⇒ **.4 Data representation** — When identifying stakeholders, the team may find need to represent the gathered information visually. These methods provide way to visually categorize stakeholders. If your project is small these models are less important than a project with many stakeholders. As you study the listed tools remember to think about the Acme Widget Factory team and how they would need to look at stakeholders. Remember, it is important that you recognize the real-world problem of your limited time, and your stakeholders' differing levels of influence within the organization. This means you cannot treat all your stakeholders the same. You are going to be required to spend more time with some and less with others. So how are you going to ensure you correctly allocate your time to the “right” stakeholders? Potential techniques include:

- ◇ **Grids** — Grids are two axis representations of stakeholder characteristics. In most cases, these are tools used in brainstorming where the team is sitting together, whether in person or via technology, discussing who the stakeholders are and how the team views them. The process begins with each member of the team brainstorming about who they think potential stakeholders are. As they come up with names they write them on stickies that are then placed on the poster paper or the whiteboard. The facilitator then draws a large four square grid on the whiteboard or poster paper. The grid is defined by two axis such as power and influence, power and interest or support and power. The team then places each stakeholder in one of the four quadrants. *Image 135* shows a sample support/influence grid.

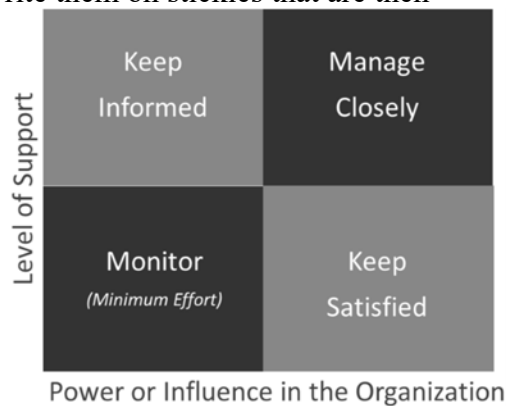


Image 135: Power vs. Influence Grid

- ◇ **Stakeholder cube** — A stakeholder cube is built on the previously discussed grids. It simply adds a third dimension or variable to the grid.
- ◇ **Salience model** — A salience model describes classes of stakeholders based on assessments of their power (level of authority or ability to influence the outcomes of the project), urgency (need for immediate attention, either time-constrained or relating to the



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stakeholders' high stake in the outcome), and legitimacy (their involvement is appropriate). There is an adaptation of the salience model that substitutes proximity for legitimacy (applying to the team and measuring their level of involvement with the work of the project). The salience model is useful for large complex communities of stakeholders or where there are complex networks of relationships within the community. It is also useful in determining the relative importance of the identified stakeholder [PMBOK® Guide 6th ed. p. 513].

To get a better understanding of this model, let's begin with a simple definition for the term salience. Salience is the degree to which managers give priority to competing stakeholders' claims in their decision-making process. The term was first coined in the field of project management by Mitchell, Agle, and Wood in 1997 when they proposed a Theory of Stakeholder Identification and Salience in response to what they saw as confusion over the definition of stakeholders and a general failure to reach a consensus over "who and what really counts" in stakeholder management [Mitchell et al. 1997, p. 853-854]

In the salience model, you assign each stakeholder values for three attributes:

- ⇒ **Power** — This is the authority or influence the stakeholder has on your project and/or its objectives. It is determined by focusing on the stakeholder's potential impact on your project or outcome. This power can be incentive, coercive, or utilitarian.
- ⇒ **Legitimacy** — This is the appropriateness of the stakeholder's involvement in your project. It answers the question, should they be there? It is generally a bad idea if you are spending a significant amount of time dealing with issues from a stakeholder who should not have a voice in the project. You also will spend more attention on a stakeholder the more their voice is legitimate.
- ⇒ **Urgency** — Does the stakeholders' needs require immediate attention. How time sensitive are the requirements from the stakeholder, or how critical are the requirements.

Each stakeholder becomes represented by assessments of these three values, and those values change over time. The most common representation of this model is a Venn diagram using three intersecting circles. Each circle represents one of three drivers, and the key to the model becomes understanding those stakeholders in the intersections. The intersection of the three attributes within the diagram creates several stakeholder groupings and seven classifications of stakeholders for the project leader to track.



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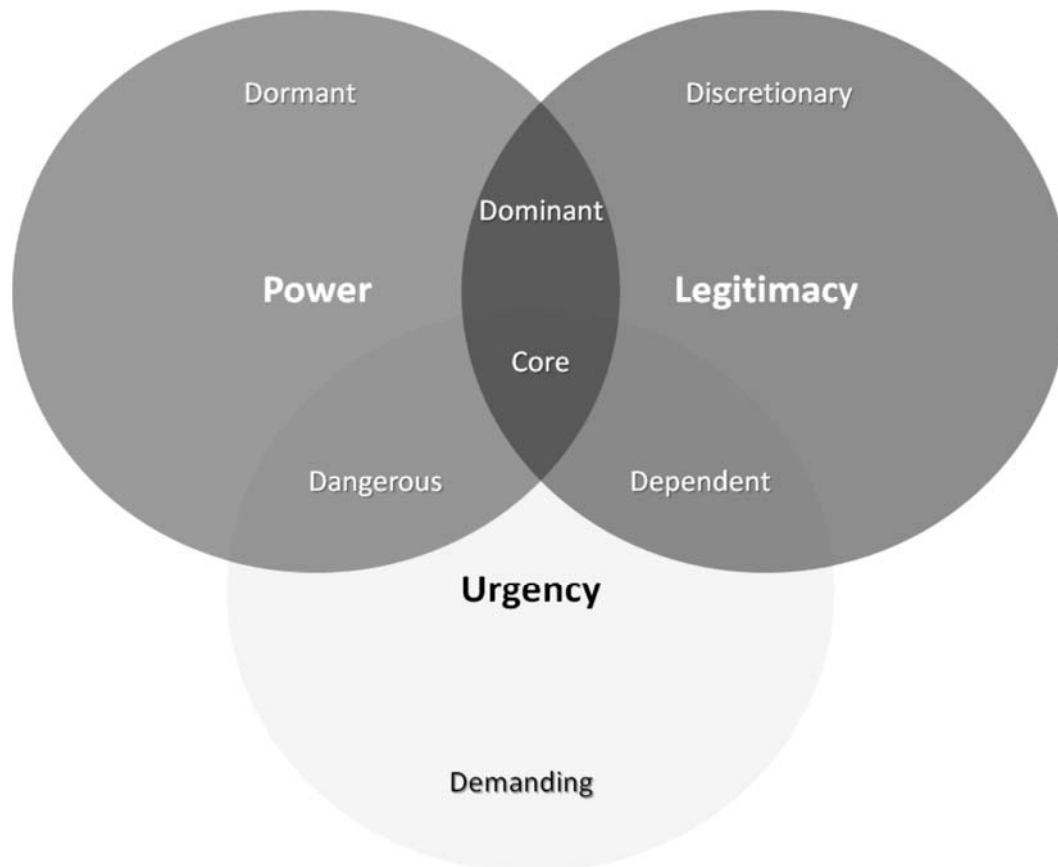


Image 136: The Salience Model

- ⇒ **Latent stakeholders** — These stakeholders have only a single attribute. This attribute can be any of the three power, legitimacy or urgency. Typically, these stakeholders are not given a majority of the team's attention. Consider this a class of stakeholder and not one of the seven.
- ⇒ **Dormant stakeholders** — These stakeholders have high organizational power, but low legitimacy and low urgency. Their high power means they can significantly impact the project so they must be managed prudently.
- ⇒ **Discretionary stakeholders** — These stakeholders have high legitimacy but low power and urgency. Because of their legitimacy the team will work to fulfill their requirements even though they don't have significant power or urgency. You must communicate with them regularly to ensure the team has the information they need to succeed.
- ⇒ **Demanding stakeholders** — These stakeholders have high urgency but low power and legitimacy. This is usually a very vocal group that can significantly influence other stakeholders if their requirements are not met. This group always wants the team's attention and must be managed carefully.



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- ⇒ **Expectant stakeholders** — These stakeholders have two attributes. The group of expectant of stakeholders are active and expect something from the project. The next three stakeholder groups fall into the group of expectant stakeholders.
 - ⇒ **Dominant stakeholder** — These stakeholders have both high power and high legitimacy. They also have low urgency. This causes them to rank below the core group, but still be very important.
 - ⇒ **Dangerous stakeholders** — These stakeholders have high power and urgency but low legitimacy. This combination is very dangerous. They can aggressive and unpredictable often creating trouble for the project. It is important that the team is cautious with these stakeholders so they do not jeopardize the project.
 - ⇒ **Dependent stakeholders** — These stakeholders have high urgency and high legitimacy but low power. The fact that they have low power means you do not have to manage them closely.
 - ⇒ **Definitive stakeholders** — These are your core stakeholders. They score high in all three measured attributes. You must manage these stakeholders very closely.
- ◇ **Direction of influence** — This tool is used to classify stakeholders according to their influence on the work of the project. This model typically uses the following variables:
 - ⇒ **Upward** — Senior management, the sponsor or steering committee.
 - ⇒ **Downward** —The team or specialists contributing knowledge or skills in a temporary capacity.
 - ⇒ **Outward** — Stakeholders outside the project team such as suppliers, government, the public end users or regulators.
 - ⇒ **Sideward** — The peers of the project manager who are in competition for scarce project resources or who collaborate with the project manager in sharing resources or information.
 - ◇ **Prioritization** — Prioritizing stakeholders is a common practice, especially with a large number of stakeholders or where the community of stakeholders is constantly changing. Just like requirements, stakeholders should be prioritized to ensure the team spends the most time with the most impactful stakeholders.



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- ⇒ **.5 Meetings** — Determining who the stakeholders are on a project can require a significant number of meetings.

The outputs from the identify stakeholders process are:

- ⇒ **.1 Stakeholder register** — The stakeholder register is the primary output from the analyze stakeholders process. It contains the details about the defined stakeholders such as who they are, their positions, major concerns and desires for the project and a classification.
- ⇒ **.2 Change requests** — This is very early in a project process so you are not going to see changes from things that haven't even been created. Instead, remember that this is an iterative process and the team must constantly be examining the project to identify new stakeholders or changes to stakeholders' position, opinions or role.
- ⇒ **.3 Project management plan updates** — When this process is first done there isn't a project management yet, but because of the iterative nature of the process, there could be updates to the project management plan at a later date.
- ⇒ **.4 Project document updates** — This is yet another case where there are no updates initially, but as the project progresses updates are often created.

10.2 Plan Stakeholder Management

The plan stakeholder management process follows much the same design as the plan processes found in other knowledge areas. The purpose of the plan stakeholder management is to define the rules and standards that will be used throughout the project. What is different about the plan stakeholder management process is that it is not the first process in the knowledge area. In this knowledge area the team must first spend time understanding who the primary stakeholders are and what their key needs are. Once those are defined the team can define which processes will best manage the stakeholders and their needs, and how the team will continue to work with its stakeholders.



Image 137: Monitor Stakeholder Engagement

The inputs to the plan stakeholder management process include the following:

- ⇒ **.1 Project charter** — The charter explains why the team is doing the project and what its success criteria is.
- ⇒ **.2 Project management plan** — The project management plan defines many of the core aspects of the project that are used to ensure the team understands what the team expects from the project. The team should specifically look at the resource management plan, communications management plan and the risk management plan. Each of these can have a big influence on what is communicated and how with stakeholders.



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- ⇒ **.3 Project documents** — The project documents can have a big impact on how and what is communicated to stakeholders. Of particular interest is the assumption log, the change log, issues log, the project schedule, risk register, and the stakeholder register.
 - ⇒ **.4 Agreements** — Any existing agreements define potential communication requirements and stakeholders for the project.
 - ⇒ **.5 Enterprise environmental factors** — Items such as organizational structure or governmental and industry standards can be key inputs to understand a project's stakeholders.
 - ⇒ **.6 Organizational process assets** — Common organizational process assets include any organizational communication requirements, issue management procedures, change control procedures, or historical information from past projects.

There are six key tools and techniques used in the plan stakeholder management process. These are all old friends you have seen many, many times before. They include the following:

- ⇒ **.1 Expert judgment** — Like most of the processes found in the PMBOK® Guide, expert judgment is used in the identify stakeholder process.
- ⇒ **.2 Data gathering** — Benchmarking is the primary data gathering tool used to plan stakeholder management. We have previously defined benchmarking as a comparison process used to compare the project or organization to something outside. The goal of benchmarking is to prevent the team from possessing tunnel vision.
- ⇒ **.3 Data analysis** — leaders may make use of assumption and constraint analysis and root cause analysis to determine their stakeholder management plan.
- ⇒ **.4 Decision making** — The major decision the team must make in the plan stakeholder management process is prioritizing or ranking the project's stakeholders.
- ⇒ **.5 Data representation** — The team uses tools such as mind mapping and a stakeholder engagement assessment matrix to display the level of engagement and interest the stakeholders have in the project.
- ⇒ **.6 Meetings** — Determining the stakeholders on a project can require a significant number of meetings.

There is just one output to the plan stakeholder management. It is the stakeholder engagement plan. The stakeholder engagement plan defines all the rules, processes and other necessary information for management stakeholders.

10.3 Manage Stakeholder Engagement

The fourth process in the stakeholder management knowledge area is manage stakeholder expectations. This process is one of the more important processes to a project's success, but it is also one of the easier processes to learn because it is mostly common sense. The manage stakeholder engagement process is about managing communications to satisfy the needs of project stakeholders, resolving issues with project stakeholders, and actively managing stakeholders to increase the likelihood of project success.



Image 138: Manage Stakeholder Engagement

The inputs to the manage stakeholder engagement process are as follows:

- ⇒ **.1 Project management plan**— The project management plan provides the communications management plan, risk management plan, the stakeholder engagement plan, and the change management plan specifically to help the team manage stakeholder engagement.
- ⇒ **.2 Project documents** — The change log, issue log, lessons learned register, and stakeholder register provide important information for effectively managing stakeholder engagement.
- ⇒ **.3 Enterprise environmental factors** — Everything from your organization's culture to the stakeholders individual risk threshold must be considered when managing the level of engagement for your stakeholders.
- ⇒ **.4 Organizational process assets** — Common organizational process assets include any organizational communication requirements, issue management procedures, change control procedures, or historical information from past projects.

The tools and techniques used in the manage stakeholder expectations process are very straightforward and common sense. Before reading through them, stop and think for a moment: what tools and techniques would you use on a project to manage expectations? It is likely you were able to come up with a list very similar to the one below.

- ⇒ **.1 Expert judgment** — Nothing is more effective in managing stakeholders than the subject matter experts on your team. Just as we have said repeatedly in this course, take it to the team. Trust your subject matter experts to engage the stakeholders.
- ⇒ **.2 Communication skills** — These are the methods the project defined in the communications management plan as discussed earlier in this chapter.
- ⇒ **.3 Interpersonal and team skills** — Interpersonal skills include things like your ability to build trust, resolve conflict, listen actively, and overcome resistance to change.



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- ⇒ **.4 Ground rules** — A good project manager is also a good manager. Do not underestimate the importance of this statement. Part of being a good manager is establishing basic, foundational rules with which the team must comply.
- ⇒ **.5 Meetings** — One of the best ways to engage stakeholders is to meet with them and then not waste their time.

The outputs from the manage stakeholder engagement process are largely changes, and represent exactly what you would expect if you stopped for a moment and thought about it. If you communicate with stakeholders throughout a project about what was happening and what they wanted, what would come from that? The formal outputs from the manage stakeholder expectations process include the following:

- ⇒ **.1 Change requests** — Managing the expectations of a project’s stakeholders can generate requested changes to the product of the project, corrective actions, or even preventive actions.
- ⇒ **.2 Project management plan updates** — Parts of the project management plan may need to be updated based upon the information obtained through managing stakeholder expectations. When new communications requirements are developed, the communications management plan is especially prone to such updating.
- ⇒ **.3 Project document updates** — Although any of the project documents may require updating because of information obtained through managing stakeholder expectations, the risk register is of particular interest.

13.4 Monitor Stakeholder Engagement

Like most of the knowledge areas, stakeholder management ends with a monitor process. Without going any further you should already know quite a bit about this process. Just like all the previous control processes, monitor stakeholder engagement is part of integrated change control found in the monitor and controlling process group.

The core objective of these processes is to ensure the team is aware of any changes and that only “good” changes are allowed to occur.

The inputs to the control stakeholder engagement process are as follows:

- ⇒ **.1 Project Management Plan** — There are a number of aspects of the project management plan which aid in the controlling of stakeholder engagement. Of particular use is the project lifecycle, the definition of how work is accomplished, how the resource requirements will met, the change management plan, and the techniques used for communication amongst the stakeholders.



Image 139: Monitor Stakeholder Engagement



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- ⇒ **.2 Project documents** — Items such as the project schedule, stakeholder register, issue log, change log and various project communications are examples of project communications.
 - ⇒ **.3 Work performance data** — These are primary observations and measurements identified during activities being performed to carry out project work.
 - ⇒ **.4 Enterprise environmental factors** — The team is now looking for tools to help them ensure the project stakeholders stay engaged with the project at the appropriate level. Everything from organizational culture and political climate to global and regional trends must come into play for the team to succeed.
 - ⇒ **.5 Organizational process assets** — Any historical information, corporate policies, and procedures and today social media tools come into play.

The tools and techniques used to control stakeholder engagement include the following:

- ⇒ **.1 Data analysis** — Alternative analysis, root cause analysis, and stakeholder analysis are all types of data analysis the team will use to monitor stakeholder engagement.
- ⇒ **.2 Decision making** — monitoring project stakeholders the team may often use multicriteria decision analysis and voting to help make decision. The key is that the team actually makes decision.
- ⇒ **.3 Data representation** — A stakeholder engagement assessment matrix allows the team to monitor whether or not the project stakeholders are engaged and to track stakeholder changes.
- ⇒ **.4 Communication skills** — Project leaders must make effective use of presentations to ensure stakeholders are kept up to date and listen to feedback from those stakeholders.
- ⇒ **.5 Interpersonal and team skills** — All the skills discussed in this course come back into play here. Tools such as active listening, cultural awareness, leadership, networking and political awareness are all used.
- ⇒ **.6 Meetings** — Primarily in the form of status review meetings, meetings are a critical tool for controlling stakeholder engagement.

The outputs from control stakeholder engagement are focused on information and updates as follows:

- ⇒ **.1 Work performance information** — All the performance data is collected from the various controlling processes and is analyzed, integrated and placed in context.
- ⇒ **.2 Change requests** — As the project manager and team interact with stakeholders, it is likely that those interactions will generate change requests.

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- ⇒ **.3 Project management plan updates** — Once the team begins producing results, the overall project management strategy can be evaluated and updated.
 - ⇒ **.4 Project document updates** — Documents outside the project management plan might also have to be updated as the team evaluates the overall effectiveness of the project management strategy.

Summary

The newly added stakeholder management knowledge area is likely the easiest are on the exam. Make sure in your studies you know the following:

- ⇒ Know the four processes
- ⇒ Know the components in each process.
- ⇒ Understand the models discussed.
- ⇒ Focus on understanding why stakeholders are important.
- ⇒ Focus on the importance of transparency and understanding each stakeholder's interest.



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Exercise 23 — Stakeholder Management Exercise**Exercise 23 –
Stakeholder
Management**

1. Which of the following is NOT an input to the identify stakeholders process?
 - A. Project charter
 - B. Enterprise environmental factors
 - C. Business documents
 - D. Statement of work
2. Which of the following is an input to the identify stakeholders process?
 - A. Work breakdown structure
 - B. Stakeholder management strategy
 - C. Agreements
 - D. Stakeholder identification strategy
3. Which of the following is a tool and technique used in the identify stakeholder process?
 - A. Expert judgment
 - B. Communication models
 - C. Communication methods
 - D. Interpersonal skills
4. Which of the following is an output from the identify stakeholders process?
 - A. Project document updates
 - B. Communication management strategy
 - C. Stakeholder analysis
 - D. Stakeholder register
5. Which of the following is an input to the plan stakeholder engagement process?
 - A. Communications management strategy
 - B. Stakeholder management plan
 - C. Agreements
 - D. RACI diagram
6. Which of the following is NOT an input to the plan stakeholder engagement process?
 - A. Enterprise environmental factor
 - B. Stakeholder register
 - C. Project management plan
 - D. Organizational process assets
7. Which of the following is NOT a tool or technique used in the plan stakeholder engagement process?
 - A. Organizational process assets
 - B. Expert judgment
 - C. Meetings
 - D. Decision making

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8. Which of the following is an output for the plan stakeholder engagement process?
 - A. Human resources management plan
 - B. Stakeholder register
 - C. Stakeholder engagement plan
 - D. Change requests
 9. Which of the following is NOT an input to the manage stakeholder engagement process?
 - A. Project management plan
 - B. Human resources management plan
 - C. Enterprise environmental factors
 - D. Organizational process assets
 10. Which of the following is a named input to the manage stakeholder engagement process?
 - A. Human resources management plan
 - B. Change requests
 - C. Communications management plan
 - D. Enterprise environmental factors
 11. Which of the following is a tool or technique used in the manage stakeholder engagement process?
 - A. Expert judgment
 - B. Management skills
 - C. Stakeholder communications
 - D. Stakeholder analysis
 12. Which of the following is not a tool or technique used in the manage stakeholder engagement process?
 - A. Expert judgment
 - B. Stakeholder analysis
 - C. Interpersonal and team skills
 - D. Ground rules
 13. Which of the following is NOT an output from the manage stakeholder engagement process?
 - A. Change requests
 - B. Approved change requests
 - C. Project management plan updates
 - D. Project document updates

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14. Which of the following is an input to the monitor stakeholder engagement process?
- A. Work performance data
 - B. Stakeholder management plan
 - C. Communications management plan
 - D. Issue log
15. Which of the following is NOT an input to the monitor stakeholder engagement process?
- A. Project management plan
 - B. Change log
 - C. Work performance data
 - D. Project documents
16. Which of the following is a tool or technique used in the monitor stakeholder engagement process?
- A. Communication methods
 - B. Interpersonal skills
 - C. Management skills
 - D. Meetings
17. Which of the following is not a tool or technique used in the monitor stakeholder engagement process?
- A. Information management systems
 - B. Expert judgment
 - C. Management skills
 - D. Meetings
18. Which of the following is not an output of the monitor stakeholder engagement process?
- A. Work performance data
 - B. Work performance information
 - C. Change requests
 - D. Project document updates
19. Which of the following is an output of the monitor stakeholder engagement process?
- A. Issue log
 - B. Stakeholder register
 - C. Stakeholder management plan
 - D. Work performance information

Exercise 23 — Stakeholder Management Exercise Answers

1. **Answer D.** PMBOK Guide p. 509-510 - The inputs to the identify stakeholders process include the following:
 - ⇒ Project charter
 - ⇒ Business documents
 - ⇒ Project documents
 - ⇒ Agreements
 - ⇒ Enterprise environmental factors
 - ⇒ Organizational process assets
2. **Answer C.** PMBOK Guide p. 509-510 - The inputs to the identify stakeholders process include the following:
 - ⇒ Project charter
 - ⇒ Business documents
 - ⇒ Project documents
 - ⇒ Agreements
 - ⇒ Enterprise environmental factors
 - ⇒ Organizational process assets
3. **Answer A.** PMBOK Guide p. 509-510 - The inputs to the identify stakeholders process include the following:
 - ⇒ Project charter
 - ⇒ Business documents
 - ⇒ Project documents
 - ⇒ Agreements
 - ⇒ Enterprise environmental factors
 - ⇒ Organizational process assets
4. **Answer D.** PMBOK Guide p. 514-515 – The output to the identify stakeholders process include the following:
 - ⇒ Stakeholder register
 - ⇒ Change requests
 - ⇒ Project management plan updates
 - ⇒ Project document updates
5. **Answer C.** PMBOK Guide p. 518-520 – The inputs to the plan stakeholder engagement process include the following:
 - ⇒ Project charter
 - ⇒ Project management plan
 - ⇒ Project documents
 - ⇒ Agreements
 - ⇒ Enterprise environmental factors
 - ⇒ Organizational process assets

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6. **Answer D.** PMBOK Guide p. 518-520 – The inputs to the plan stakeholder management process include the following:
- ⇒ Project charter
 - ⇒ Project management plan
 - ⇒ Project documents
 - ⇒ Agreements
 - ⇒ Enterprise environmental factors
 - ⇒ Organizational process assets
7. **Answer A.** PMBOK Guide p. 520-522 – The tools and techniques used in the plan stakeholder engagement process are as follows:
- ⇒ Expert judgment
 - ⇒ Data gathering
 - ⇒ Data analysis
 - ⇒ Decision making
 - ⇒ Data representation
 - ⇒ Meetings
8. **Answer C.** PMBOK Guide p. 522 – The outputs to the plan stakeholder management process include the following:
- ⇒ Stakeholder engagement plan
9. **Answer B.** PMBOK Guide p. 525-526 – The inputs to the manage stakeholder engagement process include the following:
- ⇒ Project management plan
 - ⇒ Project documents
 - ⇒ Enterprise environmental factors
 - ⇒ Organizational process assets
10. **Answer D.** PMBOK Guide p. 525-526 – The inputs to the manage stakeholder engagement process include the following:
- ⇒ Project management plan
 - ⇒ Project documents
 - ⇒ Enterprise environmental factors
 - ⇒ Organizational process assets
11. **Answer A.** PMBOK Guide p. 526-528 – The tools or techniques used in the manage stakeholder engagement process include the following:
- ⇒ Expert judgment
 - ⇒ Communication skills
 - ⇒ Interpersonal and team skills
 - ⇒ Ground rules
 - ⇒ Meetings

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12. **Answer B.** PMBOK Guide p. 526-528 – The tools or techniques used in the manage stakeholder engagement process include the following:
- ⇒ Expert judgment
 - ⇒ Communication skills
 - ⇒ Interpersonal and team skills
 - ⇒ Ground rules
 - ⇒ Meetings
13. **Answer B.** PMBOK Guide p. 528-529 – The outputs from the manage stakeholder engagement process include the following:
- ⇒ Change request
 - ⇒ Project management plan updates
 - 10. Project document updates
14. **Answer A.** PMBOK Guide p. 532-533 – The inputs to monitor stakeholder engagement process include the following:
- ⇒ Project management plan
 - ⇒ Project documents
 - ⇒ Work performance data
 - ⇒ Enterprise environmental factors
 - ⇒ Organizational process assets
15. **Answer B.** PMBOK Guide p. 532-533 – The inputs to monitor stakeholder engagement process include the following:
- ⇒ Project management plan
 - ⇒ Project documents
 - ⇒ Work performance data
 - ⇒ Enterprise environmental factors
 - ⇒ Organizational process assets
16. **Answer D.** PMBOK Guide – The tools and techniques used in the monitor stakeholder engagement process include the following:
- ⇒ Data analysis
 - ⇒ Decision making
 - ⇒ Data representation
 - ⇒ Communication skills
 - ⇒ Interpersonal and team skills
 - ⇒ Meetings
17. **Answer C.** PMBOK Guide p. 533-535 – The tools and techniques used in the control stakeholder engagement process include the following:
- ⇒ Data analysis
 - ⇒ Decision making
 - ⇒ Data representation
 - ⇒ Communication skills
 - ⇒ Interpersonal and team skills
 - ⇒ Meetings

18. **Answer A.** PMBOK Guide p. 535-536 – The outputs from the control stakeholder engagement process include the following:

- ⇒ Work performance information
- ⇒ Change requests
- ⇒ Project management plan updates
- ⇒ Project documents updates

19. **Answer D.** PMBOK Guide p. 535-536 – The outputs from the control stakeholder engagement process include the following:

- ⇒ Work performance information
- ⇒ Change requests
- ⇒ Project management plan updates
- ⇒ Project documents updates

Professional Responsibility

Overview

There is not a section on the exam for professional responsibility. It is a topic that appears in every section. PMI® addresses the topic in four areas: responsibility, respect, fairness and honesty. Most of this topic is straightforward. However, it is important to remember that PMI® uses a North American perspective on these topics. As you study and work to complete your exam, there are some important points to always keep in the forefront of your mind. These rules or guidelines can be broken into four different categories:

- ⇒ Your duty to the profession
- ⇒ Scope and estimates
- ⇒ Authority
- ⇒ Above all else

If you remember these guidelines throughout your preparation, you will find many of the questions much easier.

Your Duty to the Profession

The first category of guidelines is your duty to the profession of project management. The guidelines are based on PMI's Code of Ethics and Professional Conduct found on PMI's website at:

<http://www.pmi.org/About-Us/Ethics/Code-of-Ethics.aspx>

PMI® demands compliance with all organizational rules and policies, and compliance with PMI's Code of Ethics and Professional Conduct. It is expected that you will advance the profession.

Another key part of these obligations is the management of conflicts. As the project manager you must manage conflict of interest situations and other prohibited professional conduct. However—be careful here. Conflicts of interest are not necessarily bad. They represent situations where stakeholders or you have different interests that are opposed to each other. It is the project manager's job to balance these competing and sometimes conflicting interests. It is also the project manager's responsibility to make sure they are never in a situation where they have competing agendas. The project manager must always have the best interests of the project and their organization front and center.

For the exam, it is also important to remember the type of project you are leading. It is a large, multi-national project and it is therefore important that you understand the culture of foreign project locations and follow their customs and rules.

Scope and Estimates

The second set of guidelines to remember for the exam focus on the area of scope and estimates. It is critically important that you involve the stakeholders



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in the development of scope and engage them early in the process. Furthermore, do not perform project tasks until the scope is verified. When asked to make scope changes, do so only through the scope management process, and don't add any work without the sponsor's approval.

The PMBOK® Guide is not prescriptive, as it supports a number of methodologies each with different phases and structures. Therefore, it is important that scope verification is done at the end of each phase. As a basic rule, all deliverables must be quantifiable, and the project manager must ensure that the team develops tasks and assigns resources to all tasks to complete the scope. The project manager must also ensure the team reviews all deliverables and doesn't allow incomplete or incorrect deliverables to be released.

Another key project manager role is the preparation and publishing of accurate estimates. Sometimes this also includes the requirement to cut schedules or budgets. If forced to cut either, it's best not to make across the board reductions. Cuts should be made where they will have the greatest impact. When this occurs, the project manager must also modify scope and quality to fit the reduced budget or schedule.

Authority

The third area of focus is the project manager's authority. In the real world this is often an area of frustration for PM's due to the frequent perceived lack of authority they hold. For the exam, focus on the following four keys:

- ⇒ Work should not begin without a charter. If the project does not have a charter, the project manager cannot be sufficiently empowered to do any work or get resources to do work.
- ⇒ A project manager must understand the limits of their authority and only take actions within the limits of that authority.
- ⇒ A project manager should never misrepresent their authority to anyone for any reason.
- ⇒ When something is beyond the limits of a project manager's authority, they must escalate those items to senior management and/or the project sponsor. This is critical to ensure the credibility and success of all involved.

Above All Else...

The two most important concepts to remember for the exam impact almost every question. First, you must remember that you are looking for the BEST answer to the question, and not the perfect answer. Many questions will only provide answers that are sub-optimal. Rarely will you see an answer that is a direct quote from the standards.

The second concept is regarding the process a project manager should use to resolve any situation. In every case the project manager should first evaluate the event and evaluate the event's impact to the project's cost, schedule, scope,



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quality, and customer satisfaction. Based upon this analysis, the project team should then develop alternatives and offer a recommendation. Only then should the project manager approach the sponsor and/or management. The key here is that a project manager never simply drops a problem off with their manager. They always bring solutions.

Other less critical concepts include the fact that negotiations can involve items other than money because many internal items can be bartered. The project manager is often responsible for the development of the processes used on a project, therefore it is important that they never shortcut the defined processes. If the project manager does not follow the process, no one else will either.

Project managers who do a poor job planning their projects are likely to be out of work because poorly planned projects are most likely to be cancelled.

When reporting to senior management and/or project sponsors, milestone reports are the appropriate level of detail. This is often different from many candidates' real world experience.

Exercise 24 — Professional Responsibility



Exercise 24 — Professional Responsibility

1. You are asked to take over a project that has a SPI of 1.04 and a CPI of 1.11. As you begin your examination of the project documentation from the previous project manager, you discover a payment to one of the project's contractors in the amount of \$1,250,000 that was not approved in accordance with company policies. What should you do?
 - A. Immediately contact the sponsor.
 - B. Immediately contact the contractor.
 - C. Escrow the payment amount for further investigation.
 - D. You are significantly under budget so there is no need to worry.
2. You are leading a large multinational project. You have just learned that one of your primary vendors has bribed a subcontractor located in a nation where such activity is not only common, but expected. What should you do?
 - A. Resign from the project to allow the project to continue without putting yourself at risk.
 - B. Report the action to all contractors and subs so all parties can gain advantage.
 - C. Report the offense to the sponsor.
 - D. Take no action as this is the contractor's problem and not yours.
3. You are asked to take over a project for a project manager that has taken a leave of absence. You have met with the previous project manager and reviewed all project documents. As your first week comes to an end you produce your first status report and submit it to leadership. On the following morning you discover that an old data file was used to produce the report and is not accurate. What should you do?
 - A. Update the data and submit the correct report the following week.
 - B. Correct the data and submit the new report with an explanation of the error.
 - C. Contact management about the mistake and tell them to expect changes in the next report.
 - D. Inform management that you received faulty data and thus report was not accurate.

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4. You are given the opportunity to interview for your dream position. It is the opportunity to lead a large global project with several dozen resources across three continents. The project will require the team to work almost entirely virtually. Unfortunately, you do not have any experience working with virtual teams. What should you do when discussing the project with the sponsor?
 - A. Because you are PMP® certified inform the sponsor that you have the necessary experience.
 - B. Inform the sponsor you lack the requisite experience and decline the offer.
 - C. Since you have led large international teams before convince the sponsor that you have the experience.
 - D. Inform the sponsor that you have not led virtual teams before, but highlight why you believe you are a good fit for the project.

 5. You are one of five project managers who have been asked to participate in an upcoming portfolio management meeting. The purpose of the meeting is to help leadership select the best of several projects to complete. Each of the participating project managers has a vested interest in one of the particular projects and is therefore biased. The selected project will be highly visible and likely a great success. How should you and the other project managers proceed?
 - A. You each should not give opinions as you are not objective.
 - B. As a group you should make a single Ben Franklin T that shows the pros and cons of each project.
 - C. You each should explain why the project you would lead would be best and provide as much supporting documentation as possible.
 - D. You each should recommend the project that would be best for the organization in the long run, regardless of who will run it.

 6. You are leading a large engineering project in a foreign country. As part of the project you are required to move several very large machine components from the dock facilities to the project location. To ensure the machinery is transported successfully, your local contact informs you that a local police fee will have to be paid for traffic coordination. What should you do?
 - A. Pay the fee.
 - B. Find another way to complete the project.
 - C. Do not pay the fee because it is a bribe.
 - D. Do not pay the fee unless it was included in the project estimate.

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7. You are a functional manager who has been tasked with providing several key deliverables for a project that is strongly supported by senior management. You and the project manager strongly disagree on the tasks that need to be done, how the project should proceed, and in the project itself. The project manager is relatively new and you have significant organizational experience. What should you do?
 - A. Ask to have the work reassigned.
 - B. Sit down with the project manager and attempt to describe why the project should not be done.
 - C. Provide the project manager with what they need.
 - D. Inform your manager of your concerns and get their support.
 8. You are managing a large team. One of your resources has been tasked with writing a report which they are several days late producing. Just 30 minutes before a meeting to discuss the report, they hand you the completed report. Quickly reviewing the report, you notice several errors. What should you do?
 - A. Cancel the meeting and rewrite the report.
 - B. Continue with the meeting as planned.
 - C. Allow the meeting to continue, but require the resource to discuss how they plan to deal with the errors.
 - D. Cancel the meeting until you can fully review the report and it can be fixed.
 9. You need to schedule a meeting with your team. As you review everyone's calendar you notice that one of your resources has scheduled a meeting with a critical stakeholder who is a member of the senior leadership team. You were not aware of the meeting. What should you do?
 - A. Address the concern with the resource.
 - B. Ignore it. It is part of their job.
 - C. Discuss the situation with your boss.
 - D. Ask to be included in the meeting.
 10. You are leading a large process improvement project within your organization. Once completed, it is expected the project will save the organization 20% on its fixed costs. Your team has spent four weeks planning the project and has prepared detailed estimates for all deliverables. When you present the schedule and budget to senior management you are told to cut the budget by seven percent. What should you do?
 - A. Reduce the budget as requested and note the changes in the risk register.
 - B. Provide the accurate estimate of costs and be able to support it.
 - C. Meet with the project team and work together to reduce the budget as requested.
 - D. Revisit your plan projections to find additional project outcomes that justify the higher project costs.

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11. You are one of six project managers leading a major program. You just completed preparing your status report for the current reporting period which shows a CPI of 0.86 and an SPI of 0.84. As you prepare for the status meeting tomorrow afternoon, you recall that another project manager on the program has had several major deliverables you knew were late, but they still are reporting they are on schedule. What should you do?
- A. Stop using EVMS and simply report on schedule and budget.
 - B. Bring up the issue in private with the program manager.
 - C. Meet with the other project manager to discuss the issue.
 - D. Develop a risk strategy in case the other project truly is late and it impacts you.
12. You have a meeting scheduled for the next day with a contractor to complete the negotiations to have them deliver a major component of your project when you discover your project is likely to be cancelled. What should you do?
- A. Postpone the negotiations.
 - B. Use the meeting to inform the contractor it is likely to be cancelled.
 - C. Cut the meeting short.
 - D. Only negotiate the key elements.
13. You are taking over a project for a large manufacturing organization. The project was originally scheduled to take 22 months and is currently 14 months into the schedule. The previous project manager consistently reported the project as both on time and on budget. However, after a careful review of the project documentation and interviews with the project team you have discovered the project is significantly over budget and behind schedule. In fact the project is likely to cost twice the original budget and will likely take 36 months to complete. What should you do?
- A. Decline to accept the project.
 - B. Move forward with the original schedule and report the missed targets.
 - C. Meet with the team to restructure the project to meet the project deadline.
 - D. Report your assessment to the project sponsor.
14. You are reviewing the implementation plan for a major project you are leading. As you review the documentation you discover a key error that will prevent you from meeting a key milestone. What should you do?
- A. Change the milestone date.
 - B. Develop alternatives to meet the milestone date.
 - C. Discuss with the team the importance of hitting milestones at the next team meeting.
 - D. Inform the sponsor of the missed milestone.

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15. You work as a project manager for an IT consulting organization. Your boss has promised you a percentage of a major contract bonus if you achieve specific contractually-based performance incentives. As you complete the second-to-last major deliverable, your team informs you of a situation that will prevent you from achieving the performance incentive. What should you do?
- A. Continue the project as planned.
 - B. Alter the project schedule to achieve the incentive.
 - C. Inform your manager that you will not achieve the target.
 - D. Negotiate with the client to achieve the bonus and provide the desired result.
16. You work as a project manager for an IT consulting organization. Your boss has promised you a percentage of a major contract bonus if you achieve specific contractually-based performance incentives. You are on target to achieve the incentive target, but your team has discovered that meeting the letter of the contract will not meet the customer's functional requirements. What should you do?
- A. Continue the project as planned.
 - B. Inform your boss.
 - C. Inform the customer of the situation and work out a mutually agreeable solution.
 - D. Add as much functionality as you can while maintaining the incentive.
17. You work as a contract project manager and have been provided with a significant amount of data from your various clients that is proprietary. The daughter of your next door neighbor contacts you for help on her masters' thesis that would require you to share some of the proprietary data for academic research purposes only. What should you do?
- A. Refuse to share the information.
 - B. Contact your clients and seek permission to disclose the information.
 - C. Share the information, but ask the student to not disclose any client names.
 - D. Release the information without any direct client references.
18. Which of the following is not a responsibility of the project manager?
- A. Provide accurate and truthful representations of cost estimates.
 - B. Maintain all customer confidentialities.
 - C. Determine the legality of company project management procedures.
 - D. Ensure that a conflict of interest does not compromise the legitimate interest of the customer.

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19. You are leading a \$9,600,000 software development project when you discover that the firm providing your project with several key resources is struggling to maintain resources due to a labor dispute. Yours is one of five projects within your organization that is using the same firm for development resources. What should you do?
- A. Negotiate with the firm to ensure your project maintains proper resourcing.
 - B. Cancel the contract with the firm.
 - C. Inform the other project managers about the labor issue.
 - D. Contact the firm and advise it that you will cancel the contract if it does not settle the labor dispute.
20. You are managing a large team. One of your resources has been tasked with writing a report which they are several days late producing. Just 30 minutes before a meeting to discuss the report, they hand you the completed report. Quickly reviewing the report, you notice several errors. How could this situation have been prevented?
- A. Postpone the meeting earlier when you did not receive the report.
 - B. Coach and mentor the employee.
 - C. Require more frequent updates from the employee.
 - D. Ensure the employee was properly trained to do the job.
21. You are leading a road construction project. The effort requires your company to pour more than 24 miles of eight lane highway. You have completed more than 80% of the project and are now reviewing the latest quality test results. The tests show 40% of the poured concrete does not meet your company's quality standard, but is only slightly below standard. You are certain the concrete will function as is, and do not believe the slight variance is significant. What should you do?
- A. Ensure the remaining concrete meets the standards.
 - B. Report the lesser quality level and try to find a solution.
 - C. List in the next report that the concrete "meets the quality needs".
 - D. Ask management to change the quality standard to the achieved level.
22. You are a PMP® certified project manager and are contacted by PMI® regarding your best friend who is also a PMP®. PMI® is asking about information you have regarding unethical behavior by your friend. You know the accusations are true, but do not want to incriminate your friend. What should you do?
- A. Stay out of the situation and ignore the information request.
 - B. Contact PMI® and provide the factual information you have as required by the PMI® code of conduct.
 - C. Contact PMI® and deny the accusation.
 - D. Contact PMI® and recuse yourself from the situation because of your personal relationship with the accused.

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23. You have been asked to lead a \$60,000 petrochemicals project for your company. The project will require the cooperation of more than 50 resources across three continents. These resources speak five different primary languages and most of the work will be completed via virtual teams. What is the best way to ensure cultural differences do not derail the project?
- A. Always choose your words carefully whenever you communicate with the team.
 - B. You should spend more time on the WBS to make absolutely sure it is complete.
 - C. At a team meeting ask each team member to describe something unique about their culture.
 - D. Make sure you encode all communications.
24. You are leading an IT project within your organization. As you are preparing your weekly status report, you see that two of your resources are not reporting actual hours and are only reporting percent complete. This is skewing the EVMS reporting. What is the best thing to do?
- A. Report the resources to their functional managers.
 - B. Discuss the impacts of these actions with the resources.
 - C. Continue reporting the information as received.
 - D. Continue reporting the information as received, but report the missing data.
25. Your company president has asked that you contract part of your latest project to a firm the organization has used many times before. As the project manager, what should you be most concerned about in this situation?
- A. Meeting management's schedule expectations.
 - B. The contract terms and conditions.
 - C. Meeting management's cost expectations.
 - D. Making sure the firm has the qualifications to complete the project work.

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26. You have been asked to lead a \$60,000 petrochemicals project for your company. The project will require the cooperation of more than 50 resources across three continents. These resources speak five different primary languages. To help ensure a tightly knit team you initiate some team-building games during team meetings. However, two of your resources refuse to participate and inform you that such activities are culturally unacceptable in their country. What should you do?
- A. Tell the team members they need to be familiar with how things are done in the headquarters company's country and they should participate.
 - B. Excuse the team members from playing and arrange to discuss alternative activities with which they would be more comfortable.
 - C. Ask to have the team members removed from the team as they are likely going to have other issues as well.
 - D. Excuse the team members from the activity and any future team-building activities.
27. It is the first day of your new job with a large manufacturing organization. You are taking over as the project manager on a project that has been ongoing for nine months. As part of your review of the project documentation you discover the previous project manager made a US \$2,500,000 payment that was not approved in accordance with the organization's policies. The project currently has an SPI of 0.98 and a CPI of 1.14. What should you do?
- A. Ignore the payment as it happened prior to your arrival.
 - B. Ignore the payment because both the CPI and SPI are within acceptable boundaries.
 - C. Put the payment in an escrow account.
 - D. Contact your manager and inform them of the discrepancy.
28. A project manager is being considered as the potential leader of a project which will deal exclusively with a virtual team located on several different continents. What should they do when discussing the opportunity with the sponsor?
- A. Decline the assignment because they do not have experience with virtual teams.
 - B. Point out to the sponsor that they have not had experience with virtual teams, but also explain why they think they would be an excellent fit for the project.
 - C. Avoid any conversation regarding the types of teams involved so the sponsor does not know they lack experience in this area.
 - D. Since they have managed many projects with a wide range of teams, it does not matter that the new project involves virtual teams and they should tell the sponsor they have the relevant experience.

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29. While staffing a project in another country, the project leader from that country comes to you with a suggested team consisting of members of the project leader's family. Your first course of action should be to:
- A. Inquire if hiring only through family lines is common practice in the project leader's country.
 - B. Review the resumes of the individuals to see if they are qualified.
 - C. Ask the project leader to provide additional names of people unrelated to him/her.
 - D. Use a different project leader to prevent problems later in the project.
30. A major negotiation with a potential subcontractor is scheduled for tomorrow when you discover there is a good chance the project will be cancelled. What should you do?
- A. Do not spend too much time preparing for the negotiations.
 - B. Cut the negotiations short.
 - C. Only negotiate major items.
 - D. Postpone the negotiations.
31. One of your project resources is three days late with a report. Five minutes before the meeting where the topic of the report is to be discussed, they hand you the report. You notice some serious errors in it. What should you do?
- A. Cancel the meeting and reschedule when the report is fixed.
 - B. Go to the meeting and tell the other attendees there are errors in the report.
 - C. Ask the employee to do the presentation and remain silent as the other attendees find the errors.
 - D. Cancel the meeting and rewrite the report yourself.
32. You are leading a project that is part of a large, critical program. At a high-level status meeting, you hear another project manager report their project is on schedule even though you remember several deliverables from their project arrived late to you and negatively impacted your schedule. What should you do?
- A. Meet with the program manager.
 - B. Develop a risk control plan.
 - C. Discuss the issue with your boss.
 - D. Meet with the other project manager.
33. A large, complex construction project in a foreign country requires coordination to move needed equipment through crowded streets. To ensure the equipment is transported successfully, your contact in that country informs you that you will have to pay the local police a fee for coordinating traffic. What should you do?
- A. Do not pay the fee because it is a bribe.
 - B. Eliminate the work.
 - C. Pay the fee.
 - D. Do not pay the fee unless it is part of the project estimate.

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34. You are in the fifth year as a project manager for your organization and have successfully managed over a dozen projects. Your manager has consistently asked you to cut your budgets by ten percent after you have given it to them. You have been assigned to lead a new project with more than twenty major stakeholders and the scope is somewhat vague. This project has a high priority and is very visible throughout the organization. Which of the following is the best thing to do?
- A. Reduce the estimates prior to delivery to the sponsor and note the changes in the risk register.
 - B. Provide accurate estimates for the project costs and be able to support them.
 - C. Meet with the project team and identify where you can cut ten percent of the costs.
 - D. Re-plan the project to exceed the stakeholders' expectations.
35. You are in the middle of a large project for your organization when you discover that an external contractor your project is using is having significant issues with its employees due to a labor dispute. There are several other projects within your organization also using this contractor. What should you do?
- A. Cancel the contract with the contractor.
 - B. Inform the other project managers about the labor dispute.
 - C. Contact the contractor and advise them you will cancel the contract on your project unless the labor dispute is settled.
 - D. Attempt to keep the contractor's resources on your project.
36. You are finalizing the monthly project status report due to the project sponsor when you discover several of your resources have not been reporting their actual hours spent on project activities. This has resulted in skewed project statistics. What is the most appropriate action to take?
- A. Discuss the impacts of these actions with team members.
 - B. Continue reporting the information as presented to you.
 - C. Report the team member's actions to their functional managers.
 - D. Provide accurate and truthful representations in all project reports.

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37. Five interns from another country are working on your project. You have arranged for the entire project team to participate in some games as team-building activities to help improve team dynamics. At the event the interns refuse to participate, claiming the games involve unacceptable behavior in their country and they would feel uncomfortable participating. What should you do?
- A. Tell the students they need to become familiar with how things are done in their host country.
 - B. Excuse the students from playing the game and arrange to discuss alternative team- building activities in which they would feel more comfortable participating.
 - C. Report the interns to their functional manager and request they be removed from the project so their attitude does not negatively impact the project.
 - D. Tell the students they are excused from the games and to not attend any team-building activities in the future.

Exercise 24 — Professional Responsibility Answers

1. **Answer A.** As a project manager you might run into this situation regularly. The best thing to do is make sure the sponsor is aware of the situation and then proceed under the guidance of the project sponsor in accordance with organizational policies.
2. **Answer C.** There are many nations in the world where bribery is very commonplace. According to PMI[®], this does not make it acceptable to do. Even though the activity was done by a contractor with a sub you are still responsible.
3. **Answer B.** It is critical that management always has confidence in the information you provide. As part of this you can never be perceived as hiding or minimizing anything. Therefore, the correct answer requires you to notify management immediately with a corrected report and an explanation.
4. **Answer D.** Being ethical does not require you to give up a great opportunity such as this. The sponsor wanted to interview you based upon something they saw on your resume or heard about you. So long as you are honest about your experience and do not attempt to deceive the sponsor there is no reason to not attempt to get the job. Maybe the sponsor values something you possess more than experience leading virtual teams.
5. **Answer D.** Nothing ever said the right answer would be the easy answer. In fact, in many cases the right answer is very hard. Your professional responsibility is to make the best recommendation you can regardless of self interest.
6. **Answer A.** In this case, you should pay the fee because it is a proper payment to a government organization.
7. **Answer C.** Sometimes the simple answer is best. In this case, you are not the project manager. It is your job to provide the deliverables as the project has already been approved by senior management. You must do this first. After that you can try to change people's mind about the project.
8. **Answer D.** As a project manager, it is critical that you value people's time. As part of this you must make sure documents are properly reviewed and corrected before going forward.
9. **Answer A.** This is only a potential issue. The first thing you need to do is find out if it is a real issue. Proper resolution of this issue requires good communication. You need to go talk to the resource.
10. **Answer B.** As a project manager, you are ethically bound to provide accurate estimates and supporting detail. You should not change numbers simply to please management as you are very unlikely to hit those revised numbers.

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11. **Answer C.** You should first confront the other project manager in private to get an explanation rather than creating a public issue without justification.
 12. **Answer A.** You are ethically obligated to not waste your contractor's time and be above board with information you have. Therefore, you should at the least postpone the negotiations.
 13. **Answer D.** You already have expectations that are being missed. The best answer would be to evaluate the situation and bring alternatives to the sponsor. However, that is not one of the choices. The best of the given choices is to inform the sponsor.
 14. **Answer B.** Remember, you always develop options before you do anything else. Only then do you go to management. In this case developing alternatives is one of the choices so take it!
 15. **Answer A.** Contract incentives are provided as a means to achieve goals that are beyond the requirements. Missing an incentive does not mean you are not delivering. The best option is to continue the project as planned.
 16. **Answer C.** In this case, your first responsibility is to ensure the product you develop meets the customer's needs. The contract puts you at odds with this goal. You could easily meet the contract specifications and receive the bonus without meeting the customer's real needs. Therefore, you should inform them of the situation and negotiate a mutually agreeable solution.
 17. **Answer B.** Many companies are willing to share their information for academic purposes so long as they receive derivative works. However, you may only disclose such information with the client's permission.
 18. **Answer C.** As a project manager, unless previously agreed upon, it is not your role to determine the legality of any organizational procedure as you likely lack the specific training required.
 19. **Answer C.** Your first responsibility is to do what is in the best interest of your company. Therefore, you should inform the other project managers and work together with the contractor to resolve the situation.
 20. **Answer A.** This question is very tricky and requires you to read the choices carefully. The objective is to pick the choice that has the highest probability of preventing the problem situation, a meeting with a poorly prepared report. The only option that does that is postponing the meeting more quickly. All the other choices might solve the problem, but there are no guarantees.
 21. **Answer B.** Reporting the lesser quality level and trying to find an answer is the closest solution to a perfect world. All other choices fail to meet your ethical obligations.
 22. **Answer B.** Hopefully, this was an easy one for you, at least in theory. You are required to provide information about any unethical situation to which you are privy.

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23. **Answer C.** This is a trick question of sorts. The only answer that does not only involve you is asking the team to describe a unique aspect of their culture. All the others only address your issues.
 24. **Answer B.** The only answer that attempts to resolve the issue without escalation is discussing the impacts of these actions with the resources. Only if this does not work should you go to the resource managers.
 25. **Answer D.** Management has selected the firm. Your primary driver is making sure the firm has the ability to actually do the specified work.
 26. **Answer B.** Team building is critical to any team's success. However, it is also important that a project manager is sensitive to cultural differences. The only option that takes this into account is excusing the team members from playing the activity and arranging to discuss acceptable alternatives.
 27. **Answer D.** Ignoring the actions of the previous project manager is not an option regardless of how well the project is doing. The only viable answer is to tell your manager immediately.
 28. **Answer B.** It is always important to point out key deficiencies. However, it is also reasonable for the project manager to explain why they believe they are a good fit. So long as the project manager has provided all the pertinent facts to the sponsor they have done their job.
 29. **Answer A.** This is one of those questions where you have to ask, what would you do first? The answer is find out if hiring family members is a common practice.
 30. **Answer D.** Postponing the negotiations is the most ethical choice and shows good faith. Spending time negotiating at this time would be a waste.
 31. **Answer A.** Allowing an employee to deliver an inaccurate report, even one they create is a public condemnation of the employee and should never be done. It is best to privately discuss the issue with the employee after cancelling the meeting and give them the opportunity to correct the report.
 32. **Answer D.** This question requires you to go back to your conflict resolution methods. The best way to resolve a conflict is through confrontation or problem solving. This means meeting with the other project manager to resolve the issue before going to anyone else.
 33. **Answer C.** This is a fee paid to a governmental organization for services and is not a bribe. Do not get tricked because a bribe is listed in the possible answers.
 34. **Answer B.** If your estimates are accurate you are obligated to stick to them.

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35. **Answer B.** There is nothing in the question which indicates the dispute has caused a problem on the project, so there is no need to cancel the contract. Additionally, cancelling the contract requires following the termination procedures outlined in the contract and cannot be done unilaterally. Keeping all the resources yourself puts your interests above the organizations. The only answer which is viable is to inform the other project managers.
36. **Answer D.** A project manager should always report truthfully.
37. **Answer B.** It is important to remember that a professional project manager always respects cultural differences. Respecting differences requires the project manager to allow the interns to not participate, but also find other activities they can do so as to not demean them.

PMP 2018 Exam Prep

Course Structure

- Application & Exam
- Types of Questions
- PM Basics
- Ten Knowledge Areas
- Professional Responsibility
- Practice Exams

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The Application & Exam

PMP Application & Exam

Extra Reading

- Project and Program Risk Management, R. Max Wideman, Editor
- Quality Management for Projects and Programs, Lewis R. Ireland
- Doing Business Internationally, Walker, Walker and Shmitz
- The Cultural Dimensions of International Business, Gary P. Ferraro
- Global Literacies, Robert Rosen
- How to Lead Work Teams, Fran Rees
- Principles of Project Management, PMI®
- Project Management A Systems Approach, Harold Kerzner
- Human Resource Skills for the Project Manager, Vijay K. Verma
- Earned Value Practice Standard, PMI®
- The Scrum Guide™, Jeff Sutherland and Ken Schwaber

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PMP Application & Exam

The Acme Widget Factory

- You are a project manager for a large multinational.
- You are managing 100 resources located in five different time zones on two different continents.
- A matrixed organization and none of the resources are dedicated to only your project or report directly to you.

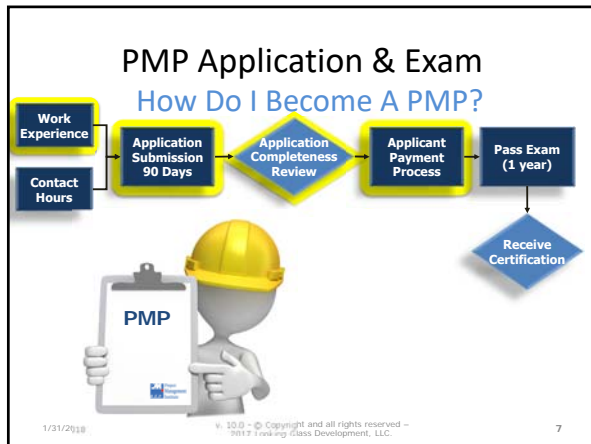
Your Challenges	
Significant Scope Change	Problems with Product Quality
Schedule & Cost Overruns	Resource Burnout
Problems with Resource Constraints	Many Don't Like Your Processes

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PMP Application & Exam

- What do the letters PMP mean?
 - Project Management Professional.
- What are the benefits of being a PMP?
 - Higher income potential.
 - Shows knowledge of international standards.
 - Is required by a growing number of employers.

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PMP Application

➤ Applying online is the fastest way
<http://www.pmi.org/certification/project-management-professional-pmp.aspx>

Mailing Address
 PMI Certification Department
 Fourteen Campus Boulevard
 Newtown Square, PA. 19073

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PMP Exam

Domain	Percentage of Questions
Initiation	13%
Planning	24%
Executing	31%
Monitoring & Controlling	25%
Closing	7%
Total Number of Scored Questions	175
Total Number of Unscored Questions	25
Total Questions on Exam	200

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PMP Exam

Task	Initiating – 13%
Task 1	Perform project assessment based upon available information, lessons learned from previous projects, & meetings with relevant stakeholders in order to support the evaluation of the feasibility of new products or services within the given assumptions and/or constraints.
Task 2	Identify key deliverables based on the business requirements in order to manage customer expectations & direct the achievement of project goals.
Task 3	Perform stakeholder analysis using appropriate tools & techniques in order to align expectations & gain support for the project.
Task 4	Identify high level risks, assumptions, & constraints based on the current environment, organizational factors, historical data, & expert judgment, in order to propose an implementation strategy.
Task 5	Participate in the development of the project charter by compiling & analyzing gathered information in order to ensure project stakeholders are in agreement on its elements.

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PMP Exam

Task	Initiating – 13%
Task 6	Obtain project charter approval from the sponsor, in order to formalize the authority assigned to the project manager & gain commitment & acceptance for the project.
Task 7	Conduct benefit analysis with relevant stakeholders to validate project alignment with organizational strategy & expected business value.
Task 8	Inform stakeholders of the approved project charter to ensure common understanding of the key deliverables, milestones & their roles & responsibilities.

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PMP Exam

Task	Planning – 24%
Task 1	Review & assess detailed project requirements, constraints, & assumptions with stakeholders based on the project charter, lessons learned, & by using requirements gathering techniques in order to establish detailed project deliverables.
Task 2	Develop a scope management plan, based on the approved project scope & using scope management techniques, in order to define, maintain, & manage the scope of the project.
Task 3	Develop the cost management plan based on the project scope, schedule, resources, approved project charter & other information, using estimating techniques, in order to manage project costs.
Task 4	Develop the project schedule based on the approved project deliverables & milestones, scope & resource management plans in order to manage timely completion of the project.

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PMP Exam

Task	Planning – 24%
Task 5	Develop the human resource management plan by defining the roles & responsibilities of the project team members in order to create a project organizational structure & provide guidance regarding how resources will be assigned & managed.
Task 6	Develop the communications management plan based on the project organizational structure & stakeholder requirements, in to define & manage the flow of project information.
Task 7	Develop the procurement management plan based on the project scope, budget, & schedule, in order to ensure that the required project resources will be available.
Task 8	Develop the quality management plan & define the quality standards for the project and its products, based on the project scope, risks & requirements, in order to prevent the occurrence of defects & control the cost of quality.

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PMP Exam

Task	Planning – 24%
Task 9	Develop the change management plan by defining how changes will be addressed & controlled in order to track & manage change.
Task 10	Plan for risk management by developing a risk management plan; identifying, analyzing, & prioritizing project risk; creating the risk register; & defining risk response strategies in order to manage uncertainty & opportunity throughout the project life cycle.
Task 11	Present the project management plan to the relevant stakeholders according to applicable policies & procedures in order to obtain approval to proceed with project execution.
Task 12	Conduct kick-off meeting communicating the start of the project, key milestones, & other relevant information in order to inform & engage stakeholders & gain commitment.
Task 13	Develop the stakeholder management plan by analyzing needs, interests, & potential impact in order to effectively manage stakeholders' expectations & engage them in project decisions.

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PMP Exam

Task	Executing – 31%
Task 1	Acquire & manage project resources by following the human resource & procurement management plans in order to meet project requirements.
Task 2	Manage task execution based on the project management plan by leading & developing the project team in order to achieve project deliverables.
Task 3	Implement the quality management plan using the appropriate tools & techniques in order to ensure that work is performed in accordance with required quality standards.
Task 4	Implement approved changes & corrective actions by following the change management plan in order to meet project requirements.
Task 5	Implement approved actions by following the risk management plan in order to minimize the impact of the risks & take advantage of opportunities on the project.
Task 6	Manage the flow of information by following the communications plan in order to keep stakeholders engaged & informed.
Task 7	Maintain stakeholder relationships by following the stakeholder management plan in order to receive continued support & management expectations.

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PMP Exam	
Task	Monitoring & Controlling – 25%
Task 1	Measure project performance using appropriate tools & techniques in order to identify & quantify any variances & corrective actions.
Task 2	Manage changes to the project by following the change management plan in order to ensure that project goals remain aligned with business needs.
Task 3	Verify that project deliverables conform to the quality standards established in the quality management plan by using appropriate tools and techniques to meet project requirements and business needs.
Task 4	Monitor & assess risk by determining whether exposure has changed & evaluating the effectiveness of response strategies in order to manage the impact of risks & opportunities on the project.
Task 5	Review the issue log, update if necessary, & determine corrective actions by using appropriate tools & techniques in order to minimize the impact on the project.
Task 6	Capture, analyze, & manage lessons learned, using lessons learned management techniques in order to enable continuous improvement.
Task 7	Monitor procurement activities according to the procurement plan in order to verify compliance with project objectives.

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PMP Exam	
Task	Closing – 7%
Task 1	Obtain final acceptance of the project deliverables from relevant stakeholders in order to confirm that project scope & deliverables were achieved.
Task 2	Transfer the ownership of deliverables to the assigned stakeholders in accordance with the project plan in order to facilitate project closure.
Task 3	Obtain financial, legal, & administrative closure using generally accepted practices & policies in order to communicate formal project closure & ensure transfer of liability.
Task 4	Prepare & share the final project report according to the communications management plan in order to document & convey project performance & assist in project evaluation.


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PMP Exam	
Task	Closing – 7%
Task 5	Collate lessons learned that were documented throughout the project & conduct a comprehensive project review in order to update the organization's knowledge base.
Task 6	Archive project documents & materials using generally accepted practices in order to comply with statutory requirements & for potential use in future projects & audits.
Task 7	Obtain feedback from relevant stakeholders using appropriate tools & Techniques & based on the stakeholder management plan in order to evaluate their satisfaction.

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PMP Exam

- Must get 61% or better
- There is no penalty for wrong answers
- Fees:
 - PMI members pay \$405
 - Non-members pay \$555
- Each applicant has one (1) year to take exam



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PMP Exam

- The exam is NOT based on the PMBOK Guide®.
- The exam requires more than memorization.
- Almost half of the exam requires you to identify what you would do in a given situation.
- The exam emphasizes the five (5) process groups, ten (10) knowledge areas and 47 processes.
- Exam requires you to answer the questions from PMI's perspective based on the RDS.

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PMP Exam

- Rarely will the answer be a direct quote from the PMBOK Guide.
- Questions can be series based, i.e. you must answer the first question correctly to answer the next three (3) or four (4) questions.
- A small percentage of the questions will be based on the inputs and outputs from the PMBOK Guide.
- Earned Value, Critical Chain, PERT, EMV, and CPM will almost certainly be on the test.
- Approximately 10%-15% of the exam will require the use of other formulas.

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PMP Exam

Test-Taking Strategies

- Predict the answer.
- Your first instinct.
- Read the whole question.
- Look for wrong answers.
- Don't overanalyze.
- Key words.
- Confusing answer choices.
- True statements.
- No pattern.

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Types of Exam Questions



Types of Questions

Two Right Answers

- Remember, what would you do first.

Made up Terms

- Failing to know the key terms & acronyms will = failure.

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Types of Questions
Two Right Answers

During your daily standup, a teammate reports that they are struggling with a critical task that is causing the project backlog item to be delayed. What should you do?

- A. Immediately inform the sponsor and key stakeholders.
- B. Evaluate alternatives with the team.
- C. Trust the team to handle it.
- D. Keep pushing ahead as there is nothing you can do.

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Types of Questions
Situational Questions

Molly works for a large multi-national organization that manufactures steel as a project coordinator. Her organization is matrixed. She is responsible for three different projects, each with teams of ten to 20 team members who are also assigned to multiple projects. Yesterday she received an email from the vice president of stamped products complaining that one of her three projects was failing to meet the customer's expectations, and they had sent notification of their intent to cancel the contract. What is the most likely cause of this problem?

- A. The customers in question were not involved early enough in the process.
- B. Customer sign-off was not obtained for the scope statement.
- C. Scope definition happened too late in the process.
- D. The customer did not read their e-mail.

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Types of Questions
Extraneous Information

You are the project coordinator for a textile manufacturing company that is based in Southeast Asia. Your project's original budget was \$648,000 USD, and you have already spent \$462,000 USD. You currently have a CPI of 0.86 and an SPI of 0.62. Your project has an EV of US \$399,000 and an ETC of \$288,316. You are more than halfway through your project, and have a TCPI of 0.86. Your sponsor has just requested a major shift in project scope; what should you do?

- A. Try to convince the sponsor to change their mind.
- B. Agree to implement the changes immediately.
- C. Evaluate the changes for impacts to the cost and schedule.
- D. Stop the project until the issue is resolved.

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Types of Questions

Understanding vs. Memorization

At lunch you are sitting with a new employee within the organization. They are an experienced scrum master and commenting about how frustrated they are with the organizational requirement to use a Work Breakdown Structures for their projects especially early in the process when requirements are so poorly defined. You comment that a properly done WBS is similar to an FBS and an important tool for project success even early in the project. Which of the following statements best justifies this statement?

- A. The WBS is a great communication tool.
- B. A well formed WBS provides a strong visualization of the product of the project across its phases.
- C. A well formed WBS is similar to a FBS allowing for task assignments.
- D. The WBS allows for progressive elaboration using placeholder work packages.

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Types of Questions

Questions With Invented Terms

Your boss wants to know what cost performance measures your team must achieve to complete the project within the original budget. Which of the following do you provide to her?

- A. The Cost Performance Index
- B. The To-Complete Performance Index
- C. The Remaining Budget Ratio
- D. The Estimate For Completion

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Types of Questions

Answers With More than One Component

According to the PMBOK® Guide, how stringently must a project manager ensure that all the defined process interactions occur?

- A. Interactions within the planning process are dependent on the nature of the project, and so there is a great deal of flexibility.
- B. Interactions within the planning process are not dependent on the nature of the project and are only depend on the PMBOK® Guide, so there is not significant flexibility.
- C. Interactions within the planning process group are not dependent on the nature of the project but there is significant flexibility based on the definitions in the PMBOK® Guide.
- D. None of the above is true.

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Recurring Themes

PMI'isms

- There is a basic assumption that you keep historical records for all your projects.
- You must understand the process of project management (what to do first, second, etc.).
- You must not only understand the topics, but also why you should care about them.
- Everything should be coordinated with the stakeholders of a project and expectations managed.

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Recurring Themes


PMI'isms

- All roles and responsibilities must be clearly defined.
- A project plan is not a Gantt chart.
- A WBS is not an org chart but is a wonderful and key element of successful project management.
- Project managers are awesome and are very skilled.
- PMI does not support gold plating (adding extra functionality).
- Expert judgment and bottoms up is preferred.
- Environmental factors are influencing the project.

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The Exam – Why People Fail

- Belief that they can pass the test from their experience (not studying).
- A lack of PM experience.
- Failure to read the questions.
- Failure to read all of the choices.
- Not trusting their knowledge.
- Nervousness.



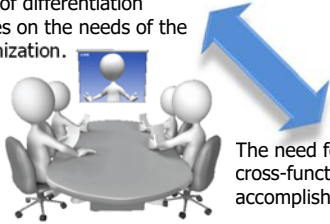
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Organizations and Project Management

Organizations

Differentiation vs. Integration

The need for specialized areas of expertise (Production, Marketing, Finance, etc.). The level of differentiation hinges on the needs of the organization.



The need for coordinated and cross-functional efforts to accomplish organizational tasks.

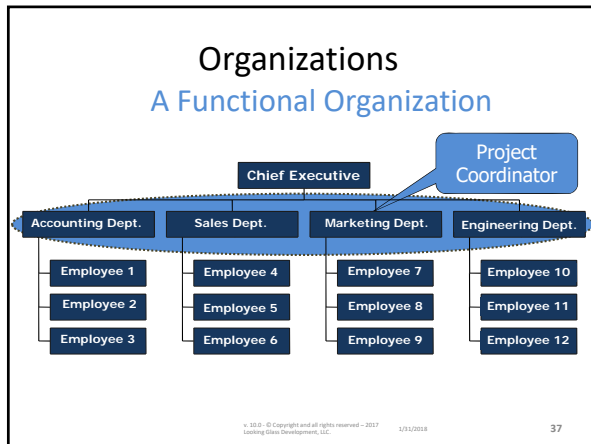
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Organizations

Organic or Simple

- Small, startup organizations.
- Every member of the team has multiple roles and responsibilities.
- No one in the organization has a project management title.
- The project managed by the owner with no administrative support.
- Is the weakest organizational structure.

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- ### Organizations
- #### Potential Advantages of a Functional Organization
- Clear reporting relationships.
 - Highly specialized expertise.
 - Homogeneous groups.
 - Drive for technical excellence.
 - Clear career path.
 - Creates high quality organizational knowledge within the functional area.
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- ### Organizations
- #### Potential Issues with a Functional Organization
- Conflicting priorities from overlapping projects.
 - Project boundaries limited to discipline.
 - Barrier to customer influence & satisfaction.
 - Employee development opportunities limited.
 - Project Manager is dependent on personal influence.
 - Hierarchical decision and communication processes.
 - Overwork technical issues vs. build to a standard.
 - Fosters part-time roles.
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- ### Organizations
- #### Potential Advantages of a Projectized Organization
- Strong project manager role.
 - Full-time administrative staff clear accountability.
 - Fosters collocation.
 - Improves focus.
 - Cost & performance tracking of projects.
 - Decision-making based on overall project view.
 - Customer relationships tied to various projects
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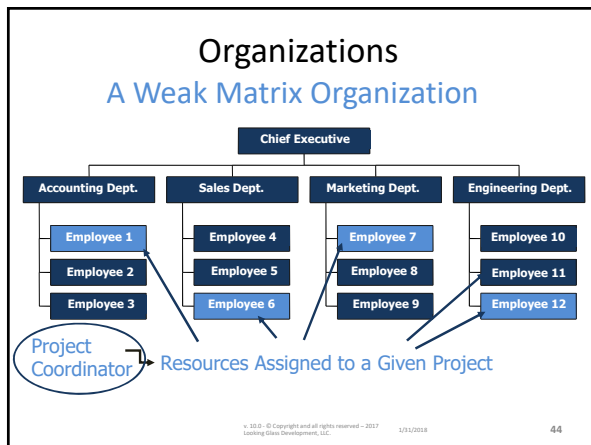
- ### Organizations
- #### Potential Issues with a Projectized Organization
- Reduction of employee's professional identity.
 - Reduced focus on technical competence.
 - Leadership by the non-technically skilled.
 - Focus on administrative work vs. technical work.
 - De-valuing of functional managers.
 - Process vs. deliverable emphasis.
 - Creates redundancy of efforts.
 - Project end can be traumatic event.
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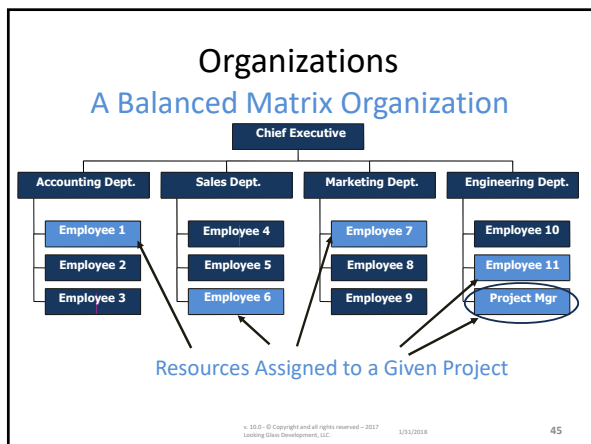
Organizations

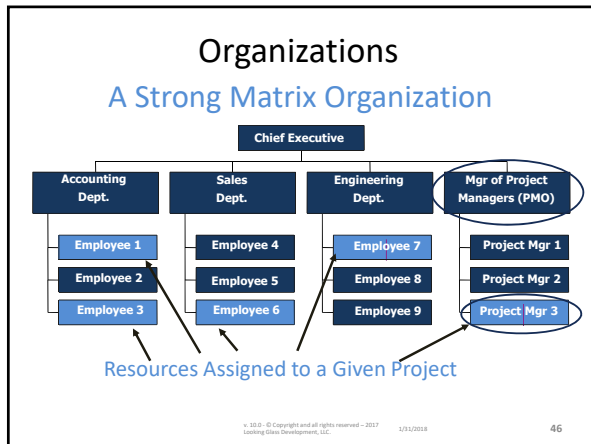
The Matrix Organization

- Are a blend of Functional and Projectized organizations.
- They are described as **WEAK** if they more closely align to Functional Organizations.
- They are described as **STRONG** if they more closely align to Projectized Organizations.

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- ### Organizations
- #### Potential Advantages of a Matrix Organization
- Visibility to project objectives.
 - Improved control of resources by project managers.
 - Rapid response to contingencies.
 - Greater support from functional managers.
 - Coordination of efforts across organization.
 - Project end is not a traumatic event.
 - Strong technical base.
 - More effective dissemination of information.
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- ### Organizations
- #### Potential Issues with a Matrix Organization
- Project personnel report to more than one boss.
 - Complex to monitor and control.
 - Conflicts with resource allocation and project priorities.
 - Potential for duplication of effort with “independent” projects.
 - Power struggles and competition for scarce resources.
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Organizations

Project Characteristics						
Organizational Structure Type	Work Groups Arranged As	Project Manager's Authority	Project Manager's Role	Resource Availability	Who Manages the Project Budget	Project Management Administration Staff
Organics or biotech	Flexibly, people working with by site	Little or none	Part time, may or may not be a designated job title combination	Little or none	Owner or sponsor	Little or none
Functional/consultant	100 being done (e.g. engineering, manufacturing)	Little or none	Part time, may or may not be a designated job title combination	Little or none	Functional manager	Part time
Multi-dimensional (e.g. multi-divisional, multi-divisional, multi-divisional)	One off products, portfolio programs, geographic regions, customer types	Little or none	Part time, may or may not be a designated job title combination	Little or none	Functional manager	Part time
Mixed	Job Function	Low	Part time, done as part of another job and NOT management job title like coordinator	Low	Functional manager	Part time
Reflexive	Job Function	Low to moderate	Part time, embedded in the function as a staff and may not be a designated job title like coordinator	Low to moderate	Mixed	Part time
Mixed	By job function, with project manager as a function	Moderate to high	Full-time designated job title	Moderate to high	Project manager	Full time
Professional services (e.g. consulting, architecture)	Project	High to almost total	Full-time designated job title	High to almost total	Project manager	Full time
Virtual	Network structure with nodes of people of contact with other people	Low to moderate	Full-time or part time	Low to moderate	Mixed	Could be full-time or part time
Hybrid	Mix of other types	Mixed	Mixed	Mixed	Mixed	Mixed
Other	Mix of other types	High to almost total	Full-time designated job title	High to almost total	Project manager	Full time

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The Basics of Project Management

The Basics of PM

What is Project Management?

- The management of a temporary endeavor undertaken to create a unique product or service.
- It requires the project team to deliver the agreed upon service or product with the agreed upon functionality on time and on budget with the agreed upon level of quality.

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The Basics of PM

Projects

- Have unique charter & goals
- Might have unique organization
- Develops a unique product or service
- Defined start & end dates
- Mostly heterogeneous teams

Operations

- Usually has semi-permanent charter
- Semi-permanent organization
- Maintains an existing set of practices
- Provides a standard product or service (e.g. an assembly line)
- Are continuous

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The Basics of PM

- A **program** is a group of related projects managed in a coordinated way to obtain benefits and control.
- A **portfolio** is a grouping of related and unrelated projects and programs managed & grouped for visibility and control purposes.

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Organizational Project Management			
	Projects	Programs	Portfolios
Scope	Projects have defined objectives. Scope is progressively elaborated throughout the project lifecycle.	Programs have a larger scope and provide more significant benefits.	Portfolios have an organizational scope that changes with the strategic objectives or the organization
Change	Project managers expect change & implement processes to keep change managed & controlled.	Program managers expect change from both inside & outside the program & are prepared to manage to it.	Portfolio managers continuously monitor changes in the broader internal & external environment.
Planning	Project managers progressively elaborate high-level information into detailed plans throughout the project lifecycle.	Program managers develop the overall program plan & create high-level plans to guide detailed planning at the component level.	Portfolio managers create & maintain necessary processes & communication relative to the aggregate portfolio.
Management	Project managers manage the project team to meet the project objectives.	Program managers manage the program staff & the project managers; they provide vision & overall leadership.	Portfolio managers may manage or coordinate portfolio management staff, or program and project staff that may have reporting responsibilities into the aggregate portfolio.
Success	Success is measured by product & project quality, timeliness, budget compliance, & degree of customer satisfaction.	Success is measured by the degree to which the program satisfies the needs & benefits for which it was undertaken.	Success is measured in terms of the aggregate investment performance & benefit realization of the portfolio.
Monitoring	Project managers monitor & control the work of producing the products, services, or results that the project was undertaken to produce.	Program managers monitor the progress of program components to ensure the overall goals, schedules, budget, & benefits of the program will be met.	Portfolio managers monitor strategic changes & aggregate resource allocation, performance results, & risk of the portfolio.

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The Basics of PM
Key Terms

Project Management Office (PMO) — Centralizes the management of projects. Typical 3 structures:

- **Supportive** – Providing a consultative role by providing templates, best practices, training, access to information, & lessons learned.
- **Controlling** – Provide support & require compliance.
- **Directive** – Take control of the projects by directly managing the projects.

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The Basics of PM
Key Terms

- **Management by Objectives (MBO)** — Requires all processes, initiatives and operations to be tracked against specific, defined objectives. MBO only works if management strongly supports it. MBO has three basic steps:
 - Establish unambiguous and realistic objectives.
 - Regularly evaluate if the objectives are being met.
 - Implement corrective action.

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The Basics of PM
Key Terms

- **Work Performance Data** — The raw observations & measurements identified during activities performed to carry out project work: % work physically completed, start & finish dates & technical measures.
- **Work Performance Information** – The performance data collected from controlling processes: status of deliverables, status of change requests, forecasted ETC.
- **Work Performance Reports** – The physical or electronic representation of work performance information.

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The Basics of PM
Key Terms

- **Project Life Cycle** — A series of phases that a project passes through from its initiation to its closure. It provides the basic framework for managing the project.
- **Project Phases** – Represent a collection of logically related project activities that culminate in the completion of one or more deliverables.

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The Basics of PM
Key Terms – Life Cycles

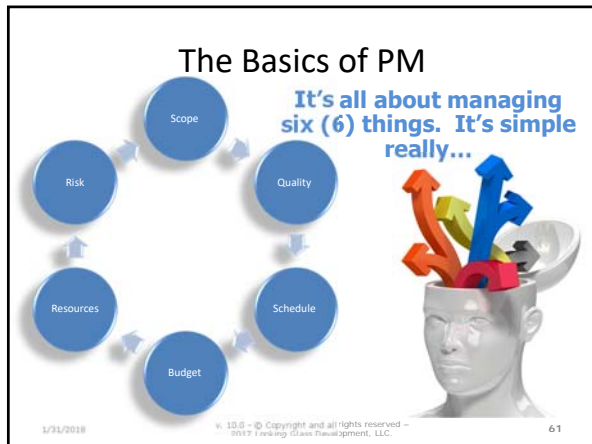
- **Predictive** — Also known as fully plan driven, are ones where the scope, time & cost are determined as early as possible – Waterfall.
- **Iterative & Incremental** – Project phases intentionally repeat one or more project activities as the team’s understanding increases.
- **Adaptive** – Change driven or agile are intended to respond to high levels of change & stakeholder involvement with fixed time & cost.

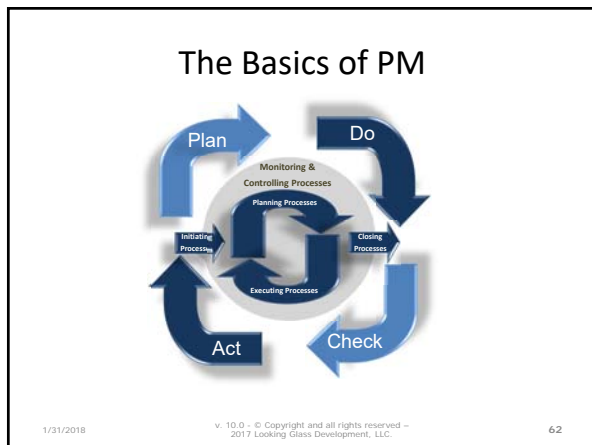
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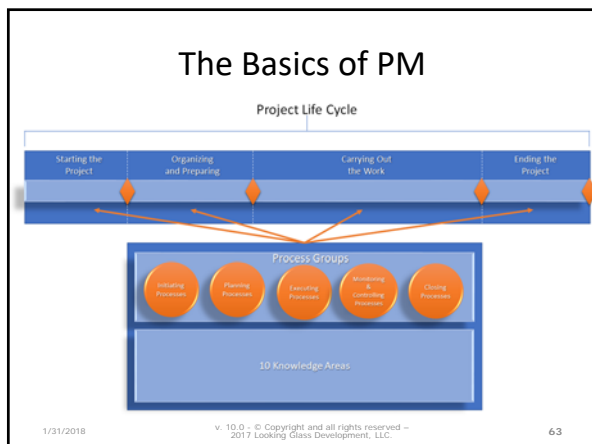
The Basics of PM
Key Terms

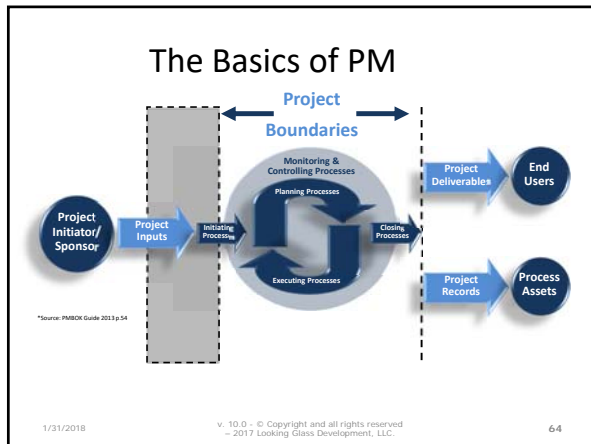
- **Constraints** — Represent factors that limit options of the project manager and project team.
 - Common constraints include time, budget, requirements, resources and/or risks.
 - Management’s responsibility to set the priority of each constraint.
 - Project manager and project team’s responsibility to analyze the impacts of changes against the project constraints.
- **Organizational Project Management Maturity Model (OPM3)** — Is PMI’s model to help organizations determine their level of project management maturity.
- **Stakeholders & Stakeholder Management** — Stakeholders represent anyone with a vested interest in the project.

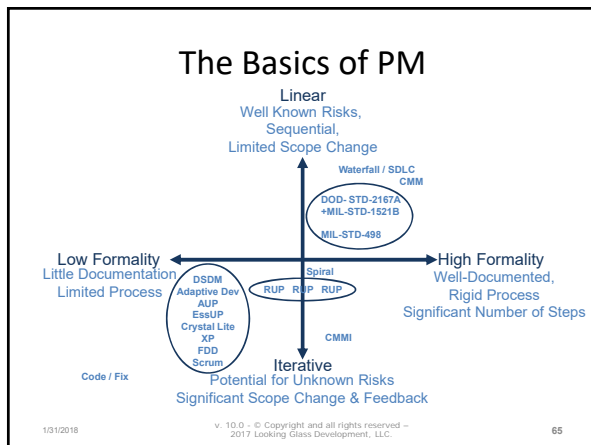
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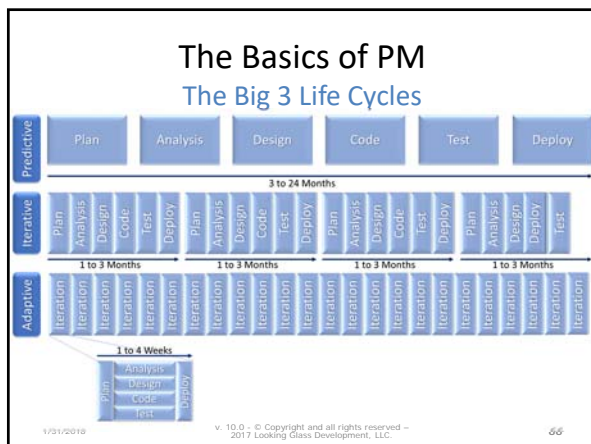













The Basics of PM

Keys to the Predictive Waterfall Model

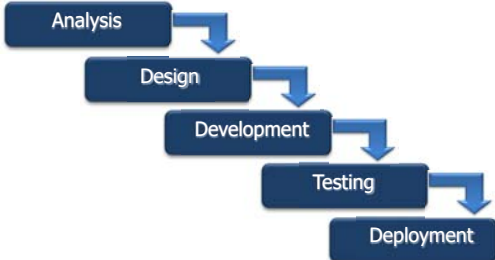
- The Waterfall Model offers the most number of standard decision gates.
- Examples include:
 - Conceptual Design Review
 - Requirements Review
 - Preliminary Design Review
 - Critical Design Review



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The Basics of PM

The Basic Predictive Model



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The Basics of PM

Keys to the Predictive Model

- A waterfall model offers the easiest departmentalization and managerial control.
- A waterfall model forces the team to completely define all requirements before proceeding to the next phase. This is also its biggest disadvantage.
- The waterfall model has strong emphasis on documentation and the development of source code.
- The waterfall model provides a very structured and disciplined approach to development. This high degree of structure may also be seen as a disadvantage by many.

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The Basics of PM

Keys Challenges to the Predictive Model

- Real projects rarely follow the sequential flow of the waterfall model.

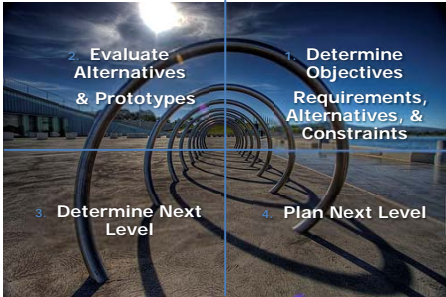
- At the beginning of a project requirements can often be uncertain.

- Developing in a waterfall model can be a long process without yielding any results until the very end.

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The Basics of PM

The Iterative Life Cycles



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Advantages of the Iterative Model

- The spiral model is evolutionary.

- The spiral model provides strong focus on project risk.

- Prototypes allow for rapid evaluation.


- Can incorporate other models within iterations as special cases.

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Challenges of the Iterative Model

- Team must have strong risk assessment expertise.
- Potentially less ability to control costs and schedule overruns.



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Prototyping

- Prototyping assumes it is often difficult to know all the requirements at the beginning of the project.
- Prototyping requires the developer to build a simplified version of the proposed system and present it to the customer as part of the development process.
- The prototype should never be deployed!

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Reasons to Prototype

- Prototypes can be used to complete requirements analysis.
- Prototypes can account for design uncertainty.
- Prototypes can allow experimentation and comparison of multiple solutions.

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Dangers of Prototyping

- **False Expectations** – “the system is now complete”.
- **Increased Expense** – must develop prototype and production system.
- **Poorly Designed Systems** – Prototyping focuses on rapid development which can lead to heavy layering and a failure to make global considerations.

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The Basics of PM

Managing WIP

Deliverable 1			
Option 1	A	A	
Option 2	A	C	A
Deliverable 2			
Option 1	B	B	
Option 2	B	B	C
Deliverable 3			
Option 1	C	C	
Option 2			

- In **Option 1** the best resource for the deliverable attempts to do each task for the feature and nothing gets delivered.
- In **Option 2** resourcing is applied based upon availability and two features are delivered.

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The Basics of PM

- Based on industrial process theory.
 - Self-organization
 - Emergence
- Defined process control vs. empirical process control.
 - **Defined Processes** - Repeatable processes such as in manufacturing. Leads to commoditization. In projects often leads to rework.
 - **Empirical Processes** - Complex processes where it is difficult to have consistent processes. Focuses on 3 keys.

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The Basics of PM

Foundation

- **Visibility** – The aspects of the process that affect the outcome must be visible to those controlling the process & what is seen must be true.
- **Inspection** – The various aspects of the process must be examined frequently enough that unacceptable variances in the process can be detected.
- **Adaptation** – If one or more of the processes are determined out of control the processes change.

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The Basics of PM

The Scrum Roles

- **Product Owner** – Responsible for representing interests of all stakeholders, obtaining funding, defining initial requirements, ROI, and objectives (Product Backlog).
- **The Team** – Develops the functionality. Is self-managing, self-organizing, and cross functional.
- **Scrum Master** – Responsible for the Scrum process, teaching Scrum to everyone, implementing Scrum so it fits with culture, and that everyone follows Scrum rules & practices.

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The Basics of PM


Scrum

Scrum = 3 Roles + 4 Artifacts + 5 Meetings

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The Basics of PM A Project Vision


- Serves as a Charter or Project Vision
- Required to begin any project.
- Never longer than a single page.
- Includes 5 key pieces of information: Need, justification, success criteria, prioritization, constraints & assumptions.



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Key Scrum Artifacts Product Backlog

- A prioritized list of items to be delivered.
- Each item is “relatively independent” of the others.
- Backlog may be reprioritized at any time.
- Items = User Stories or PBIs
- PBI = Product Backlog Item

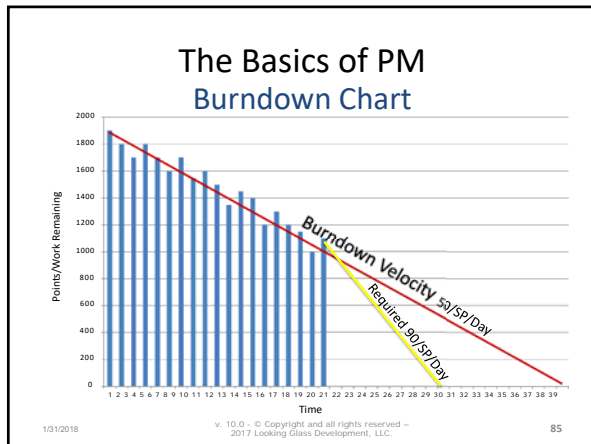


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PBI	To Do	In Progress 5	Validate 3	Impeded 2	Done
PBI	Task	↑	↑	↑	
PBI	Task				
PBI	Task				
PBI	1 Task				
PBI	1 Task				
Technical Debt					

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- ### The Basics of PM Sprint Planning Meeting
- PO speak to the sprint goal.
 - Acceptance criteria.
 - Team forecasts number of stories.
 - Team breaks PBIs into tasks.
 - Estimate tasks: 0.5 / 1.
 - Build sprint burndown and task board.
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- ### The Basics of PM The Daily Scrum
- 10 to 15 minute meeting for team to answer 3 questions.
 - Stand up means STAND UP!
 - Target 10 minutes, 15 max.
 - Same time every day & don't miss a day.
 - Stand in front of the visual progress artifact.
 - Everybody is present.
 - No typing during the meeting.
 - Concentrate on the 2nd and 3rd questions.
 - Don't talk to the Scrum Master. Talk to the team.
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Sprint Review

- Summary of sprint by PO.
- PO demonstrates every acceptance criteria of every story delivered.
- Gather feedback from stakeholders and incorporate into product backlog.
- Update release plan and discuss next step.

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Sprint Retrospective

- The most important Scrum meeting.
- Important to change something in every sprint.
- Remember: "It's not a lesson learned until you do something about."
- Work on only the 2 most important lessons.

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Day 1		Day 2 - X	Last Day
AM	Sprint Planning	Daily Scrum	Plan Retro & Review
		Work & Backlog Grooming	Sprint Review & Sprint Retrospective
PM	Work	Work & Backlog Grooming	1. Free Time 2. Google 20% Time 3. Personal Time

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The Basics of PM

PMBOK® Guide Knowledge Areas

Knowledge Areas describe project management knowledge and practice in terms of their component processes.

- Integration Management
- Scope Management
- Schedule Management
- Cost Management
- Quality Management
- Resource Management
- Communications Management
- Risk Management
- Procurement Management
- Stakeholder Management

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The Basics of PM

Ten Knowledge Areas Extended

- 4 Integration Management
- 5 Scope Management
- 6 Schedule Management
- 7 Cost Management
- 8 Quality Management
- 9 Resources Management
- 10 Communications Management
- 11 Risk Management
- 12 Procurement Management
- 13 Stakeholder Management

- 6.1 Plan Schedule Management
- 6.2 Define Activities
- 6.3 Sequence Activities
- 6.4 Estimate Activity Durations
- 6.5 Develop Schedule
- 6.6 Control Schedule

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The Basics of PM

```

graph LR
    A[Inputs] --> B[Tools & Techniques]
    B --> C[Outputs]
  
```

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The Basics of PM Ten Knowledge Areas Extended

- 4 Integration Management
 - 6.1 Plan Schedule Management
- 5 Scope Management
 - 6.2 Define Activities
- 6 Schedule Management
 - 6.3 Sequence Activities
 - 6.4 Estimate Activity Durations
 - 6.5 Develop Schedule
 - 6.6 Control Schedule
- 7 Cost Management
 - 6.3.1 Inputs
- 8 Quality Management
 - 6.3.2 Tools & Techniques
- 9 Resources Management
 - 6.3.2.1 Precedence diagramming method (PDM)
- 10 Communications Management
 - 6.3.2.2 Dependency determination and integration
- 11 Risk Management
 - 6.3.2.3 Leads and lags
- 12 Procurement Management
 - 6.3.2.4 Project management information system
- 13 Stakeholder Management
 - 6.3.3 Outputs

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The Basics of PM The Process Groups & Knowledge Areas Combined

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Project Integration Management

Integration Management

The processes and activities needed to identify, define, combine, unify and coordinate the various processes and project management activities within the Project Management Process Groups.

Initiating Process Group
4. Project Integration Management
4.1 Develop Project Charter

Planning Process Group
4. Project Integration Management
4.2 Manage Project Charter

Executing Process Group
4. Project Integration Management
4.3 Develop Project Management Plan
4.4 Acquire Resources
4.5 Manage Project Team

Monitoring & Controlling Process Group
4. Project Integration Management
4.6 Monitor Project Work
4.7 Perform Integrated Change Control

Closing Process Group
4. Project Integration Management
4.8 Close Project or Phase

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Integration Management

4.1 Develop Project Charter

- Names the project manager & sponsor.
- Explains how the project supports the organizational strategy.
- Explains the business need & why the need exists.
- Defines any constraints and assumptions that exist (this includes any deadlines, budget limitations, resource limitations, any known risks, and scope must haves).
- Defines the project success criteria (it is always recommended that success criteria be quantitative in nature as subjective success criteria usually leads to failure).

Initiating Process Group
4. Project Integration Management
4.1 Develop Project Charter

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Integration Management

4.1 Develop Project Charter


Inputs	Tools & Techniques	Outputs
<ul style="list-style-type: none"> .1 Business documents .2 Agreements .3 Enterprise environmental factors .4 Organizational process assets 	<ul style="list-style-type: none"> .1 Expert judgment .2 Data gathering .3 Interpersonal and team skills .4 Meetings 	<ul style="list-style-type: none"> .1 Project charter .2 Assumption log

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Integration Management

The Business Case

- **Benefit Measurement Methods** – subjective measures.
- **Constrained Optimization Methods** – linear, integer, dynamic or multi-objective programming.
- **Economic Models**
 - Payback Period
 - Future Value
 - Present Value
 - Net Present Value (NPV)
 - Internal Rate of Return (IRR)
 - Benefit / Cost ratio (BCR or BCI)



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Integration Management

The Business Case

Discounting or Present Value – Value today of funds available in the future.

$$PV = FV / (1 + i)^n$$

- If you want \$1,000 in three (3) years how much do you have to invest today at 8% to receive your \$1,000?
- End of Yr. 1 = \$1,000 / (1 + 8%) = \$925.93
- End of Yr. 2 = \$925.93 / (1 + 8%) = \$857.34
- End of Yr. 3 = \$857.34 / (1 + 8%) = \$793.83

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Integration Management

The Business Case


- **Net Present Value** – Present Value minus present cost.
- **Internal Rate of Return** - Average rate of return earned over the life of the project. It is where discounted cash flow – up front cost = 0.

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Integration Management

4.2 Develop Project Management Plan

- The **Project Management Plan** is a key project document that is a collection of the outputs of the planning processes of the **Planning Process Group**.
- Describes which project management processes will be used.
- Describes how the project is executed, monitored and controlled, and closed.
- Updated throughout the project.



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Integration Management

4.2 Develop Project Management Plan

Inputs

- .1 Project charter
- .2 Outputs from planning processes
- .3 Enterprise environmental factors
- .4 Organizational process assets

➔

Tools & Techniques

- .1 Expert judgment
- .2 Data gathering
- .3 Interpersonal and team skills
- .4 Meetings

➔

Outputs

- .1 Project management plan

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Integration Management

Project Management Plan	Project Documents	
1. Scope management plan	1. Activity attributes	19. Quality control measurements
2. Requirements management plan	2. Activity list	20. Quality metrics
3. Schedule management plan	3. Assumption log	21. Quality report
4. Cost management plan	4. Basis of estimates	22. Requirements documentation
5. Quality management plan	5. Change log	23. Requirements traceability matrix
6. Resource management plan	6. Cost estimates	24. Resource breakdown structure
7. Communications management plan	7. Cost forecasts	25. Resource calendars
8. Risk management plan	8. Duration estimates	26. Resource requirements
9. Procurement management plan	9. Issue log	27. Risk register
10. Stakeholder engagement plan	10. Lessons learned register	28. Risk report
11. Change management plan	11. Milestone list	29. Schedule data
12. Configuration management plan	12. Physical resource assignments	30. Schedule forecasts
13. Scope baseline	13. Project calendars	31. Stakeholder register
14. Schedule baseline	14. Project communications	32. Team charter
15. Cost baseline	15. Project schedule	33. Test & evaluation documents
16. Performance measurement baseline	16. Project schedule network diagram	
17. Project life cycle description	17. Project scope statement	
18. Development approach	18. Project team assignments	

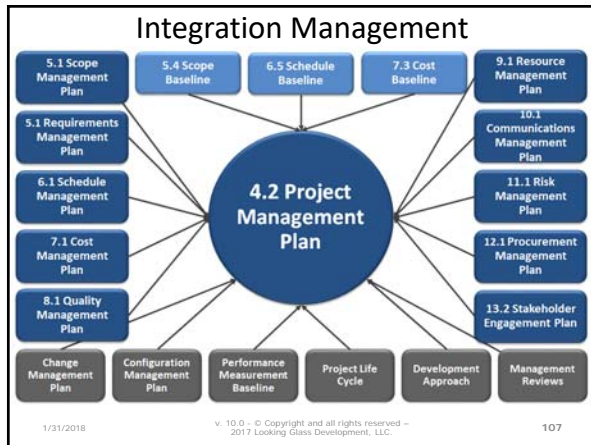
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Integration Management

Baselines, Logs & Registers

- **Scope baseline** — The scope baseline includes the scope statement, work breakdown structure (WBS), and WBS dictionary.
- **Milestone list** — The milestone list is a listing of the major, defined milestones for the project.
- **Resource calendars** — A good project manager knows when their resources will be available to complete project work and does not assume they will simply be there when the schedule says they will.
- **Schedule baseline** — The schedule baseline represents a snapshot or picture of the schedule as promised to the sponsor. It is critical that the project manager is always comparing the actual delivered results to the scheduled results found in the schedule baseline.
- **Cost baseline** — The cost baseline is the same as the Schedule Baseline, except it is focused on the project budget instead of the schedule.
- **Risk register** — The risk register is a critical document for project success. The Risk Register documents all the known potential risks, their triggers, categories, owners, and the response strategies. The risk register is discussed extensively in the risk management knowledge area.

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Integration Management

4.3 Direct & Manage Project Work

- Project Manager, with project team, directs performance and manages interfaces with the rest of the organization

Executing Process Group

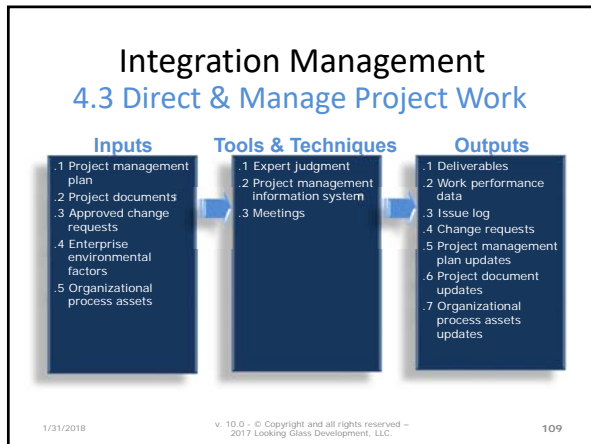
4. Project Integration Management

Direct & Manage Project Work

Project Performance

Project Knowledge

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Integration Management

4.4 Manage Project Knowledge

➤ This is the process where the team uses existing knowledge and also creates new to achieve the project's objectives and contribute to organizational learning.

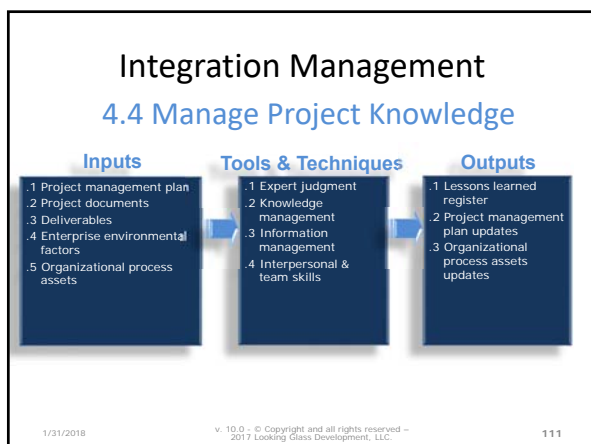
➤ There are two types of knowledge used in this process:

- **Explicit** – Knowledge that can be readily codified using words, pictures, or numbers.
- **Tacit** – Knowledge that is personal and often difficult to express such as beliefs, insights, experience

➤ People can't be forced to share what they know.

Executing Process Group W.

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Integration Management

4.5 Monitor & Control Project Work

- **Monitoring processes** – collect, measure, disseminate, assess.
- Control via corrective actions.
- Compare actual work to plans/baselines.
- Analyze, track, forecast.
- Monitor implemented changes.

Monitoring & Controlling Process Group

4. Project Integration Management

Monitor & Control Project Work Perform Integrated Change Control

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Integration Management

4.5 Monitor & Control Project Work

Inputs	Tools & Techniques	Outputs
<ul style="list-style-type: none">1 Project management plan2 Project documents3 Work performance information4 Agreements5 Enterprise environmental factors6 Organizational process assets	<ul style="list-style-type: none">1 Expert judgment2 Data analysis3 Decision making4 Meetings	<ul style="list-style-type: none">1 Work performance reports2 Change requests3 Project management plan updates4 Project document updates

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Integration Management

4.6 Perform Integrated Change Control

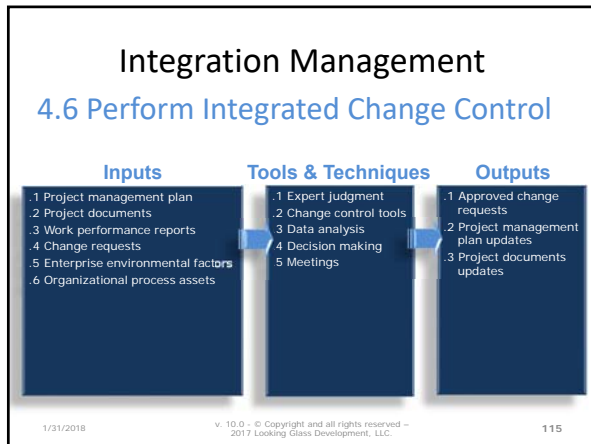
- Performed from the very beginning to the very end.
- Identify that a change has occurred.
- Influence factors that circumvent the integrated change control process.
- Review, approve (or reject), monitor change requests.
- Maintain integrity of the baselines.
- Review and approve all recommended corrective and preventive actions.
- Assess impact of proposed changes.

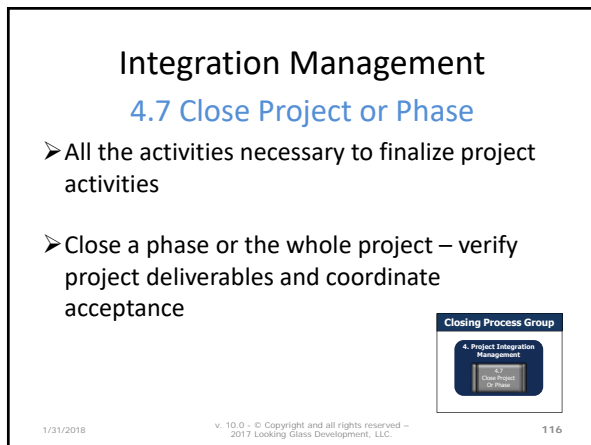
Monitoring & Controlling Process Group

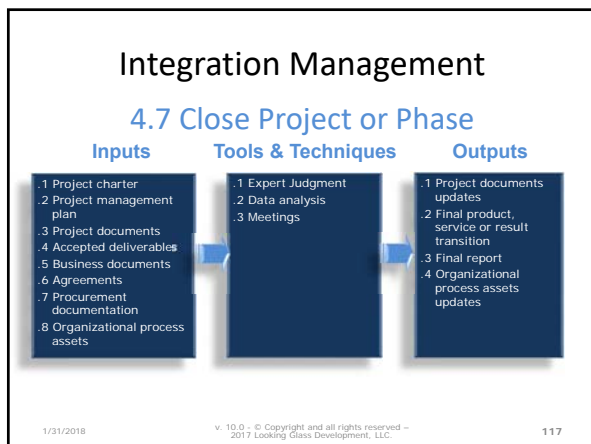
4. Project Integration Management

Monitor & Control Project Work Perform Integrated Change Control

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Integration Management Summary

- Seven (7) processes.
- Role and components of the charter.
- Charter issued by party external to the project.
- Project management plan is collection of other plans – level of detail depends on the project.
- Change control throughout the project.
- Closure = deliverables **AND** project records.
- Environmental factors are at play.

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Project Scope Management

Scope Management

- Scope management is the process of defining what work is required and then making sure all of that work and only that work is done. (PMBOK Guide p.129)
- No project is ever conducted without a plan.
- A WBS must be created for all projects.
- Involve all the project stakeholders in requirements
- You must obtain approval of the project scope before execution begins.
- Do not ever gold plate the project.
- Scope changes allowed so long as they follow the agreed upon change management process.

Planning Process Group

Monitoring and Controlling Process Group

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Scope Management

The Product vs. Project Scope:

- **Project Scope** –The work that must be performed to deliver a product, service or result with the specified features and functions. PMBOK Guide 2012 p. 555
- **Product Scope** – The features and functions that characterize a product service or result. PMBOK Guide 2012 p. 552

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Scope Management

The Scope Management Plan Answers...

- How will you determine the product scope for the project? This includes the specific requirements of the product, service, or result.
- How will you balance the needs of all your stakeholders?
- What tools and techniques will the project team specifically use?
- Are there enterprise environmental factors and organizational process assets that must be accounted for or used?
- What will the scope change management process be?
- How will you measure scope performance and adjust to variances as needed?

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Scope Management

The Steps in Scope Management

- Determine the product, service, or result requirements. Make sure all the requirements tie back to the business need described in the charter.
- Balance the needs of the various stakeholders to determine the correct requirements.
- Develop a Work Breakdown Structure according to PMI® standards that is focused on being deliverable.
- Verify that the scope that has been specified is being accomplished according to the plan.
- Measure the project scope performance and adjust it according to the Scope Change Management Plan.

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Scope Management

How Scope is Measured

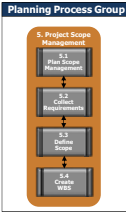
- Project scope is measured against the project management plan. Did the team finish the work they said they would do.
- Product scope is measured against the project requirements.

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Scope Management

5.1 Plan Scope Management

- Process of creating a scope management plan that documents how the project scope will be defined, validated & controlled.
- It tells everyone how scope will be managed throughout the project.



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Scope Management

5.1 Plan Scope Management

Inputs	Tools & Techniques	Outputs
<ul style="list-style-type: none"> .1 Project charter .2 Project management plan .3 Enterprise environmental factors .4 Organizational process assets 	<ul style="list-style-type: none"> .1 Expert judgment .2 Data analysis .3 Meetings 	<ul style="list-style-type: none"> .1 Scope management plan .2 Requirements management plan

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Scope Management

5.2 Collect Requirements

- Process of defining and documenting stakeholders' need to meet the project objectives.
- This process is directly tied to managing expectations.

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Scope Management

5.2 Collect Requirements

Inputs	Tools & Techniques	Outputs
<ul style="list-style-type: none"> .1 Project charter .2 Project management plan .3 Project documents .4 Business documents .5 Agreements .6 Enterprise environmental factors .7 Organizational process assets 	<ul style="list-style-type: none"> .1 Expert judgment .2 Data gathering .3 Data analysis .4 Decision making .5 Data representation .6 Interpersonal and team skills .7 Context diagram .8 Prototypes 	<ul style="list-style-type: none"> .1 Requirements documentation .2 Requirements traceability matrix

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Scope Management

Requirements Data Gathering

- Brainstorming
- Interviews
- Focus groups
- Questionnaires and surveys
- Benchmarking
- Nominal group techniques
- The Delphi technique

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Scope Management

Voting

- **Voting** — This is exactly what it sounds like. Decisions are made based upon the opinions of a group. There are a number of ways this can be done:
 - **Unanimity** — This is where everyone agrees on a course of action.
 - **Majority** — This is a process where the majority of members in the group decide direction. Anything over 50% wins.
 - **Plurality** — This is used when a simple majority is not possible. In these cases, whichever group has the largest number wins—even though it is not a majority.
- **Autocratic decision making**— This is a fancy way of dictatorship. In this method, one person makes the decision for the group.
- **Multicriteria decision analysis** — Establishes a basic framework for making a decision when the team is looking at aspects in conflict with each other. A common example is the relationship between cost and quality.

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Scope Management

Idea Mapping Guidelines

- Idea maps use the way the brain processes information associatively. They are single-page diagrams that visually captures ideas in a non-linear format.
- Characteristics of a Mind Map:
 1. The main idea, is crystallized in a central image.
 2. The main themes radiate from the central image as 'branches'.
 3. Each branch comprises a key image or word drawn or printed on its associated line.
 4. Topics of lesser importance are represented as 'twigs' of the relevant branch.
 5. The branches form a connected nodal structure.

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Scope Management

Brainstorming Steps

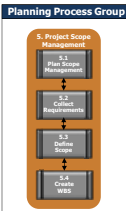
1. A question or problem is posed to the group and each member silently generates and writes down their ideas.
2. The moderator writes down the ideas on a flip chart until all the ideas are recorded.
3. Each recorded idea is discussed until all group members have a clear understanding.
4. Individual vote privately to prioritize the ideas, using a scale of 1 to 5, with 1 being the lowest and 5 being the highest. After each vote the ballots are counted and the team revote until the highest option is selected.

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Scope Management

5.3 Define Scope

➤ Taking the detailed requirements defined in the collect requirements process and developing a detailed description of the product or service that will meet those needs.



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Scope Management

5.3 Define Scope

Inputs

- .1 Project charter
- .2 Project management plan
- .3 Project documents
- .4 Enterprise environmental factors
- .5 Organizational process assets

Tools & Techniques

- .1 Expert judgment
- .2 Data analysis
- .3 Decision making
- .4 Interpersonal and team skills
- .5 Product analysis

Outputs

- .1 Project scope statement
- .2 Project documents updates

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Scope Management

Charter vs. Scope Statement

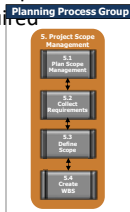
Project Charter	Project Scope Statement
Project purpose	Project scope description (progressively elaborated)
Measurable project objectives and related success criteria	Project deliverables
High-level requirements	Acceptance criteria
High-level project description, boundaries, and key deliverables	Project exclusions
Overall project risk	
Summary milestone schedule	
Preapproved financial resources	
Key stakeholder list	
Project approval requirements (i.e., what constitutes success, who decides the project is successful, who signs off on the project)	
Project exit criteria (i.e., what are the conditions to be met in order to close or to cancel the project or phase).	
Assigned project manager, responsibility, and authority level.	
Name and authority of the sponsor or other person(s) authorizing the project charter	

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Scope Management

5.4 Create WBS

- A WBS is a deliverable-oriented, hierarchical decomposition of the work to be executed by the project team. It enables them to accomplish the project objectives and create the requirements for the product, service, or result.



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Scope Management

WBS Terminology

- Work Packages
- Decomposition
- Progressive elaboration
- Placeholder work packages
- Control account

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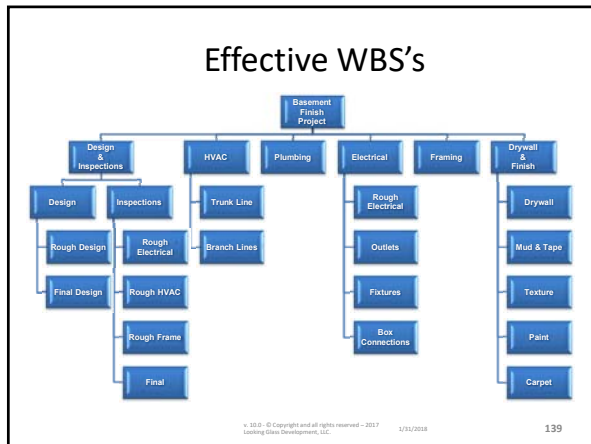
Scope Management Components of the WBS

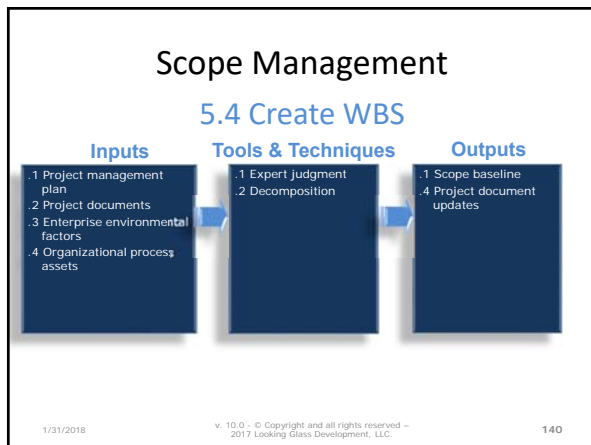
- **The WBS Structure** – resembles an organization chart or decision tree.
- **The WBS Dictionary** – A brief synopsis of the project and each major component or work package.
- **The Code of Accounts** – The numbering system used to reference and roll-up the WBS.
 - The highest level is 1
 - The next level is 1.x
 - The next level is 1.x.x and so on

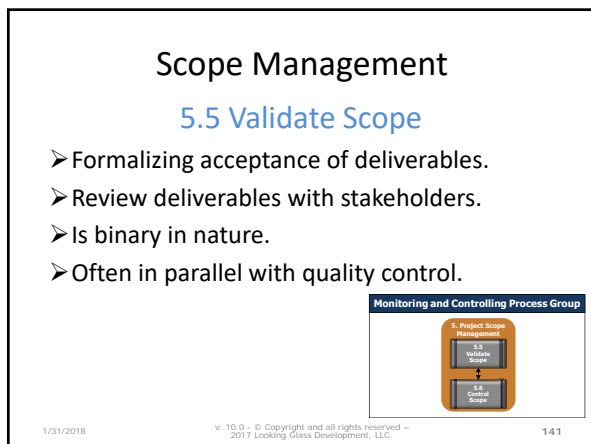
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Scope Management

5.5 Validate Scope


Inputs	Tools & Techniques	Outputs
<ul style="list-style-type: none">.1 Project management plan.2 Project documents.3 Verified deliverables.4 Work performance data	<ul style="list-style-type: none">.1 Inspection.2 Decision making	<ul style="list-style-type: none">.1 Accepted deliverables.2 Work performance information.3 Change requests.4 Project document updates

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Scope Management

5.6 Control Scope

- Influence the factors that create project scope changes.
- Control the impact of those changes.
- Ensure use of **Integrated Change Control**.
- Manage changes.
- Scope creep.



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Scope Management

5.6 Control Scope

Inputs	Tools & Techniques	Outputs
<ul style="list-style-type: none">.1 Project management plan.2 Project documents.3 Work performance data.4 Organizational process assets	<ul style="list-style-type: none">.1 Data analysis	<ul style="list-style-type: none">.1 Work performance information.2 Change requests.3 Project management plan updates.4 Project document updates

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Scope Management

Project Scope Management - Summary

- Six (6) processes.
- Project and product scope.
- Scope is revised throughout project.
- **WBS** – know its importance and that it is used in many other processes; and it is deliverables based.

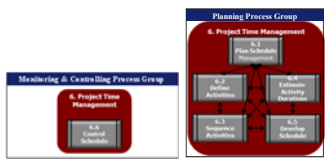
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Schedule Management



Schedule Management

- All the processes required to ensure timely completion of the project.
- The major output of these processes is the project schedule.




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Schedule Management

6.1 Plan Schedule Management

- Defines the “rules” for developing & managing the schedule.
- The benefit of this process is that it provides guidance & direction on how the schedule will be managed.



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Schedule Management

6.1 Plan Schedule Management


Inputs	Tools & Techniques	Outputs
<ul style="list-style-type: none"> .1 Project charter .2 Project management plan .3 Enterprise environmental factors .4 Organizational process assets 	<ul style="list-style-type: none"> .1 Expert judgment .2 Data analysis .3 Meetings 	<ul style="list-style-type: none"> .1 Schedule Management plan

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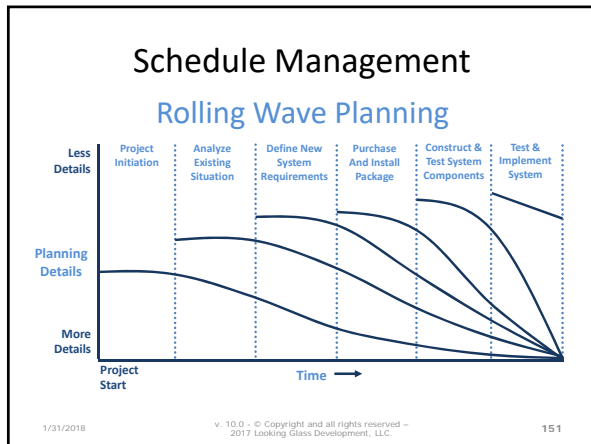
Schedule Management

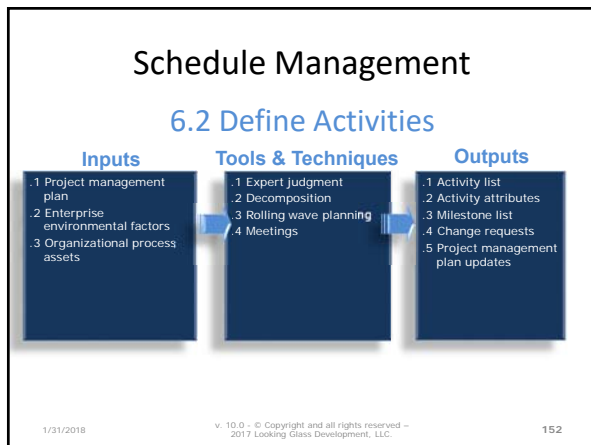
6.2 Define Activities

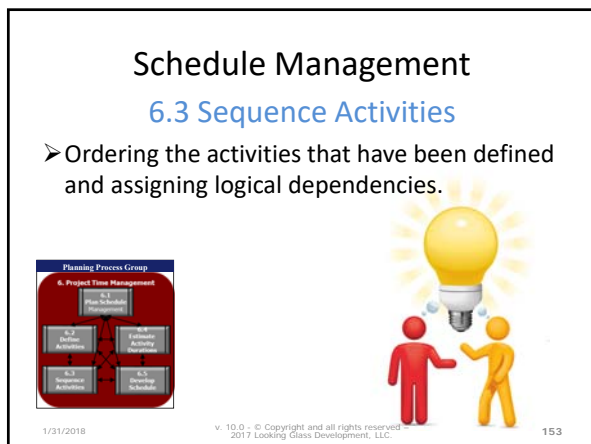
- Creating a “list” of all the work that needs to be done to produce the project deliverables.
- Work packages are decomposed into schedule activities.
- These schedule activities provide a basis for estimating, scheduling, executing, and monitoring and controlling.



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Schedule Management

6.3 Sequence Activities

Inputs	Tools & Techniques	Outputs
<ul style="list-style-type: none">.1 Project management plan.2 Project documents.3 Enterprise environmental factors.4 Organizational process assets	<ul style="list-style-type: none">.1 Precedence diagramming method (PDM).2 Dependency determination and integration.3 Leads and lags.4 Project management information system	<ul style="list-style-type: none">.1 Project schedule network diagrams.2 Project document updates

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Schedule Management

PDM

- Finish to Start
- Start to Start
- Finish to Finish
- Start to Finish

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Schedule Management

Conditional Diagramming

- GERT is most common.
- Allows for probability.
- Allows for looping.

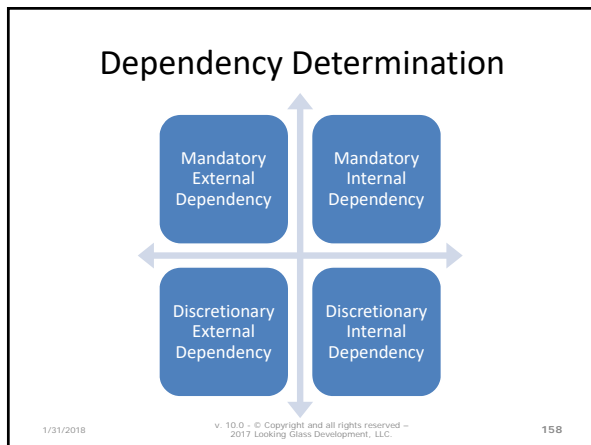
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Schedule Management

Dependencies

- **Mandatory (hard logic)** — Mandatory dependencies are defined as situations where the ordering of task, activities or deliverables is locked into place by the work itself and there is no other alternative path.
- **Discretionary (soft logic)** — Discretionary dependencies are situations where there is more than one possible path to complete the project work, but someone has chosen a specific path for some reason.
- **External** — External dependencies refer to situations where dependencies are placed on the project team by some outside force, regardless of logic or preference. Regulations and laws are the most common form of external dependencies.

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Schedule Management

Leads & Lag

- **Lead time** occurs whenever a finish-to-start relationship allows the successor task to start prior to the completion of the predecessor.
- **Lag time** represents a relationship that requires a delay between the two tasks.

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Schedule Management

Leads & Lag

A finish-to-start relationship with
A finish-to-start relationship with **LAG**
time

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Schedule Management

6.4 Estimate Activity Durations

- Compilation (not the sum) of activity duration estimates results in the project duration.
- All supporting data is documented.
- Uses identified risks and cost estimates.
- Accuracy improves over time.
- Ranges, e.g. 280 days -5% to +10%.

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Schedule Management

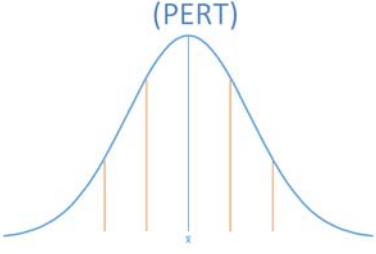
6.4 Estimate Activity Duration

Inputs	Tools & Techniques	Outputs
<ul style="list-style-type: none"> .1 Project management plan .2 Project documents .3 Enterprise environmental factors .4 Organizational process assets 	<ul style="list-style-type: none"> .1 Expert judgment .2 Analogous estimating .3 Parametric estimating .4 Three point estimating .5 Bottom-up estimating .6 Data analysis .7 Decision making .8 meetings 	<ul style="list-style-type: none"> .1 Duration estimates .2 Basis of estimates .3 Project document updates

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Schedule Management

Project Evaluation & Review Technique (PERT)



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Schedule Management

Project Evaluation & Review Technique (PERT)

$$\text{PERT Weighted Average} = \frac{\text{Optimistic} + 4 \times \text{Most Likely} + \text{Pessimistic}}{6}$$

$$\text{PERT Standard Deviation} = \frac{\text{Pessimistic} - \text{Optimistic}}{6}$$

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Schedule Management

Distributions

- A **binomial distribution** is used whenever there are only two possible outcomes.
- A **uniform distribution** represents a scenario where each value of a random variable has an equal probability of occurrence.
- A **triangular distribution** is a continuous probability distribution that begins with a minimum value, ends with a maximum value, and makes use of a mode, or most likely value somewhere along the continuum.
- A **beta distribution** represents a distribution of probabilities when we don't know what the probability is.
- The **central limit theorem (CLT)** states that the mean of a large population of independent and random variables, each having a finite mean and variance will be normally distributed.

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Schedule Management Reserves

- **Contingency Reserves** — These represent reserves controlled by the project manager and they are to be used for know unknowns. This means the project manager and team can plan for an event that they see as possible.
- **Management Reserves** — These represent reserves controlled by the project sponsor or the senior management. They cannot be accessed without their permission. Management reserves are used to respond to unknown unknowns. These are events that cannot be planned for.

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Schedule Management Agile Estimation

- **Ideal Time** - Assumes resources 100% dedicated
- **Relative Sizing** – Often called T-Shirt sizing.
- **Story Points** – Aggregates complexity & time.
- **Fibonacci Sequence** – Another comparison technique.
- **Affinity Estimating** – Process of grouping requirements into categories or collections. Used to group similarly sized user stories together.

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Schedule Management 6.5 Develop Schedule

- Iterative.
- Determines planned start and end dates for activities and the whole project.
- Baseline for measuring progress.



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Schedule Management

CPM

- The **Critical Path** is the project path which will be the longest duration or where all activities have zero float.
- The **Critical Path** does not necessarily have the greatest risk.
- The **Critical Path** determines the earliest completion of the project.

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Schedule Management

CPM

ES	DUR	EF
Deliverable		
LS	Float	LF

- **ES** - Early Start is the earliest the task can begin.
- **Dur** - Duration is the amount of calendar time the task will take.
- **EF** - The Early Finish is the earliest the task can end.
- **LS** - The Late Start is the latest the task can begin.
- **LF** - The Late Finish is the latest the task can end.
- **Float** - The Slack, slip or float is amount of time the task can delay without impacting the project end date. Also called **Total Float**.
- **Near Critical Path** - A network path close in length to the critical path.
- **Free Float** - The amount of time a task can delay without delaying the early start date
- **Project Float** - The amount of time the project can be delayed without impacting an externally imposed completion date.

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Schedule Management

The Critical Path Method

- **EF = ES + DUR = Forward Pass**
- **LS = LF - DUR = Backward Pass**
- **Float = LF - EF or LS - ES**

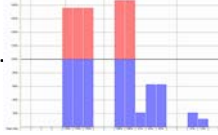
ES	DUR	EF
Deliverable		
LS	Float	LF

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Schedule Management

Resource Optimization

- After CPM.
- Redistribute resource assignments where a resource is needed on more than one task in the same time period.
- Can change the critical path.

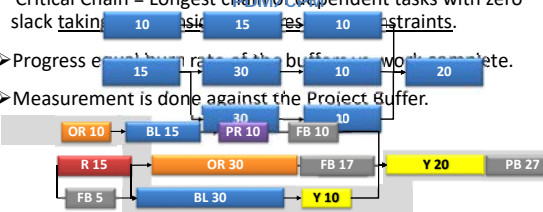


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Schedule Management

Critical Chain Method

- Critical Chain = Longest chain of dependent tasks with zero slack taking into account resource constraints.
- Progress equals burn rate of the buffer until work is complete.
- Measurement is done against the Project Buffer.



- Using CPM would take an estimated 75 units. Which is then missed by 100%.
- CCPM allows for more accurate estimates with smaller misses.

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Schedule Management

A Sample Story Map

The Backbone

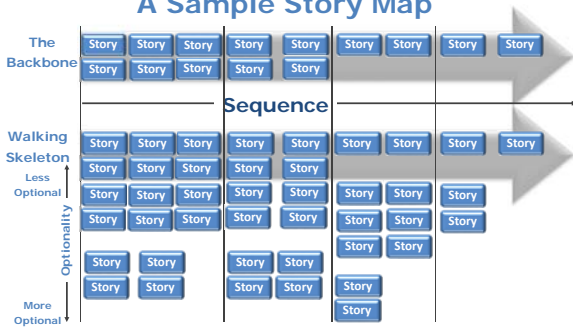
Walking Skeleton

Less Optional

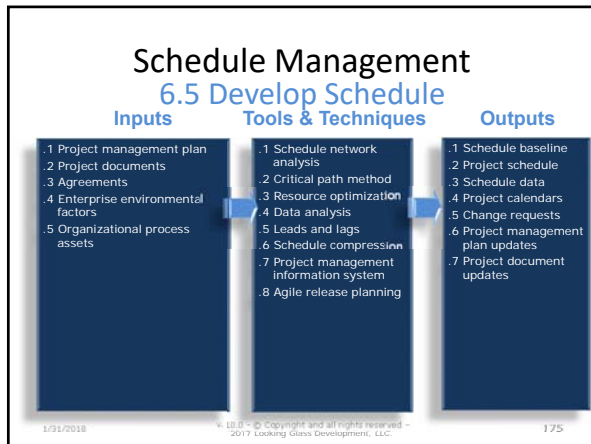
Optionality

More Optional

Sequence



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Schedule Management

Leveling vs. Smoothing

- **Resource leveling** involves adjusting the start and finish dates of tasks to prevent resources from becoming over allocated.
- **Resource smoothing** adjust the project activities so they do not exceed predefined resource limits. This is different from leveling in that smoothing does not allow the project's critical path to change and the project's completion date cannot be delayed.

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Schedule Management

Leveling vs. Smoothing

Similarities	
Resource Leveling	Resource Smoothing
A schedule network analysis technique.	A schedule network analysis technique.
A resource optimization technique.	A resource optimization technique.
Improves resource utilization.	Improves resource utilization.

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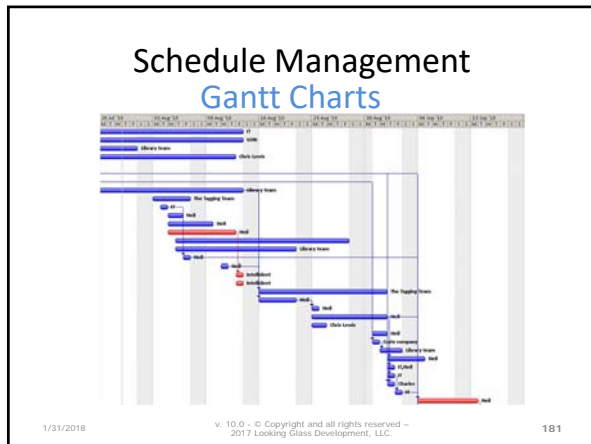
Schedule Management Leveling vs. Smoothing

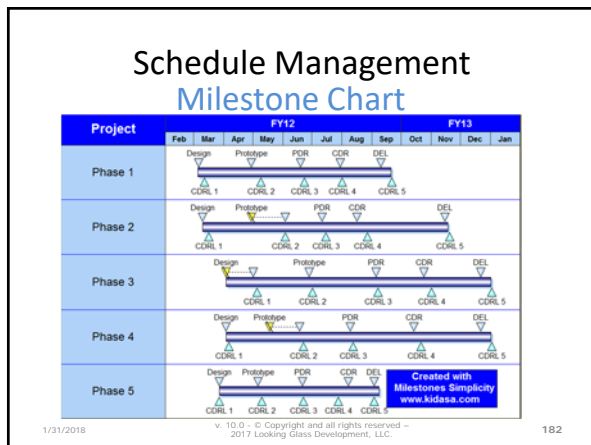
Differences	
Resource Leveling	Resource Smoothing
Aim is to adjust start and end dates of a project with resource constraints while balancing resource requirements and resource availability	Aim is to achieve optimal resource usage by avoiding peaks and valleys in the resource usage profile. Hence the name smoothing.
Used in resource-constrained scheduling.	Used in time-constrained scheduling.
Critical path of the project will be affected, and usually the length of critical path will increase.	Critical path of the project won't change.
Can be applied to resources on critical path.	Doesn't apply to resources on critical path.
Free and total float (or slack) may be used.	Free and total float (or slack) are used.
Will optimize all the resources and may change the duration of the project.	May not be able to optimize all the resources if sufficient slack (or float) isn't available, but does not change the duration of the project.
Risk: May change the critical path and hence the duration.	Risk: Loss of flexibility due to reduction in slack. Hence chances of increase in number of near-critical activities.

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- ### Schedule Management Other Terms
- **One-Point Estimate** – A single value estimate.
 - **Regression Analysis** – A graphic analysis to track if two variables are related.
 - **Heuristic** – A rule of thumb.
 - **Learning Curve** – The improvement achieved by doing an activity more than once.
 - **Monte Carlo Simulation** – A computer model which allows the analyst to simulate an activity 1,000 or more times to achieve a probability of a result.
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- ### Schedule Management Crashing vs. Fast Tracking
- **Fast Tracking** — Fast Tracking is doing dependent items in parallel. It amounts to changing a finish-to-start relationship to a start-to-start or a finish-to-finish relationship. For the exam it is important that you remember that the negative impact of Fast Tracking is the potential for rework.
 - **Crashing** — Crashing is increasing the number of hours worked. This can be done by adding resources assigned to a task, activity or deliverable or by simply working overtime. The negative impact of Crashing that must be remembered is a likely increase in costs.
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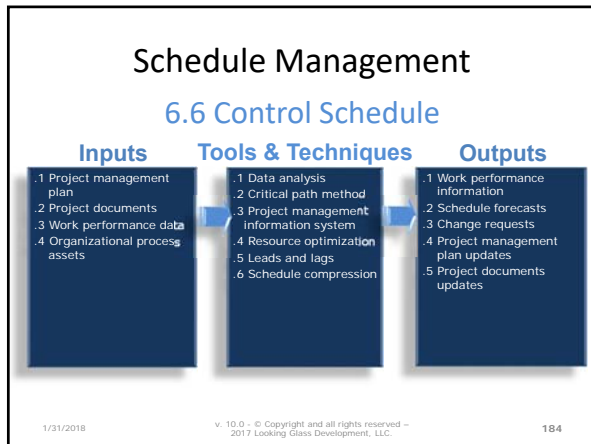




Schedule Management 6.6 Control Schedule

- Part of **Integrated Change Control**.
- Determine the current status of the project schedule.
- Influence the factors that create schedule changes.
- Determine that the project schedule has changed.
- Manage the changes as they occur.

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Schedule Management

Schedule Management – Summary

- Six (6) processes.
- PERT, GERT, PDM, CPM, CCPM.
- Crashing, fast tracking.
- Decomposition, baseline, float or slack.
- Schedule development is iterative.

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Cost Management

All the process involved in planning, estimating, budgeting, and controlling costs so that the project can be completed within the approved budget.

Monitoring and Controlling Process Group

Planning Process Group

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Cost Management

- Primarily concerned with cost of resources.
- Also concerned with
 - Life-cycle costing
 - Opportunity cost
 - Sunk costs
- The Cost Management Plan is part of overall project management plan.
 - Control thresholds
 - Earned value rules
 - Reporting formats

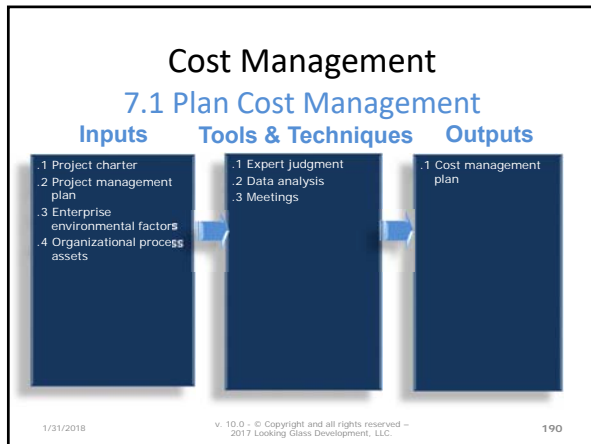
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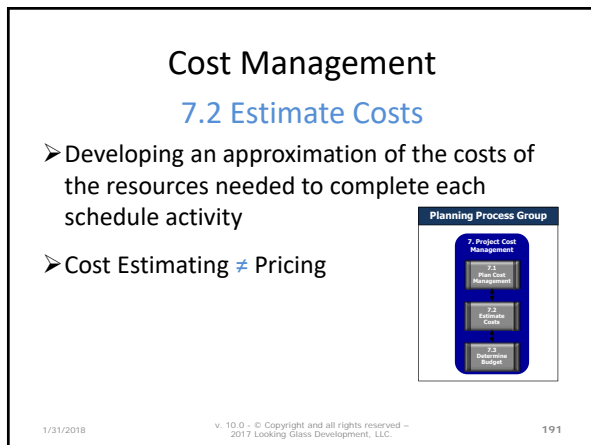
Cost Management

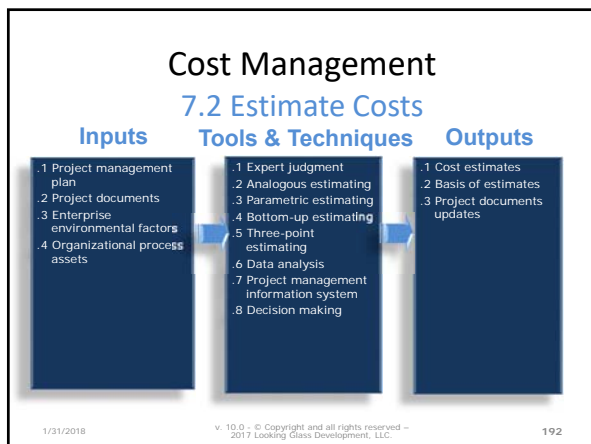
7.1 Plan Cost Management

- Defining the rules which are used to manage project costs.
- It defines how the team will manage the money.

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Cost Management

Accuracy of estimates increases as the project progresses

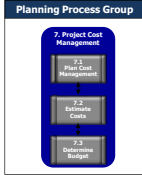
- **Rough Order of Magnitude**
-25% to +75%
- **Budget Estimate or the Budget**
-5% to +10%

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Cost Management

7.3 Determine Budget

Aggregating the cost estimates of individual activities or work packages to establish a total **Cost Baseline**.



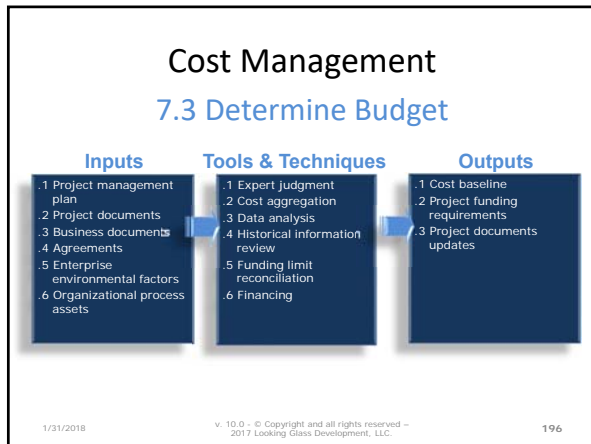
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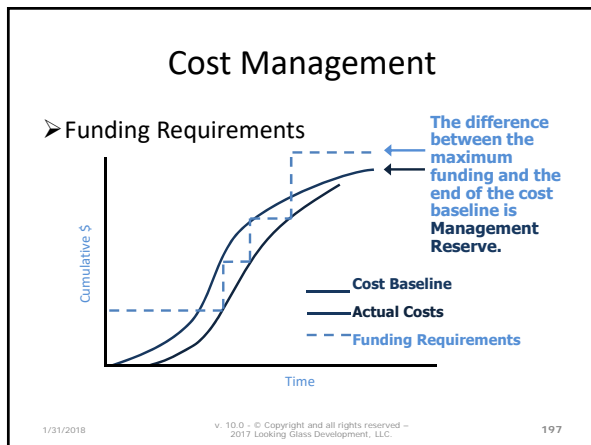
Cost Management

Accounting Terms

- **Variable Costs** – Costs that change as the units produced changes.
- **Fixed Costs** – Costs that do not change with changes to volume produced.
- **Direct Costs** – Costs that are directly attributed to project work.
- **Indirect Costs** – Items that benefit more than one project and are not attributed to a specific activity.
- **Value Analysis or Engineering** – Finding less costly ways to do the same work.

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Cost Management

Depreciation

➤ **Straight Line Depreciation** – Present value minus present cost.

$$\frac{\text{cost} - \text{residual value}}{\text{useful life}} = \text{Depreciation amt. to deduct each year till salvage value is reached}$$

➤ **Production Method** -

$$\frac{\text{cost} - \text{residual value}}{\text{estimated units of useful life (production)}} = \text{Depreciation amt. to deduct each year till salvage value is reached}$$

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Cost Management Depreciation

Double Declining Balance (DDB) – Accelerated depreciation method. Begin by dividing 100% by the term of the asset and doubling the result. Each subsequent year, that same percentage is multiplied by the remaining balance to be depreciated. Using a purchase price of \$100,000 and a residual of \$25,000 on a five (5) year schedule:

- 100% / 5 Year Term = 20%
- Double the 20% rate or 40%
- Year 1 value = \$100,000 - (\$100,000 * 40%) = \$60,000
- Year 2 value = \$60,000 - (\$60,000 * 40%) = \$36,000
- Year 3 value = \$36,000 - (\$36,000 * 40%) = \$21,600
- Since this is less than the salvage value it is \$25,000

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Cost Management Depreciation

Sum of the Years Digits (SYD) – Accelerated depreciation method. Begin by adding the number of years in the schedule. For example, for a five (5) year schedule add 1+2+3+4+5 = 15. Next, take the asset value minus the residual value and divide it by this result (15). If the salvage value is \$25,000 then:

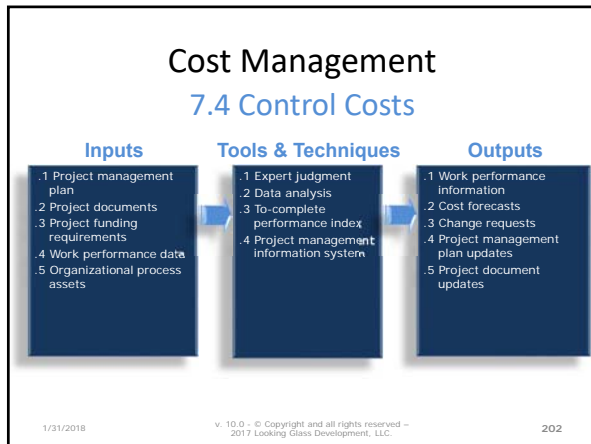
- Year 1 value = \$100,000 - (5/15 * \$75,000) = \$75,000
- Year 2 value = \$75,000 - (4/15 * \$75,000) = \$55,000
- Year 3 value = \$55,000 - (3/15 * \$75,000) = \$40,000
- Year 4 value = \$40,000 - (2/15 * \$75,000) = \$30,000
- Year 5 value = \$30,000 - (1/15 * \$75,000) = \$25,000

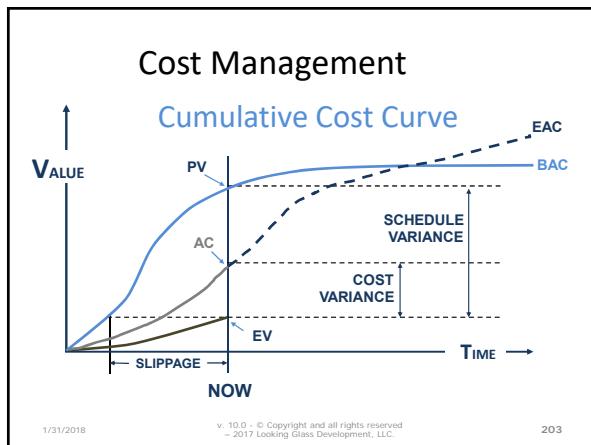
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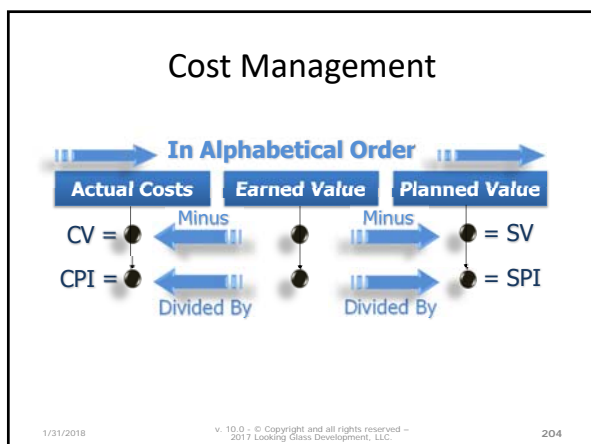
Cost Management 7.4 Control Costs

- Influencing the factors that create changes to the cost baseline.
- Ensuring requested changes are agreed upon.
- Managing the actual changes when and as they occur.
- Assuring that potential cost overruns do not exceed the authorized funding periodically and in total for the project.

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Cost Management Forecasting - ETC


- ETC based on new estimate.
- ETC based on atypical variances.
 $ETC = BAC - EV$
- ETC based on typical variances.
 $ETC = (BAC - EV) / CPI$
- ETC based on both the CPI & SPI.
 $ETC = (BAC - EV) / (CPI * SPI)$

BAC = Budget at Completion
 BAC - EV = Remaining Work
 VAC = Variance at Completion
 CPI * SPI = Critical Ratio

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Cost Management Forecasting - EAC

- Using a new estimate
– $EAC = AC + ETC$
- Using remaining budget
– $EAC = AC + (BAC - EV)$
- Using CPI
– $EAC = AC + ((BAC - EV) / CPI)$
- Using both CPI & SPI
– $EAC = AC + ((BAC - EV) / (CPI * SPI))$



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Cost Management Forecasting - TCPI

- The calculated projection of cost performance that must be achieved on the remaining work to meet a specified management goal.
- Using BAC
– $TCPI = (BAC - EV) / (BAC - AC)$
- Using EAC
– $TCPI = (BAC - EV) / (EAC - AC)$
- $VAC = BAC - EAC$

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Cost Management
Earned Schedule Theory

- Provides formulas for forecasting the project completion date, using the earned schedule, actual time and estimated duration.
- **Schedule at Completion (SAC)** — This is the original planned completion duration of the project.
- **Earned Schedule (ES)** — The duration from the beginning of the project to the date the planned value is supposed to equal to the BAC.
- **Actual Time (AT)** — This is the duration from the beginning of the project to status date.

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Cost Management
Earned Schedule Theory

- **Time variance or (TV)** — A measure of schedule performance in time units rather than cost units and is defined by the formula:
$$TV = ES - AT$$
- **Time Estimate at Completion (TEAC)** — The forecast of time at completion and is similar to EAC. It uses the same basic formulas as EAC but replaces cost with schedule.

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Cost Management
Earned Schedule Theory

- **Time Variance at Completion (TVAC)** — The estimated amount of time either ahead or behind schedule the project is. It uses the following formula:
$$TVAC = SAC - TEAC$$

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Cost Management

Cost Management – Summary

- Four (4) processes.
- Earned value concepts and calculations.
- Life cycle costing.
- Cost baseline.
- Estimating vs. budgeting.
- Types of estimates and estimating.
- Contingency and management reserve.

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Project Quality Management

Quality Management

All the activities of the performing organization that determine quality policies, objectives, and responsibilities so that the project will satisfy the needs for which it was undertaken.

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Quality Management

Key Terms

- Project Quality Management must address the management of the project & product.
- **Quality** - "the degree to which a set of inherent characteristics fulfill requirements." (American Society for Quality, 2000)
- **Gold Plating** – Giving the customer extra functionality, adds no value to the project; PMI argues against gold plating.
- **Marginal Analysis** – Finding the point where the cost of the incremental improvement in quality equals the value of the improvement.

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Quality Management

- International Organization for Standardization (ISO)
- Total Quality Management (TQM)
- Six Sigma
- Kaizen
- Quality vs. Grade
- Precision vs. Accuracy
- PDCA

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Quality Management

Thought Leaders


- **W.E. Deming:** (PDCA), Quality = results of work efforts / total costs
- **J.M. Juran:** quality planning, control & improvement. People are cause. Fitness for Use
- **P. Crosby:** Quality is Free, 0 Defects Conforming to Rqmts, Doing It Right the First Time" (DIRFT)
- **K. Ishikawa:** Cause-Effect (Fishbone) Diagram, Design Statistics, introduced quality circles
- **G. Taguchi:** Quality as part of the Design, not Inspection, Taguchi Method.

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Quality Management

8.1 Plan Quality

- Identifying which quality standards are relevant to the project, and determining how to satisfy them.
- Performed in parallel with other planning processes.
- Quality is planned, designed, and built in, not inspected in.



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Quality Management

8.1 Plan Quality Management

Inputs

- .1 Project charter
- .2 Project management plan
- .3 Project documents
- .4 Enterprise environmental factors
- .5 Organizational process assets

Tools & Techniques

- .1 Expert judgment
- .2 Data gathering
- .3 Data analysis
- .4 Decision making
- .5 Data representation
- .6 Test and inspection planning
- .7 Meetings

Outputs

- .1 Quality management plan
- .2 Quality metrics
- .3 Project management plan updates
- .4 Project documents updates

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Quality Management

Cost of Quality

Conformance		Nonconformance	
Prevention	Planning	Scrap	Failure
Appraisal	Training	Rework	
	Auditing	Expediting	
	Testing	Warranty Service	
	Controlling	Recalls	

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Quality Management

Flowcharts

Shape	Name	Description
	Flowline	Shows the process order of operations. Arrows do an odd job if the flow is not the standard top-to-bottom, or left-to-right.
	Terminal	A terminal is the beginning or ending of a program or sub-process. A terminal typically contains the word "Start" or "End" to signify where it is.
	Decision	A decision is a conditional operation where one of two (or more) paths. The operation is typically a yes/no or true/false question.
	Input / Output	This is the input or output of data. For example, it can be entering data or displaying results.
	Annotation	An annotation provides a additional information about a step in the program. It is represented as an open rectangle with a dashed or solid line connecting it to the corresponding symbol on the flowchart.
	Predefined Process	A predefined process is one that is defined elsewhere. It is represented by a rectangle with double-stroke vertical edges.
	On-Page Connector	An on-page connector replaces long or confusing lines on a flowchart with a small circle with a letter inside.
	Off-Page Connector	An off-page connector is used when the target is on another page. It is represented by a hexagon-shaped pentagon.

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Quality Management

Flowcharts

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Quality Management

SIPOC

- Sometimes called COPIS.
- Tool that summarizes the inputs and outputs of one or more processes in table form.
- Acronym SIPOC stands for suppliers, inputs, process, outputs, and customers which form the columns of the table.
- First used in TQM programs.
- Used today in Six Sigma and Lean manufacturing.

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Quality Management

SIPOC Steps

1. Create an area that will allow the team to post additions to the SIPOC diagram. This could be a transparency (to be projected by an overhead) made of the provided template, flip charts with headings (S-I-P-O-C) written on each, or headings written on post-it notes posted to a wall.
2. Begin with the process. Map it in four to five high level steps.
3. Identify the outputs of this process.
4. Identify the customers that will receive the outputs of this process.
5. Identify the inputs required for the process to function properly.
6. Identify the suppliers of the inputs that are required by the process.
7. Optional: Identify the preliminary requirements of the customers. This will be verified during a later step of the Six Sigma measurement phase.
8. Discuss with project sponsor, Champion, and other involved stakeholders for verification.

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Quality Management

SIPOC

The diagram illustrates the SIPOC process flow. It consists of five main components in blue boxes: Supplier, Input, Process, Output, and Customer, connected by arrows. Below the Process and Customer boxes are two feedback loops labeled 'Requirements & Feedback Loop'. Underneath each of these loops are two lists: 'Requirements List' and 'Measurements List', each with five blank lines for notes.

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Quality Management

Logical Data Model

- A logical data model is also referred to as a logical schema.
- It is a data model of a specific problem domain that is expressed independently of any specific named database product or storage technology.
- It focuses on the foundational data structure and its elements such as relational tables, columns, object-oriented classes and/or XML tags.
- It represents the abstract structure of a domain of information.
- A logical data model is most often used in business process seeking to capture the important aspects of the organization and how they relate to one another.
- The logical data model is the basis for the physical data model.
- It is sometimes used as a synonym for a domain model, but the two are not the same. A domain model is more focused on capturing the concepts in the problem domain rather than the structure of the data associated with that domain.

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Quality Management

Matrix Diagram Symbols

⊙ Strong relationship

○ Moderate relationship

△ Weak or potential relationship

S Supplier

C Customer

D Doer

O Owner

+ Positive relationship

○ Neutral relationship

- Negative relationship

↑ Item on left influences item at top

→ Item at top influences item on left. The arrows usually are placed next to another symbol indicating the strength of the relationship

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Quality Management

Sample Matrix Diagrams

	Customer A	Customer B	Customer C	Customer D
Measure #1	15	22	19	12
Measure #2	95	105	125	97
Measure #3	29	36	27	56
Measure #4	41	58	36	61

L-Shaped Matrix

Y-Shaped Matrix

⊙ Primary relationship
 ○ Secondary relationship
 △ Weak relationship

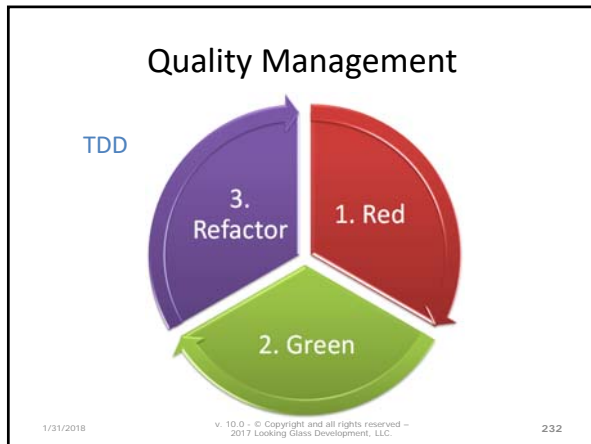
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Quality Management

Test Driven Development (TDD)

- Tests are written **BEFORE** the code.
- A Unit Test is a test of a small, functional piece of code.
- Unit Tests are given priority in TDD.
- Unit tests make it...
 - Easier to find bugs.
 - Easier to maintain the code, but not test maintainability or test readability.
 - Easier to have full code coverage.
 - Easier to design & develop code.
 - Easier to deliver early & often.
 - Easier to track performance.

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Quality Management

Test Driven Development (TDD)

- Must be able to make it fail. No code can be written without a failing test. This mean we actually run the tests to ensure the failure state before writing any code.
- Running the test to prove failure is a fundamental difference of TDD.
- Make it work. Code must be as simple as possible. The code must ONLY pass that new test for which it was designed.
- Make it better. This means you must refactor.

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Quality Management

Acceptance Test-Driven Development

- Also called ATDD
- Moves testing focus from code to business requirements.
- Tests created before coding.
- Might use functional test framework such as FIT (Framework for Integrated Testing) or FitNesse

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Quality Management

Acceptance Test-Driven Development

- Four stages:
 - Discuss the requirements – during planning meeting ask acceptance criteria.
 - Distill tests in a framework-friendly format
 - Develop the code and hook up the tests
 - Demo through exploratory testing
- Regardless of method team must think about how the system will be tested before coding.

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Quality Management

Refactoring

- Refactoring – Process of changing existing code to improve the way it functions.
- In XP you are not afraid of refactoring.
- Refactoring is part of your regular work & not a separate task.

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Quality Management

Types of Refactoring

- Yuck – You look at code and it works, but is unsatisfactory. This is about making small improvements.
- The Not Understood – Code that you look at and cannot understand what it is doing. You must make code easier to understand.
- New Insights – When new functionality needs to be added, or you learn something.

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Quality Management
Types of Refactoring

- **Planned Refactoring** – Actually adding refactoring to your project plan as a deliverable.
 - M. Fowler says it should hardly ever be done, because it represents a failure of the team to do the refactoring in small enough pieces to be constant.
 - Planned refactoring almost always requires justification.
 - Is evidence that you are not doing enough of the other types of refactoring.

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Quality Management
Types of Refactoring

- **Long Term Refactoring** – Trying to get closer to some large future goal. Get some vision of where you want things to be in the future.
 - Must be done gradually.
 - Does not require significant planning.
 - The essence is doing small steps.

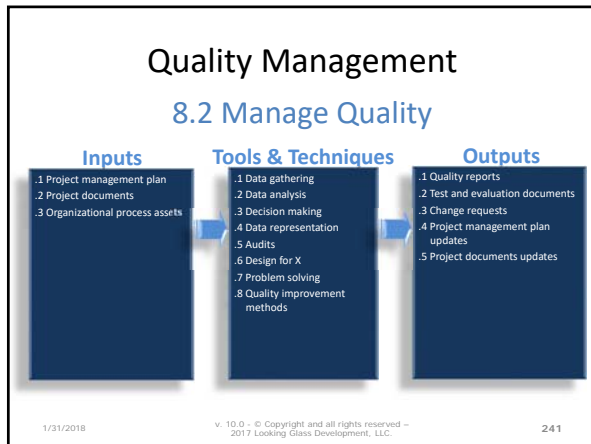
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Quality Management
8.2 Manage Quality

- Answers the question are we following the right standards. e.g. if we follow these standards what will the results be?
- Provides an umbrella for Continuous Improvement . . .
- Completed during execution.



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Quality Management

Root Cause Analysis

- **A Root Cause** is - if removing the item from the problem-fault sequence prevents the final undesirable outcome from occurring then the item is considered a root cause.
- **A Causal Factor** - Removing a causal factor can benefit the outcome, but it does not prevent its recurrence with certainty.

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Quality Management

Root Cause Analysis

- Define and properly describe the event or problem.
- Establish a timeline from the normal situation until the failure.
- Distinguish between root causes and causal factors.
- The team then focuses on problem prediction to determine when the problem will happen next and what must happen to prevent future occurrence.

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Quality Management

Affinity Diagrams

- An affinity diagram is one of the “Seven Management and Planning Tools”.
- Created by Jiro Kawakita in the 1960s.
- Sometimes referred to as the KJ Method.
- Used to sort a large number of ideas created during brainstorming based on their natural relationships for review and analysis.

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Quality Management

Affinity Diagrams Steps

1. Record each idea on card or PostIts™.
2. Look for ideas that seem related.
3. Sort the cards into groups until all the cards have been used.
4. Once the cards are sorted create clusters or subgroups for easier analysis.

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Affinity Diagrams

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