

PMP® Exam Prep Boot Camp

Version 2.0 - Student

Based on the PMBOK Guide, 4th Edition



EdWel is Different!

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This publication PMP® Exam Prep Boot Camp was created by Richard J Perrin Project Engineering Corp in cooperation with Evolutionen Skillware

Release 2.6 0612

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ACKNOWLEDGEMENTS

To Umbrella Editing and Emily R. Asher for a ruthless edit of this manuscript!

To my wife Frances, who put up with all the late hours as I burned the midnight oil to get this done. You are a true believer.

Notice:

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All Inputs, Tools and Techniques and Outputs listed in this manual are from the *PMBOK® Guide*, 4th edition.

Table of Contents

Conventions Used in This Study Guide	x
About the Author.....	x
How to Use This Guide – READ THIS FIRST!!	xi
Chapter 1 : PMP® Examination Overview	1-1
Section Objectives	1-1
PMP® Examination Overview	1-2
Examination Question Types	1-3
Preparing for the Exam.....	1-4
Useful Exam Tips.....	1-5
Maintaining the PMP Certification.....	1-7
In Summary.....	1-7
Chapter 2 : Project Life cycle and Organization	2-1
Project Management Life Cycle and Standard for Management of a Project	2-1
Section Objectives	2-1
Definition of Project Management.....	2-2
Project Constraints	2-2
The Project Manager's Role.....	2-3
What Is a Project?.....	2-4
What Are Programs, Portfolios and Sub-Projects?.....	2-5
The PMO	2-6
The Project Life Cycle.....	2-6
Phase-to-Phase Relationships	2-7
The Project Life cycle Versus the Project Management Life cycle	2-9
Defining the Product Life Cycle	2-10
Understanding Stakeholder Needs.....	2-11
Organizational Influences	2-12
Functional Organizations.....	2-13
Functional Advantages and Disadvantages.....	2-13
The Matrixed Organization.....	2-14
Matrixed Advantages and Disadvantages	2-14
Projectized Organizations.....	2-16
Projectized Advantages and Disadvantages.....	2-16
What Is Your Organizational Structure?	2-17
MBO, OPM3™ and Progressive Elaboration.....	2-17
Section Review:	2-18
Chapter Two Memory Check.....	2-19
Chapter 2 Test	2-20
Chapter 2 Test Answers.....	2-24
Chapter 3 Project Management Processes and Knowledge Areas	3-1
Section Objectives	3-1
The Project Management Process Groups	3-2
Initiating Process Group	3-3
Planning Process Group.....	3-4
Executing Process Group	3-6

Monitoring and Controlling Process Group.....	3-6
Closing Process Group	3-8
Cross-Cutting Skills	3-9
Knowledge Area Logistics	3-10
Project Integration Management.....	3-10
Project Scope Management	3-11
Project Time Management.....	3-12
Project Cost Management.....	3-12
Project Quality Management	3-13
Project Human Resource Management	3-13
Project Communications Management.....	3-14
Project Risk Management.....	3-14
Project Procurement Management.....	3-15
Mapping Knowledge Areas to Process Groups	3-16
Understanding Process Interactions.....	3-17
In Summary.....	3-19
Chapter Three Memory Check	3-20
Chapter 3 Test	3-21
Chapter 3 – Test Answers	3-26
Chapter 4 : Project Integration Management	4-1
Section Objectives	4-1
Integration Process Summary	4-2
Project Integration Management.....	4-2
Develop the Project Charter.....	4-3
Charter Elements	4-3
Project Statement of Work.....	4-4
Enterprise Environmental Factors	4-5
Organizational Process Assets	4-5
Project Selection Methods	4-6
The Murder Board	4-6
Weighted Scoring Models	4-7
Computing Present Value and Net Present Value.....	4-7
Future Value	4-7
Internal Rate of Return (IRR)	4-7
Payback Period	4-8
Benefit Cost Ratio	4-8
Opportunity Costs.....	4-8
Project Cost Selection Methods: Quick Quiz	4-9
Constrained Optimization Methods	4-9
Project Selection Summary	4-10
Additional Financial Terms	4-10
Develop the Project Management Plan	4-11
Project Management Plan Defined	4-11
Why the Project Management Plan Is Needed	4-12
Project Management Plan Components	4-13
Baselining the Project Management Plan	4-14
Configuration Management	4-14
Project Management Information System (PMIS)	4-15

Project Kickoff Meeting	4-16
Direct and Manage Project Execution	4-17
Project Execution Actions	4-17
Monitor and Control Project Work	4-18
Corrective Action	4-19
Perform Integrated Change Control	4-19
Change Requests	4-20
Who Authorizes Changes? Quick Quiz	4-21
Close Project or Phase	4-21
Administrative Closure Activities	4-22
Contract Closure	4-22
Lessons Learned	4-23
Project Integration Management – Key Process Interactions	4-24
In Summary	4-24
Chapter Four Memory Check	4-25
Chapter 4 Test	4-26
Chapter 4 Test – Answers	4-31
Chapter 5 : Project Scope Management	5-1
Section Objectives	5-1
Scope Process Summary	5-2
What is Scope Management?	5-2
Scope Baseline	5-2
Scope Management	5-3
Collect Requirements	5-4
Requirements Management Plan	5-4
Requirements Collection Tools	5-5
Requirements Traceability Matrix	5-6
Define Scope	5-7
Scope Statement	5-8
Create WBS	5-9
WBS Defined	5-9
WBS Benefits	5-10
WBS Dictionary	5-10
Verify Scope	5-13
When Scope Verification Occurs	5-13
Control Scope	5-14
Scope Control Methods	5-15
Project Scope Management: Key Process Interactions	5-16
Summary	5-16
Chapter Five Memory Check	5-17
Chapter 5 – Test	5-18
Chapter 5 Test – Answers	5-23
Chapter 6 : Project Time Management	6-1
Section Objectives	6-1
Project Time Management Process Summary	6-2
Time Management	6-2
Define Activities	6-3
Sequence Activities	6-3

Network Diagrams.....	6-4
Precedence Relationships.....	6-4
Activity on Arrow	6-5
GERT	6-6
Network Dependency Types.....	6-6
Milestones	6-7
Leads and Lags.....	6-7
Estimate Activity Resources	6-8
Estimate Activity Durations	6-9
Duration Estimating Types	6-10
Accuracy of Estimating Methods.....	6-11
Statistics for the Exam	6-11
PERT Calculation	6-13
Develop Schedule	6-14
Slack and Float.....	6-15
Critical Path Definition.....	6-16
Critical Path: Quick Quiz	6-16
Critical Path Solution	6-17
Network Diagram Setup	6-18
Computing the Forward Pass	6-19
Computing the Backward Pass	6-20
Computing Float and Slack	6-21
Schedule Compression Techniques	6-21
Scheduling Techniques	6-23
Monte Carlo Analysis.....	6-23
Critical Chain Method	6-24
Resource Leveling	6-25
Bar Charts	6-26
Milestone Charts	6-27
Control Schedule	6-27
PDM Exercises	6-28
Project Time Management: Key Process Interactions.....	6-30
In Summary.....	6-30
Chapter Six Memory Check	6-31
Chapter 6 Test	6-32
Chapter 6 Test – Answers	6-37
Chapter 7 : Project Cost Management.....	7-1
Project Cost Management Process Summary	7-2
Cost Management	7-2
Estimate Costs	7-3
Cost Types.....	7-5
Cost Estimating Tools	7-5
Analogous Estimating	7-5
Bottom-Up Estimate.....	7-6
Parametric Estimating	7-7
Estimate Types.....	7-7
Determine Budget	7-8
Control Costs	7-9

Earned Value Definitions	7-10
Earned Value Formulas.....	7-10
Earned Value Accrual – Progress Reporting	7-13
Performance Reviews and Variance Analysis.....	7-14
Earned Value Practice Exercises	7-14
Project Cost Management: Key Process Interactions	7-16
Summary.....	7-16
Chapter Seven Memory Check.....	7-17
Chapter 7 Test	7-18
Chapter 7 Test – Answers	7-22
Chapter 8 : Project Quality Management	8-1
Section Objectives	8-1
Project Quality Management Process Summary.....	8-2
Quality Overview	8-2
<i>PMBOK® Guide, 4th edition ISO Certification</i>	8-3
Project Quality Management	8-3
Plan Quality.....	8-4
Quality Planning Tools.....	8-4
Cost-Benefit Analysis	8-5
Benchmarking.....	8-5
Control Charts and Statistical Sampling	8-6
SPC (Statistical Process Control) Chart Example	8-6
Design of Experiments (DOE)	8-7
Cost of Quality	8-7
Additional Quality Planning Tools	8-9
Quality Management Concepts.....	8-9
Zero Defects.....	8-10
Fitness for Use	8-10
W. Edwards Deming	8-11
Kaizen	8-12
Six Sigma	8-12
Quality Philosophies	8-13
CMMI	8-14
Perform Quality Assurance.....	8-14
Quality Audit.....	8-15
Perform Quality Control	8-15
Additional Statistical Terms	8-16
Variable and Attribute Sampling	8-17
Ishikawa Diagram	8-18
Statistical Process Control	8-19
Stability Analysis/Zone Test.....	8-19
Flowchart	8-20
Pareto Chart.....	8-21
Run Chart	8-21
Scatter Diagram	8-22
Project Quality Management: Key Process Interactions	8-23
In Summary.....	8-23
Chapter Eight Memory Check.....	8-24

Chapter 8 Test	8-25
Chapter 8 Test – Answers	8-29
Chapter 9 : Project Human Resource Management.....	9-1
Section Objectives	9-1
Project Human Resource Management Process Summary.....	9-2
Project Human Resource Management	9-2
Human Resource Roles.....	9-2
Develop Human Resource Plan	9-4
HR Enterprise Environmental Factors & Organizational Process Assets.....	9-5
Roles and Responsibilities	9-5
Staffing Management Plan	9-6
Acquire Project Team	9-7
Develop Project Team	9-8
Project Manager Authority.....	9-8
The Tuckman Model.....	9-9
Motivational Theories	9-10
Maslow's Hierarchy of Needs	9-11
Herzberg's Hygiene Theory.....	9-11
Expectancy Theory.....	9-12
Achievement Theory	9-13
Leadership Theories	9-14
Theory X and Y	9-15
Theory Z.....	9-15
Situational Leadership	9-16
Manage Project Team.....	9-16
Conflict Management	9-17
Causes of Conflict	9-18
Conflict Resolution Methods	9-18
Project Human Resource Management: Key Process Interactions	9-20
In Summary.....	9-20
Chapter Nine Memory Check	9-21
Chapter Nine Test.....	9-22
Chapter 9 Test – Answers	9-27
Chapter 10 : Project Communications Management.....	10-28
Section Objectives	10-28
Project Communications Management Process Summary	10-2
Project Communications Management.....	10-2
Identify Stakeholders.....	10-3
Stakeholder Analysis.....	10-3
Power/Interest Grid.....	10-4
Stakeholder Register	10-5
Stakeholder Management Strategy.....	10-6
Plan Communications.....	10-7
Communications Management Plan	10-7
Communication Sender-Receiver Model	10-8
Communication Hierarchies	10-9
Meetings: Best Practices	10-10
Project Manager Communication	10-10

Distribute Information.....	10-11
Communications Barriers/Enhancers.....	10-11
Types of Communication.....	10-12
Communication Situations	10-13
Manage Stakeholder Expectations.....	10-13
Communication Methods.....	10-14
Interpersonal and Management Skills.....	10-14
Issue Logs.....	10-15
Report Performance	10-16
Variance Analysis.....	10-16
Forecasting Methods.....	10-17
Project Communications Management: Key Process Interactions	10-18
In Summary.....	10-18
Chapter Ten Memory Check.....	10-19
Chapter 10 Test	10-20
Chapter 10 – Answers.....	10-24
Chapter 11 : Project Risk Management.....	11-1
Section Objectives	11-1
Project Risk Management Process Summary.....	11-2
Risk Management Overview.....	11-2
Project Risk Management.....	11-3
Plan Risk Management	11-4
The Risk Management Plan	11-4
Risk Breakdown Structure	11-5
Categories of Risk	11-6
Identify Risks.....	11-6
Risk Information Gathering Techniques	11-7
Brainstorming and Delphi.....	11-7
Root Cause Analysis (RCA) and Expert Interviewing	11-8
SWOT Analysis	11-9
The Risk Register.....	11-9
Perform Qualitative Risk Analysis.....	11-10
Qualitative Risk Assessment Matrix	11-11
Risk Register Updates	11-11
Perform Quantitative Risk Analysis	11-12
Failure Modes Effects Analysis (FMEA)	11-13
Expected Value/ Expected Monetary Value.....	11-14
Monte Carlo Analysis.....	11-15
Decision Tree Analysis	11-15
Plan Risk Responses.....	11-17
Risk Response Strategies	11-18
Contingency Plans	11-19
Residual and Secondary Risks.....	11-19
Contingency and Management Reserve	11-20
Risk Register Updates	11-20
Monitor and Control Risks.....	11-22
Risk Audits and Reviews	11-22
Additional Risk Tools	11-23

Workarounds.....	11-24
Project Risk Management: Key Process Interactions	11-25
In Summary.....	11-25
Chapter Eleven Memory Check	11-26
Chapter 11 Test	11-27
Chapter 11 Test – Answers.....	11-31
Chapter 12 : Project Procurement Management.....	12-1
Section Objectives	12-1
Project Procurement Management Process Summary	12-2
Project Procurement Management.....	12-2
Procurement for the <i>Exam</i>	12-3
Required Contract Elements.....	12-3
Project Manager’s Role in Procurement	12-3
Centralized/Decentralized Contracting	12-4
Plan Procurements	12-5
Perform Make or Buy Analysis	12-6
Procurement Statement of Work.....	12-6
Contract Types and Risk Assessment	12-7
Point of Total Assumption	12-9
Fixed Price Plus Incentive – PTA	12-10
Unit Price and Time & Materials Contracts	12-10
Standard Procurement Documents.....	12-11
Additional Terms	12-12
Non-Competitive Forms of Procurement.....	12-13
Conduct Procurements.....	12-14
Vendor Evaluation Criteria	12-14
Bidder Conferences	12-15
Qualified Sellers Lists.....	12-15
Review Seller Proposals.....	12-15
Contract Negotiations and Tactics.....	12-16
Administer Procurements.....	12-17
Contract Administration	12-17
Contract Change Control System.....	12-18
Contract Monitoring	12-19
Close Procurements.....	12-20
Closure Activities	12-20
Project Procurement Management: Key Process Interactions	12-21
In Summary.....	12-21
Chapter Twelve Memory Check	12-22
Chapter 12 Test	12-23
Chapter 12 Test – Answers.....	12-27
Chapter 13 : Professional and Social Responsibility.....	13-1
The PMI Code of Ethics and Professional Conduct.....	13-2
The Code of Ethics – Four Areas.....	13-2
Responsibility.....	13-2
Respect	13-3
Fairness.....	13-4
Honesty.....	13-5

Contribute to the PM Body of Knowledge	13-6
Chapter 14 : Exercise Answers	14-1
PDM Exercise Answers	14-2
Earned Value Exercise Answers.....	14-5
Chapter 15 - Memory Check Answers.....	15-1
Chapter 2 Memory Check Answers	15-2
Chapter 3 Memory Check Answers	15-3
Chapter 4 Memory Check Answers	15-4
Chapter 5 Memory Check Answers	15-5
Chapter 6 Memory Check Answers	15-6
Chapter 7 Memory Check Answers	15-7
Chapter 8 Memory Check Answers	15-8
Chapter 9 Memory Check Answers	15-9
Chapter 10 Memory Check Answers	15-10
Chapter 11 Memory Check Answers	15-11
Chapter 12 Memory Check Answers	15-12

Conventions Used in This Study Guide

- **Exam Tip** - pay particular attention to these exam tips. They outline critical elements you need to know to help you be successful on the exam
- **Brain Dump** - every time you see the following symbol on a manual page or next to a formula, it indicates a formula that you need to memorize for specific questions on the exam:



- This guide focuses on the elements needed to pass the exam. As such, it is not a 'how to' guide. There are plenty of books on project management and its specialties upon which the reader can avail themselves. That being said, this guide contains a number of footnoted references that may be very useful to the project practitioner and are strongly recommended for further study after the reader has passed the PMP exam(!)

About the Author

Richard Perrin (PMP, CSM, CSP, PMI-ACP, MBB) has worked in the aerospace, finance/brokerage, healthcare, energy, telecommunications, insurance industries and state/federal government for over 30 years. His efforts as a Director of Development for a telco startup helped his company garner the IEC Infovision Award for most innovative AIN product in 1998.

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How to Use This Guide – READ THIS FIRST!!

Using this guide correctly will help insure you pass the PMP exam on your first attempt. Do the following:

- Review each chapter thoroughly. Then read through the corresponding chapter in the *PMBOK® Guide*. **Pay particular attention to the outputs for each Knowledge Area and the processes that feed into each Knowledge Area. Memorize all Exam Tips and Critical Notes.**
- Take the chapter quiz, marking your answers on a separate sheet of paper. If you scored better than 80% you have a good grasp of the material. If not, mark the chapter for review on your second pass through the manual.
- Go through the remaining chapters using the same approach. When you have completed the guide you will then review the chapters in which you scored below 80%
- Retake the chapter quizzes in which you scored below 80%.
- When you have passed all quizzes at the 80% level, take the post-test; it is a full blown PMP exam simulation. Give yourself 4 hours to take the sim – if you score better than 80%, you are ready to sit for the exam.
- If you score less than 80%, call the test center where you will be sitting for the exam and reschedule the test! You can do so for up to 48 hours prior to the exam without forfeiting the exam fee.
- If you need additional testing material, sign up for practice tests at:
<http://iwebprep.com/Default.aspx>

Chapter 1 : PMP® Examination Overview

Section Objectives

- Exam Questions
- Exam-Taking Tips
- Maintaining the *PMP®* Certification

Exam Overview

	PMP	PMP %
Initiating	26	13%
Planning	48	24%
Executing	60	30%
Monitoring and Controlling	50	25%
Closing	16	8%
Total	200	100.0%
Passing		
Time Limit	4 hours	

PMP® Examination Overview

- ▶ The PMI certification examination consists of 200 multiple-choice questions, each question consisting of only four possible answers. The questions that you will see on your specific exam are selected from a bank of over 13,000 questions. There is no way to predetermine what the specific selection mix of questions will be.
- ▶ Unlike the GMAT, The PMI exam is non-adaptive. You may select questions for review and move on to other questions, returning to those questions that gave you difficulty, without penalty.
- ▶ The PMI examination is four hours and once begun, the clock will tick until four hours are complete, or the test taker submits the exam for grading prior to the completion of four hours.
- ▶ Make sure you answer all questions - no credit will be given for unanswered questions. In this case an unanswered question is the same as an incorrect answer.
- ▶ There are 25 'pretest' questions on the exam that carry no credit. You are only graded on 175 questions out of the 200 questions presented; however you will not know which questions are experimental and which questions you are being graded on.
- ▶ As of this writing there is no definitive passing score for the exam - for each of the sections outlined above you will be graded either a) Proficient, b) Moderately Proficient, or c) Below Proficient. According to the PMI Certification Department, the following is In effect:
 - ▶ "There are not a minimum or maximum number of domains or chapters in which candidate needs to demonstrate proficiency in order to pass the exam. The pass/fail rate is determined based on overall performance, not on how many questions were answered right or wrong in a particular domain or chapter. Each of the domains or chapters has a different number of questions within them that are relative to each other but not equal to each other. That means it is possible to score *Below Proficiency* in one of the domains and yet still pass the examination. It all depends on how many items were present in the domains that were failed."¹

¹ Helen Welsh, Certification Department, Project Management Institute

Examination Question Types

Questions on the *PMP®* certification exam are designed to test your analytical abilities, application experience, and general project management knowledge. The types of questions you will see on the exam will fall into the following general categories:

- **Situational:** A scenario or situation will be presented to you in which you must analyze the question and choose the best answer based on your experience, analysis, and knowledge. Many test takers state that the predominant percentages of questions on the exam are situational.
- **More than one right answer:** Frequently, a test question will have two or more correct answers; however there will always be one answer that is more correct than the others. In this situation it is usually simple to eliminate at least two of the answers. Focus your attention on what the project manager needs to do next.
- **Extraneous information:** PMI is famous for the wordy multi-paragraph question, loaded with misdirection (red herrings) and nonessential information that has nothing to do with the actual question. When encountering such questions for the first time, read the answer set and the final paragraph first - this is usually the place where the actual question is contained.
- **Something you never heard of:** Don't be surprised to see a question containing something you have never seen before. The field of project management changes on a daily basis and the tools and techniques used by the project manager are expanding seemingly at a geometric rate. Take your best guess and move on.
- **Mathematical:** Expect to see anywhere from 5 to 10 questions involving formula computations. Earned value, PERT or questions involving standard deviation are typical computation questions.
- **Diagrams:** You may be asked to interpret a graph or construct a precedence diagram from instructions. On the computer at the test center, there may be a button on the screen that you can push that will bring up a graphic or some other diagram. Take advantage of all information provided.
- **Correct answer to a different question:** You will sometimes see answers that may be correct statements by themselves, but do not answer the question.
- **A new approach to a known topic:** You will frequently see questions that will present a different point of view or skew to a known topic. These questions will test concepts but using language that is different from what you studied for the exam. Thus it is critical that the concepts be understood ahead of simple rote memorization of project management knowledge.
- **Double negatives:** A number of questions are designed to be deliberately confusing ("which of the following would NOT be the least likely choice to make..."), which is another way of saying; "what would be your most likely choice".
- **Recall:** There will be a few fairly short questions that test your inventory of certain project management facts and knowledge areas.

Critical Note: Make sure you do a careful and thorough read of each question - many of the answers to exam questions turn on a single word. If you skim over or miss that key word, you will get the question wrong. *Read all questions carefully*. Answer what is asked!

Preparing for the Exam

PMP® exam is four hours and 200 questions - this means that you have approximately 1 minute and 12 seconds to answer each question. In order to ensure an optimal testing experience there are specific stress relievers you can employ that will help you get through the test with a minimum of angst.

Consider the following as part of your test taking strategy:

Arrive Early. Consider traffic and time of day when making your way to the exam center. You don't want to arrive in a rushed or stressed state before the exam begins. ***It is strongly recommended that you scope out the exam facility a week or two before the actual examination, if at all possible.*** You want to know what to expect walking through the door of the test facility. You will be under constant video monitoring and observation for the entire duration of the exam.

Rest Up. Take the evening off from studying the night before the exam - if you don't know the material by this point, cramming into late hours the evening before the test will simply multiply your stress level by a factor of two or three. It is most important that you be rested with a good night's sleep under your belt on the day of the exam. If you can, schedule the test for early afternoon instead of early morning.

Consider Earplugs. There may be some distracting noises in the examination room such as a fan, or test-taker for a different exam tapping a pencil on a desk. Bring earplugs just in case.

Dress in Layers. Frequently exam rooms are air conditioned to a point where they are too cold for many people. Therefore it is recommended that you dress in layers and remove layers or add layers as necessary to maintain your own individual comfort level.

Bring Food and Drink. If you get thirsty or need a nutritional boost during the exam, make sure you bring bottled water, bottled juices, or any snacks you will need for the four-hour test. If you have to leave the room to use a water fountain or go to a vending machine, the test clock will still be ticking.

Do the Brain Dump! Prior to the start of the exam and during the 15 minute tutorial you will have time to write on scratch paper all the formulas you will need for the test. While many of us pride ourselves on our airtight memories, rest assured that if exam panic sets in, all that you thought you had memorized will fly out of your head in an instant. Do yourself a favor and write down these formulas in an unstressed state prior to the actual start of the exam - this will pay dividends many times over while you are taking the exam. Some past test takers have actually reported that examination proctors upon handing scratch paper to the test-taker will state, "don't forget your brain dump".

Formulate a Plan. Have a strategy in mind prior to taking the test. If you know you will need to stand up and stretch after 90 minutes, allocate time in your strategy to do just that. The idea is that you want to pace yourself for your own maximum comfort and effectiveness on exam day. One effective plan involves the following approach:

- Go through the entire exam and answer the questions you can answer very quickly - within 20 to 30 seconds. Mark all other questions for review. You can frequently answer 80 questions in 45 minutes using this approach.
- Now approach all the 'marked for review' questions on the second pass - these questions will take you a little longer to answer but only because they require more thought. You can answer another 70 questions in the next hour and 15 minutes using this approach. Sometimes other questions and answers will jog your memory on a question you marked for review.
- You will now be left with your 50 most difficult questions on the third pass for which you have a full two hours to ponder the answers. Having this much time to approach your toughest questions is a real stress reliever and a major confidence builder for the exam.

Breathe! Students of yoga have utilized this technique for years. While in a stressed state, the simplest and most effective way to calm your system is by deep controlled breathing. This will produce a calming effect on your mind as well as your body, and can even lower blood pressure. If you feel a moment of

panic during the exam, sit back in your chair, close your eyes and breathe deeply and slowly for 15 to 20 seconds.

Useful Exam Tips

Think Like PMI! When you are answering questions for the exam, unless stated otherwise, assume the following is true:

- You are the customer if procuring services from an external vendor unless stated otherwise
- As the project manager you are in control of the budget, the timeline, and the resources
- The project is of sufficient size to warrant the use of a project management plan and all subsidiary plans
- You are following the formal processes as outlined by PMI, even if you don't use them in real life
- You have access to historical information and that formal project management processes are followed in your organization

The exam does not test memorization. Being a quiz kid with an eidetic memory will not help you pass the *PMP®* examination. You could memorize the *PMBOK® Guide*, 4th edition cover to cover and easily fail the exam. The *PMP®* exam tests your experience as a project manager as well as your understanding of project management concepts, and your ability to correctly analyze situations that occur on projects.

While some memorization is required it is not the focal point of the examination.

Answer all questions. You do not get any credit for an unanswered question. If you are completely stumped by a question there are only four possible answer alternatives. You have at least a 25% chance of getting it right. If you can eliminate at least two apparently incorrect answers your chances have improved to 50-50. *Always answer a question even if time is running out.*

Fill in the blanks. With a fill-in-the-blanks type of question, sometimes the correct answer is not grammatically correct. Don't let that stop you from filling in the correct answer.

Software calculator. You will be provided with an online, basic calculator that performs the following functions: add, subtract, multiply, and divide. A TI-83 graphing calculator with sophisticated integral and derivative calculus functions will not be allowed in the exam room.

Look for sweeping generalizations. Frequently you will see broad generalizations and questions using terms such as; "MUST, NEVER, AWAYS, COMPLETELY" or other absolutes. When referring to the project manager's actions, these terms are almost always wrong. Make sure you understand PMI's point of view first before attempting to answer questions containing these terms.

NEXT, BEST, WORST, LEAST, MOST, FIRST, LAST. On a number of exam questions you will be asked what is the BEST or FIRST action you should take regarding a specific situation. When we see questions like this, it is a tipoff that there is usually more than one correct answer. Read these questions carefully and understand what is being asked.

Cheerleader answers. There are a fair number of question responses that are what we call 'cheerleader' answers. Statements such as "quality is really important" or "scope verification is really time consuming" are answer choices that are guaranteed incorrect. Also keep an eye out for answers in which there is some type of emotional response to a situation. Project managers manage projects with data and fact. "Touchy-feely" answers can usually be eliminated immediately from consideration.

Use the whole exam time. Allow yourself the full four hours to complete the exam unless the following situation applies: you have answered all the questions and double-checked the answers. Studies have

shown that over-thinking answers on an examination will frequently cause test takers to second-guess themselves. More often than not, they will change correct answers to incorrect answers. Your first instinct on a difficult question will generally be correct. If you have used the three-pass method, double-checked your answers, and 30 minutes on the exam remains, your best strategy may simply be to submit your answers for grading.

Know PMI's recurring themes for the exam. The following themes need to be well understood to increase your chance of passing the exam the first time:

- The project manager puts the interests of the project ahead of his/her own self-interest
- The project manager is assigned during the Initiating phase of the project
- Organizations have a Project Management Office (PMO), that has clearly defined authority over the implementation of project processes
- The WBS is the foundation for all project management planning
- Stakeholders are engaged throughout the project
- Planning is a key element in all projects
- All roles and responsibilities are clearly defined and documented for the project
- Due to the uniqueness of the project, the project manager focuses on risk identification and risk management
- Project management plans are agreed, realistic and signed off by all relevant stakeholders
- The Project manager is responsible for realistically assessing all time, budget and quality constraints and resolves any issues with the management *prior to* the start of project work
- Continuous process improvement on the project is one of the key responsibilities of the project manager
- The project manager determines the quality metrics to be used on the project
- The project management plan is the key document by which the project is managed
- Projects are continually re-estimated throughout the life of the project so that an accurate budget and timeline may be forecasted
- Progressive elaboration is a key concept used by the project manager to tighten estimates as the project moves forward
- The project manager has authority. The PM can reject changes to scope and control the project budget and timeline for the benefit of the customer
- The PM protects the project from unnecessary changes
- In the event that scope changes must be made, the PM will ensure that a thorough impact assessment will be performed assessing changes to time, budget, resources, risks, quality, and customer satisfaction
- Project managers spend 90% of their time communicating with stakeholders to ensure everyone connected with the project knows what is going on
- Project managers proactively seek out additional risks, problems, and other changes to prevent future problems with the project
- Project managers have a fundamental understanding of contract language
- Project managers ensure organizational policies are followed for the duration of the project
- When closing a project, the project manager archives all project records
- Projects are not considered complete until final acceptance has been received from the customer and the PM releases resources upon project completion

Maintaining the PMP Certification

Maintaining the PMP Certification requires the credential holder to document 60 Professional Development Units (PDUs) every three years. This can be accomplished in many ways, including, but not limited to the following:

- Attend a PMI chapter meeting: 1.5 PDU
- Any PM training from a PMI Registered Education Provider (REP): 1 PDU per hour of training
- Any PM course offered by an accredited College or University: 1 PDU per hour of training
- Self study
- Speaking, lecturing or publishing articles on any aspect of project management

Consult the PMI website at www.pmi.org for a comprehensive listing.

CRITICAL NOTE:

Starting August 31, 2011, the exam section concerning Ethics and Professional and Social Responsibility will no longer be tested as a separate entity apart from the five process groups, but will be subsumed within each process group. This means that questions regarding ethics can appear in the Initiating, Planning, Executing, Monitoring and Controlling and Closing process groups.

In Summary...

- ▶ In this section we covered:
 - ▶ Requirements necessary to qualify for certification
 - ▶ Exam application process
 - ▶ What types of questions to expect on the test
 - ▶ Study and test-taking tips
 - ▶ Requirements necessary to maintain certification

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Chapter 2 : Project Life cycle and Organization

Project Management Life Cycle and Standard for Management of a Project

- ▶ Project Management Defined
- ▶ The Project Management Life Cycle vs. the Project Life Cycle
- ▶ Project Stakeholders and Stakeholder Influence
- ▶ Organizational Project Structures

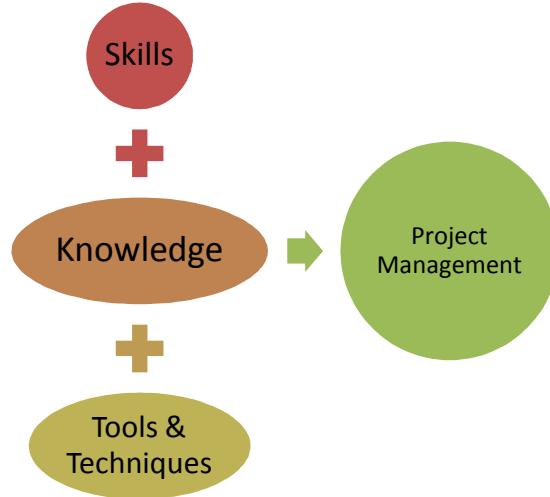
Section Objectives

- Projects and Project Management defined
- The role of the project manager
- Projects, programs and portfolios are defined
- Define the difference between projects and ongoing operations
- Explanation of the project phase structure
- Describe differences between the project life cycle and the Project Management life cycle
- The Product life cycle
- Understanding stakeholder needs
- Organization influences on Project Management

Definition of Project Management

According to PMI, project management is:

- The application of knowledge, skills, tools, and techniques to project activities to meet project requirements
- project management is accomplished through the appropriate application and integration of the 42 logically grouped project management processes comprising the five process groups



The five process groups are, in order:

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

Critical Note: Many organizations implementing the PMI Project framework in their organizations make the mistake of thinking that the five process groups constitute project phases. They do not. According to PMI: "**The Process Groups are not project phases**"²

Project Constraints

There can literally be hundreds of constraints on a project. Constraints are limiting factors that set up boundaries for the project. These boundaries may be necessary for the successful completion of the project, however sometimes boundaries and constraints may severely impact project optimization and ultimately customer satisfaction.

As of the printing of the *PMBOK® Guide*, 4th edition, PMI has abandoned the pure triple constraint model from previous years (cost-schedule-scope) in favor of a more inclusive definition that focuses on the following key constraints (*PMBOK® Guide*, 4th edition, p. 6):

² *PMBOK® Guide*, 4th edition, p 41 ©2008

- Scope
- Quality
- Schedule
- Budget
- Resources
- Risk



All of the constraints have an impact on customer satisfaction. The project manager is responsible for balancing all the constraints on the project to drive the highest levels of customer satisfaction. Different constraints may come into play at different times in the project, and each of these constraints needs to be evaluated in terms of ultimate customer satisfaction and the needs of the project.

The Project Manager's Role

The project manager is assigned by the organization to achieve the project objectives. Depending upon the organizational structure, the project manager may report to a functional manager or an operations manager. In other situations the project manager may report to a program manager or a portfolio manager who is responsible for enterprise-wide projects and programs.

While the project manager is responsible for applying the correct tools and techniques to ensure the success of the project, effective project management requires that the project manager also possess the following characteristics:

1. **Knowledge.** What the project manager knows about project management
2. **Performance.** What the Project manager is able to accomplish while applying project management knowledge
3. **Personal.** How the project manager behaves when performing project related activities. The personal effectiveness of the project manager consists of personality characteristics, leadership ability, problem solving skills, attitude, and the ability to guide the project team while achieving project objectives and balancing project constraints

What Is a Project?

- A Project:
 - A time-scaled/time-boxed activity
 - Has a beginning, middle and an end
 - Creates a unique product, service or result
 - A 'progressive elaboration'
- Operations:
 - Endures for the lifetime of the product, process or service
 - Can be incrementally improved or enhanced over operational lifetime
 - Enhancements/improvement typically done as a series of smaller projects

A project as defined by PMI states the following:

"A Project is a temporary endeavor undertaken to create a unique product, service, or result." The project is completed when the objectives have been reached from the customer's perspective, when the project is terminated because its objectives cannot be met, or if the need for the project no longer exists.

The term 'temporary' refers to the execution of the project and not to the *product* of the project, which is usually created to deliver a lasting or sustained outcome. An example of this type of project would be a national coast-to-coast railroad system or a national monument.

The term 'unique' means you are doing something that is without like or equal. This does not mean that every aspect of the project is unique. A project may contain repeating elements such as processes or infrastructural elements.

Operations endure for the lifetime of the *product*. *Operations* address assembly-line type processes that are both predictable and repeatable. *Many projects contain repeatable elements that resemble operational processes.*

Point of view is also very important to consider when identifying an operational process or a project. To the customer the work effort may be a project, however to the performing organization the work effort may be purely operational and something they do all the time.

There are distinct similarities between projects and operations:

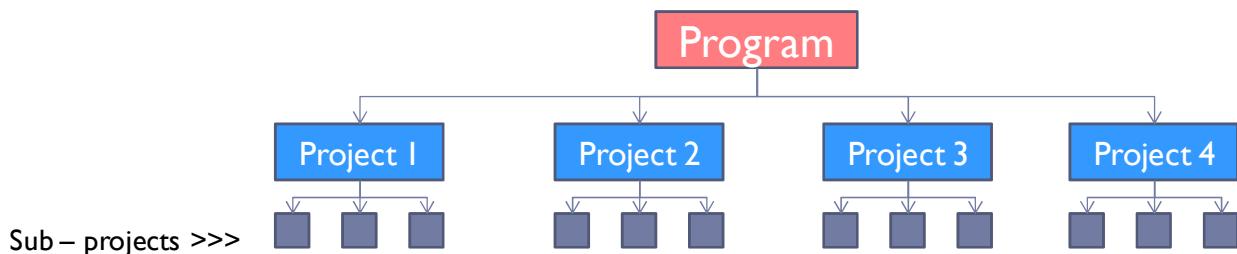
1. Both are performed by individuals
2. Both are subject to constraints including resources, schedule, risk and others
3. Both are planned, executed and controlled
4. Both are designed to meet organizational and/or strategic objectives

The key differences between projects and operations:

1. The project ends at some point, whereas operations continues for the lifetime of the product
2. The project may contain a number of unknown, unpredictable elements, whereas operational elements are both predictable and repeatable
3. Projects continually evaluate risk, whereas operational processes are usually designed to minimize or eliminate risk. (Operational elements are both predictable and repeatable)

What Are Programs, Portfolios and Sub-Projects?

- A Program:
 - A program is a group of related projects managed in a coordinated way to obtain benefits and control not available from managing them individually
- A Portfolio:
 - A portfolio is a collection of projects or programs and other work that are grouped together to facilitate effective management of that work to meet strategic business objectives.
 - The projects or programs in the portfolio may not necessarily be interdependent or directly related
- A Subproject: Smaller portion of an overall project



A Program is a group of related projects. The purpose in managing a group of projects in this manner is to derive economies of scale, decrease risk and potentially create synergies for improved resource utilization, as well as reduce costs. Programs can also address administrative functions as well as ongoing operational functions.

A Portfolio can include a combination of projects and programs designed to meet the strategic objectives of the organization. The individual projects/programs may not be related to each other from a management perspective. For example, a financial organization may have a portfolio of individual products all relating to wealth building. It may have a different portfolio of products related to risk

avoidance/mitigation. Each of the products within these portfolios may have been created through the execution of an individual project or a program. The portfolio helps to group these products in a manner that makes marketing and sales of these products more efficient and comprehensible to the organization's customers.

Subprojects are created by subdividing a larger project into smaller, more manageable pieces or components. This may be useful if the project follows a phase-gate approach to execution in which specific subprojects are completed within each project phase.

The PMO

The purpose of the PMO - Project Management Office - is to centralize the management of projects across the organization. Typically the PMO will provide one or all of the following for a project:

- Methods and procedures, templates, methodologies and policies for managing projects
- Guidance and training to the organization on project management concepts, principles, and how to manage projects within the organization
- A resource pool of project managers for various organizational initiatives

Depending on your organizational structure the PMO may play the following roles in your organization:

- Audit compliance with Project policies, standards, and procedures companywide
- Help to provide project resources
- Cancel projects
- Provide templates and standardized forms for project use
- Offer coaching, training and mentoring for project managers
- Serve as a centralized communications conduit for projects
- Manage dependencies between projects, programs, or portfolios
- Function as a stakeholder

The Project Life Cycle

- “There is no single way to define an ideal structure for project. Although industry common practices will often lead to the use of the preferred structure, projects in the same industry- or even in the same organization-may have significant variation”³
- The **phases** of a software project life cycle will differ from a construction project life cycle or a pharmaceutical drug development life cycle

Project life cycles are as unique as the industries they serve. Projects are generally broken into phases which are used to control project execution and ensure its success. Within an organization it is not uncommon to find established policies that standardize projects around a specific methodology or project approach. Other organizations may allow the project team to organize around the most

³ PMBOK® Guide, 4th edition. P. 19

appropriate approach for their individual project. Regardless of the approach taken by the organization there is no standard project life cycle that fits all organizations. It is truly a case of 'one size fits none'.

Organizational governance across the project life cycle must provide a consistent method for controlling the project and ensuring success. The phase structure provides a formal basis for such control. At the completion of each phase, a management review or 'decision gate' is executed to determine whether the project can continue, needs further adjustments, or should be canceled.

Thus a phase-end review can achieve two goals for the project:

- Authorization to close the current project phase
- Authorization to initiate the subsequent project phase

Phase-to-Phase Relationships

As of this writing, PMI has elaborated three fundamental phase-to-phase relationships are contained within the project life cycle. These phases are described as follows:

- Sequential Relationship. This describes the traditional finish-to-start relationship. Phase 1 must be completed before phase 2 can begin. Traditional construction projects frequently use the sequential phase relationship when constructing a house or an office building.
- Overlapping Relationship. In this case, a subsequent phase can begin before the previous phase has completed. Stated differently, phase 2 can start before phase 1 is done. This technique allows for schedule compression called fast tracking, and overall reduction of the timeline of the project. This approach can increase risk and rework - interdependencies between the phases must be managed diligently to avoid risk and rework.
- Iterative Relationship. This concept addresses agile methodologies as a project management approach. This phase type is particularly useful with projects in which there are uncertainties, rapidly changing market conditions or complete unknowns. It allows for incremental planning and delivery of the 'product of the project' in distinct incremental steps, allowing for the progressive elaboration of the plan, the timeline, and the budget while sequentially delivering the highest priority features as defined by the customer.

Graphic representations of the three types are shown below:

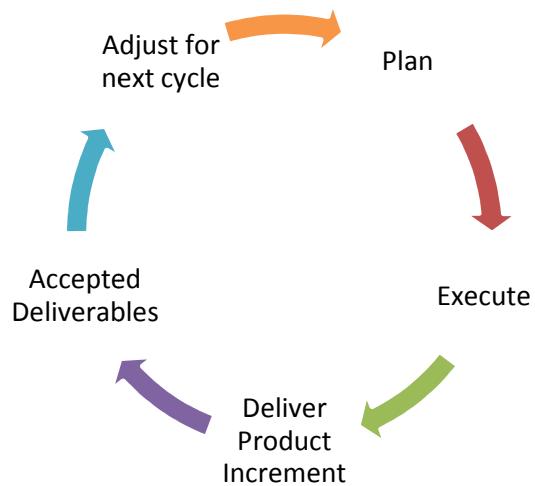
Sequential:



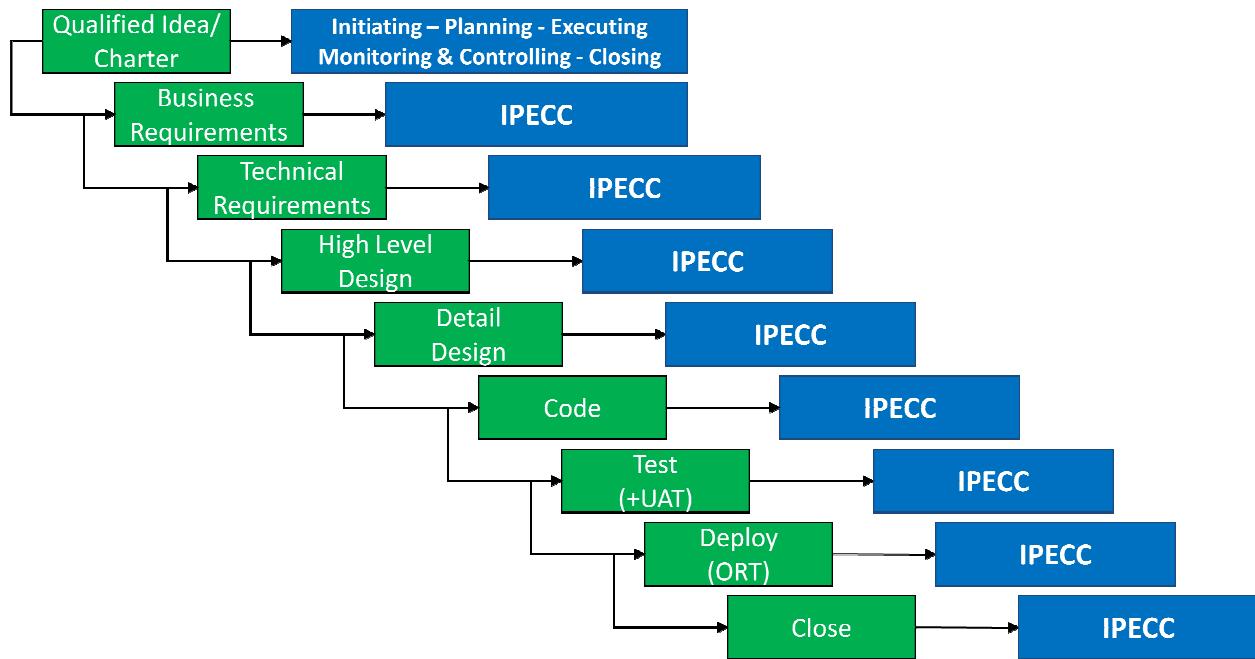
Overlapping:



Iterative:



The Project Life cycle Versus the Project Management Life cycle



The example shown above does not need to be memorized. It demonstrates the difference between a specific project lifecycle and the processes contained in the Project Management Lifecycle. The IPECC acronym represents the five process groups.

The distinction between the *project management life cycle* versus the *project life cycle* is this:

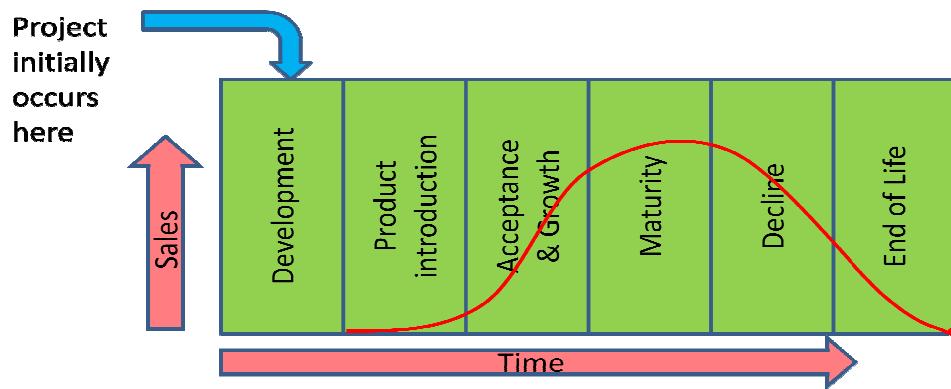
1. The project life cycle is frequently unique to each organization and industry. While there may be similarities between project life cycles, you will see distinct differences between a project life cycle for a construction project, a software project, an energy project, an airline project, a pharmaceutical project, etc. The clear distinction is this; while project life cycles may vary industry to industry,
2. The Project Management Life Cycle is immutable and always consists of the following five process groups:
 - Initiating
 - Planning
 - Executing
 - Monitoring and Controlling
 - Closing

The five process groups are applied to each phase in the project. This means that no matter what project life cycle or phase structure you may use for your project, the five project management process groups will be executed within each phase of your project. (PMBOK® Guide, 4th edition, p. 41).

For example: You will **initiate** a phase, **plan** the work of the phase, **execute** the work of the phase, **monitor and control** the work as it is being executed for the phase, and finally you will **close** the phase or the project. Closing a phase includes a process called ‘lessons learned’ in which we identify what’s working, what’s not working, where we can improve, what puzzles us, etc. This lessons-learned process is applied at the completion of every phase of your project.

The figure above shows a generic software development life cycle. Notice that for each phase of the software development life cycle we execute the process groups defined in the project management life cycle: initiating, planning, executing, monitoring and controlling, and closing.

Defining the Product Life Cycle



- Endures for the life of the product
- A *project* may have been implemented to create the product
- Many smaller projects may be implemented to incrementally improve the product

The **product** is what is created as a result of executing a **project**. When we talk about project management what we are talking about is the work that is being done in the project to produce and deliver the product of the project.

While your project may have taken two years to deliver its product, the product may have a much longer lifetime. As the product grows and matures, a series of smaller projects may be implemented to enhance, improve or change the product over time. Each of these smaller projects is in support of the product and ensuring its longevity in the marketplace.

However, just as a product may have been an ideal solution at one fixed point in time, the need for the product may have deteriorated significantly over the years. The Ford Model-T was at one point, an optimal solution for a specific transportation problem. Today the model-T is considered a quaint antique compared to the vehicles available today. The wood-burning/coal-burning locomotive at one point was an optimal solution for railroad transportation. Today, the use of diesel and electric engines has rendered the wood-burning/coal-burning locomotive obsolete.

Defining the product life cycle is important because from a strategic perspective, the organization must determine when it is of no use to the organization to utilize resources and funds to improve a product that is essentially at the end of its lifetime.

Understanding Stakeholder Needs

A stakeholder:

1. Anyone who is positively or negatively impacted by the project
2. Anyone who can exert influence over the project's objectives and outcomes.

Typical key stakeholders can include, but are not limited to:

- **Project manager**
- **Customer/user**
- **Performing organization**
- **Project team members**
- **Project management team**
- **Sponsor**
- **Functional/Senior Manager**
- **Operations**
- **Business partners**
- **Influencers**
- **PMO**
- **The public**

To iterate, a project stakeholder is anyone who can be positively or negatively impacted by the results of the project. As such, it is the job of the project manager to balance stakeholder needs while delivering the project's product. The project manager may have to deal with the following when addressing stakeholder needs:

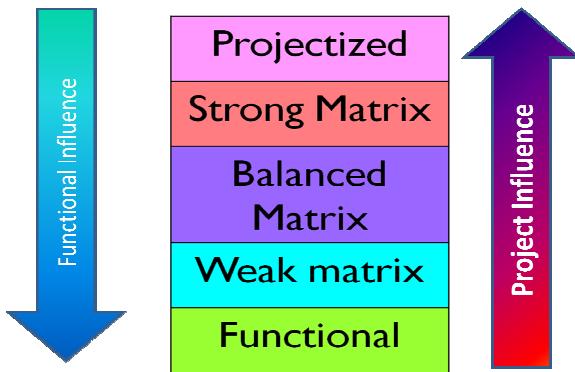
- Conflicting stakeholder needs or interests
- Stakeholder disagreement regarding the product of the project
- Different communication needs from stakeholder to stakeholder
- Varying levels of stakeholder influence

It is the project manager's responsibility to identify all potential stakeholders on a project and make sure that they are treated as members of the project team. Failure to do so can sink your project late in the game. Taking the effort to determine stakeholder likes, dislikes, hot buttons, critical needs and influence can pay huge dividends for your project as it progresses.

Stakeholder identification is also a continuous process in that different stakeholders may be impacted at various phases of the project. Testing resources will have more of an impact or influence later in your project than they will near the beginning of your project when an initial high level design is being created.

We will address stakeholder management more completely in the Communications chapter.

Organizational Influences



Different types of organizational structures will have a positive or negative effect on the effectiveness of project management in your organization.

There are three fundamental organizational structures that you need to know for the exam:

- Functional
- Matrix (Weak, Balanced, Strong)
- Projectized

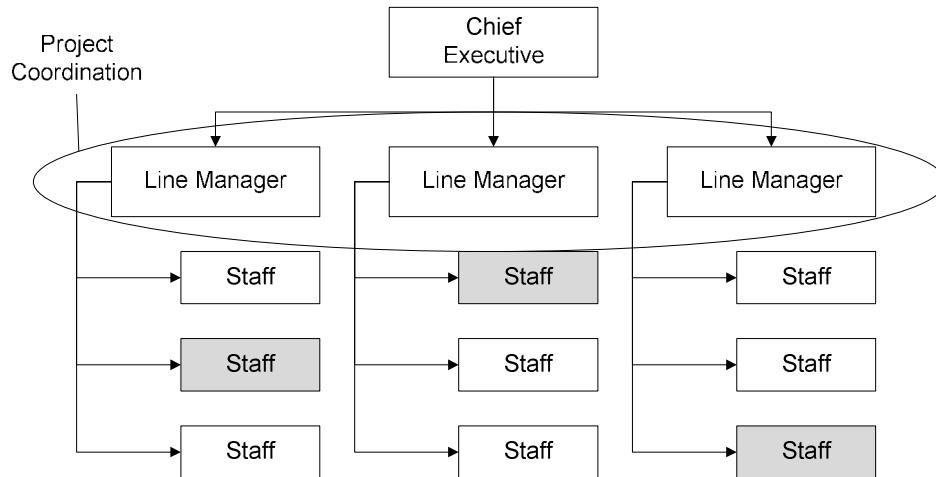
The influence of functional organizations in which project resources report to line managers or senior managers, impact the project manager's ability to influence the successful execution of the project.

In a Projectized organization project manager has ultimate authority over time, schedule, resources, and every other aspect of the project.

In a matrix organization project manager shares responsibility to a greater or lesser degree with line managers or senior managers when it comes to managing project elements such as budget, timeline, resource availability, communications and others.

An organization that uses a combination of organizational structures is called a "composite organization".

Functional Organizations



Gray boxes correspond to staff performing project activities

Drawing based on *PMBOK® Guide*, 4th edition, p. 29

In this organization type, the project manager has little to no authority on the project. Usually the project manager is part time and is often referenced as a 'project expediter' or 'project coordinator'. The functional hierarchy is that all the team resources report to a functional or line manager. The project manager has little or no input into performance reviews of the project team and frequently must approach functional managers 'hat in hand' to make the best case they can for project resources.

► Exam Tip:

- Project _____ is an assistant that cannot make or enforce decisions
- Project _____ have some decision making authority

Each of these designations can be found in a weak matrix organization as well⁴

Functional Advantages and Disadvantages

- **Advantages**
 - Clearly defined career paths
 - Familiar structure
 - Direct supervisor reporting structure
 - Employees are experts
- **Disadvantages**
 - Employee's job difficult to change
 - Much contention for resources and project priority

⁴ "Weak matrices maintain many of the characteristics of a functional organization, and the project manager role is more of a coordinator or expediter..." *PMBOK® Guide*, 4th edition p. 29

- Performance reviews and promotions are functional manager responsibility
- PM has little or no authority
- PM usually part time - no clearly defined career path for the PM

You'll notice from looking at the list above that with the functional approach to managing projects, the disadvantages clearly outnumber the advantages.

As the project manager in this type of environment, ensure that you have a very clear understanding of the structural hierarchy of the organization and that you work within the bounds of the tools that the organization has left at your disposal (generally few to none).

The Matrixed Organization

The matrixed organization was developed in the 1970s to attempt to combine the advantages of both the functional and the Projectized organization while minimizing the disadvantages. There are three types of matrixed organizations that PMI has defined:

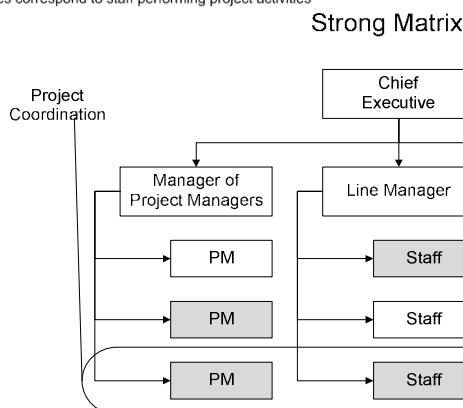
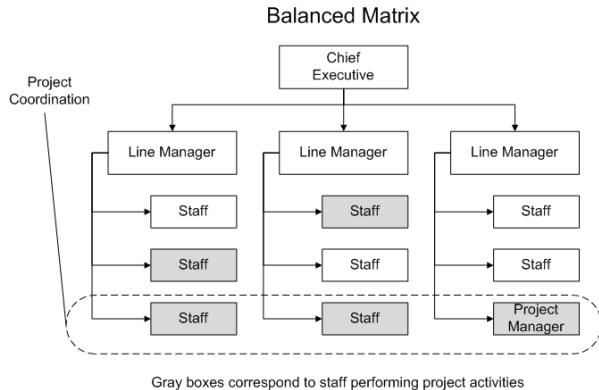
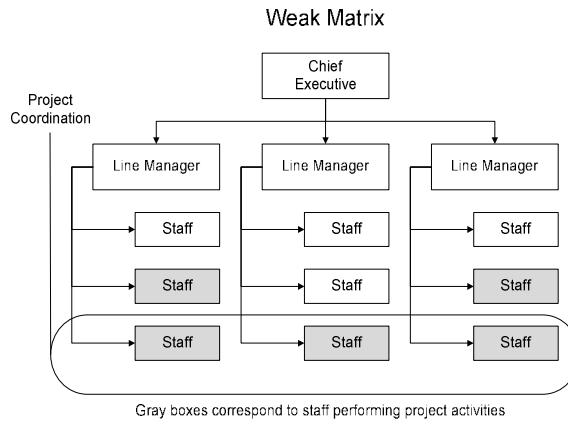
- **Weak matrix.** Similar to the functional organization in that project resources report directly to functional managers
- **Balanced matrix.** With this organization type, project power and influence is shared between the project manager and the functional manager
- **Strong matrix.** Here most of the project authority is similar to the projectized organization in that the project manager has almost complete control of project resources, budget, timeline, quality, and customer satisfaction

Exam Tip: you may see the term 'tight matrix' on an exam question. A tight matrix simply means that the offices for the project team are co-located in the same room.

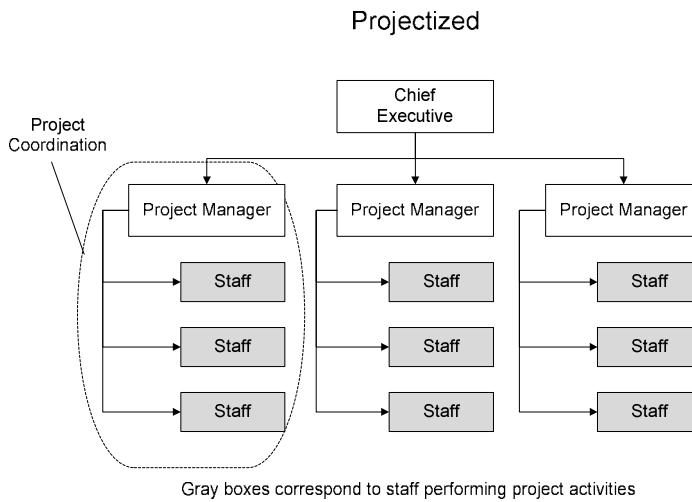
Matrixed Advantages and Disadvantages

- **Advantages:**
 - Objectives remain visible
 - Increased support from functional managers
 - Increased control by project manager
 - Improved flexibility
 - Job remains after project is complete
 - Multiple inputs on team members' performance
- **Disadvantages:**
 - Multiple bosses
 - Adds complexity
 - Additional policies and procedures are necessary
 - Different priorities or objectives may exist

Notice that in a matrix environment, the advantages outnumber the disadvantages. As with the other organizational types, you will be asked questions on the exam regarding the advantages and disadvantages of working in one of the matrixed environments. Some graphical examples of matrix organizations appear below (Drawings based on *PMBOK® Guide*, 4th edition, pp. 29-30):



Projectized Organizations



The projectized organization is one that derives its primary income from delivering projects. In this organization, the project manager has ultimate authority over the project, including the timeline, the budget, the resources, the scope, the quality and, ultimately, customer satisfaction.

In this environment the project resources are dedicated 100% to working on projects and focused on the project at hand. This approach is effective when the project is very high priority and requires the dedicated focus of everyone on the team. Typically, very large and complex projects are executed in a projectized environment.

Projectized Advantages and Disadvantages

- Advantages:
 - Dedicated project focus
 - Project loyalty
 - Efficient project organization
 - Efficient project communication
- Disadvantages:
 - Job is gone once project is complete
 - Resources are siloed rather than shared
 - Job functions and facilities can be duplicated

For the exam, the above outlined advantages and disadvantages need to be understood, as exam questions may make oblique references to the Projectized (or any other) organization type.

Example:

You are a project manager in which you have ultimate authority over the project, including the budget, the timeline, and the resources. While this dedicated focus serves the needs of the project, there may be a disadvantage in approaching a project in this way. Which of the following would be the BIGGEST disadvantage using this approach?

- a. As the project manager, you get all the pressure
- b. Line managers may not respect your authority

- c. Your job may be gone once the project ends
- d. Negotiating conflicting stakeholder needs is more difficult

A clear reading of the question describes a projectized organization type. Based on your understanding of the Projectized organization, you also understand the disadvantages of executing a project in this organizational environment.

What Is Your Organizational Structure?

Project characteristics Organization structure	Functional	Matrixed Organizations			Projectized
		Weak Matrix	Balanced Matrix	Strong Matrix	
Project Manager's Authority	Little or None	Limited	Low to Moderate	Moderate to High	High to Almost Total
Resource Availability	Little or None	Limited	Low to Moderate	Moderate to High	High to Almost Total
Who controls the project budget	Functional Manager	Functional Manager	Mixed	Project Manager	Project Manager
Project Manager's Role	Part-time	Part-time	Full-time	Full-time	Full-time
Project Management Administrative Staff	Part-time	Part-time	Part-time	Full-time	Full-time

Drawing based on *PMBOK® Guide*, 4th edition, p. 28

The chart above summarizes the functional, matrix and projectized organizations.

Exam Tip: For the purposes of the exam assume that you are working in a strong matrix environment unless the question explicitly (or implicitly) states otherwise.

For the exam, you would do well to commit the above chart to memory.

MBO, OPM3™ and Progressive Elaboration

Management by Objectives (MBO) is a term that was first introduced by Peter Drucker in his 1954 book 'The Practice of Management'.

Exam Tip: MBO will only work if it is supported by management.

OPM3™ - the Organizational Project Management Maturity Model. The model was based on the Software Engineering Institute's Capability Maturity Model Integration (CMMI) for software. OPM3™ helps organizations determine their level of maturity in project management.

Progressive Elaboration - this concept is key to the entire PMI framework. It fundamentally states that you cannot come up with a definitive estimate for timeline and budget at the very start of a project. Why? The reason is that there are many unknowns and very little analysis has been done at the beginning of the project. As the project team dives into the analysis, consults with subject matter experts, and begins to define the details of the project - only then can more accurate estimates be created.

The greater the number of the unknowns that exist in a project, the more a progressive elaboration is required to ensure project success.

Section Review:

- ▶ Definition of PM terms, such as project, PMO, stakeholder, project life cycle, product life cycle, project management life cycle, project management system
- ▶ The role of the project manager
- ▶ Definition of project constraints
- ▶ Project phase concepts
- ▶ Advantages and disadvantages of different organizational structures

Chapter Two Memory Check

1. A project is _____, _____ and delivers a _____, _____ or _____
2. Three key constraints on a project are _____, _____, and _____ as well as quality, resources and risk
3. Three key characteristics of the project manager include; _____, _____, and _____ effectiveness
4. A _____ is a group of related projects. A _____ can be a collection of projects, programs or sub-projects
5. A _____ centralizes and co-ordinates the management of portfolios, programs and projects
6. The _____ life cycle deals with the work done to accomplish the goals of the project, while the _____ life cycle deals with the lifetime of the deliverable(s)
7. The three categories of multi-phase project types are; _____, _____, and _____
8. A stakeholder is anyone who is _____ or _____ impacted by the project
9. The three basic organizational types are; _____, _____, and _____
10. The term used to describe the process of delivering more accurate estimates for time and budget as the project progresses is called _____
11. Clearly defined career paths and little PM authority describe an advantage and a disadvantage of a _____ organization
12. Project loyalty and the possibility of not having a job after the project completes describes an advantage and a disadvantage of a _____ organization
13. Increased PM control and multiple bosses describes an advantage and a disadvantage of a _____ organization
14. A project _____ has very little decision making authority on a project, whereas the project _____ has some decision making authority
15. The three types of matrixed organizations are referred to as: _____ matrix, _____ matrix and _____ matrix

Chapter 2 Test

1. The five process groups of the Project Management Life cycle are, in order:
 - a. Initiating, Executing, Planning, Monitoring, Closing
 - b. Initiating, Analysis, Design, Executing, Closing
 - c. Initiating, Planning, Executing, Monitoring and Controlling, Closing
 - d. Initiating, Planning, Monitoring and Controlling, Validating, Closing
2. You have just started a new position as a project manager with your new company. Upon starting your job you are informed by the line manager that all budgetary decisions rest with her and that all key project decisions will be her responsibility as well. Most likely, PMI would say you are functioning as a _____?
 - a. Resource coordinator
 - b. Project manager
 - c. Functional expeditor
 - d. Project coordinator
3. The project manager that you just hired said that she came from a Projectized organization prior to working for your company. Your VP just asked you what that means in terms of her level of authority. You responded:
 - a. she had responsibility for the project but not for the budget
 - b. she had little responsibility for the project or the budget
 - c. she split the project and budget responsibilities with the functional manager
 - d. she was responsible for the budget and the project almost 100%
4. The company you are working for has decided to adopt Scrum as a project management method. You've never heard of Scrum before but decide to do some research and discover that Scrum is an agile method. What kind of project phase method is being adopted here?
 - a. Iterative
 - b. Sequential
 - c. Overlapping
 - d. Phase-neutral
5. Two junior project managers who are working on the same project are having a heated discussion (an argument) on the difference between the project management life cycle and the project life cycle. The first project manager is saying there is essentially no difference between the two while the second project manager is saying that there is a significant difference between the two. While this debate is occurring, a senior vice president from your division interrupts the two and asks them the following question: "When the project is completed what is the expected lifetime of the deliverable?" Essentially, what is the vice president asking them?
 - a. He is asking about the status of the project life cycle
 - b. He is asking about the status of the project management life cycle
 - c. He is asking about the status of the product
 - d. He is trying to determine if they understand life cycle costing
6. What is the *BEST* definition for a project manager's role on the project?
 - a. Take instruction and direction from functional managers
 - b. Assigned by the organization to achieve project objectives
 - c. Balance stakeholder interests on the project
 - d. Effectively manage the project team while also being an expert technical resource

7. A key disadvantage in the Projectized organization is frequently described as:
- Resource dedication to the project
 - The project manager controls the budget and the resources
 - There are multiple sponsors on the project creating a multi-tiered complexity
 - Your job is done when the project is done
8. You have just gotten a new job within an organization that can't spell 'project management' much less figure out how to run a project. Their project management process has been described by some in the organization as an 'adrenaline pounding thrill-ride usually resulting in a train wreck'. At your project kickoff meeting a number of the team members have expressed dismay at how the last project was managed and ask if this one will be just like the last one. In terms of the project approach, what is the *BEST* response you can offer?
- As the project manager, you will protect the team from executive interference
 - You will take a life-cycle approach to managing the project
 - You will ask the project team for a list of difficult stakeholders so that you can defuse problems before they begin.
 - Your project management approach is calm, cool, and collected
9. The Director of Product Development and the chief engineer of the company have decided to add scope to the project you are managing. They have completed the necessary paperwork, received the required sign-offs and have told you to simply get it done. In this instance you are probably:
- In a strong matrix environment
 - Project administrator
 - Working a balanced matrix function
 - Project expeditor
10. The project team has been arguing about what should go into the project management plan. They've built the same product over a hundred times before and have always been bothered that the project management plan never seemed to get completed. They were determined to get it done *right* this time. The team has come to you for advice regarding the project management plan. The most *appropriate* response you can give them is:
- Use project phase concepts ; initiate, plan, execute, monitor & control, and close
 - They need training in project management
 - The 'project' is really operations
 - Tell them to take direction from the PMO
11. Management by Objectives is most successful when:
- The organization's executives stay out of the way of the project team
 - Management delegates the work of the organization to the most senior project managers
 - You were managing projects in the 1950s. Technique is rarely used now
 - It is supported by upper management
12. The portfolio manager from your division thought it might be helpful to the project teams if she delivered a short presentation on the elements in her portfolio. A number of team members, after receiving the e-mail announcement for the presentation, come to you and ask if this meeting is worth their time. After all isn't a portfolio just a big project? As a Senior Project manager your *best* response would be:
- You're right. The meeting probably would be a waste of your time
 - Not really. A portfolio is a group of related projects managed together to achieve synergies between the projects and establish common methods and procedures.
 - Not really. A portfolio can be a group of programs, projects, or sub-projects designed to help the organization meet specific business goals

- d. Not really. A portfolio is a collection of documents, methods, and procedures that help us manage projects
13. The executives are debating about whether to implement a PMO for their organization. One of the executives thinks that PMO means 'project management overhead' while others are wondering about the actual value it will bring to the organization. As a senior project manager, they bring you in to the meeting on a consultative basis to help them get their hands around what value the PMO brings the organization. All of the following answers are correct *except*:
- a. The PMO serves as a disciplinary organization for project managers
 - b. The PMO helps the organization align its projects around strategic organizational objectives
 - c. The PMO provides the organization with project management standards, methods, and procedures
 - d. The PMO helps to mentor and train project managers within the organization
14. All of the statements about the project life cycle are true *except* which of the following:
- a. The project life cycle consists of five distinct phases
 - b. The project life cycle is different for every organization
 - c. The project life cycle works with the project management life cycle to help meet project objectives
 - d. The project life cycle can be modified depending on the needs of the project
15. You have contracted a third-party to install five rack-mounts and the server gear at your new data center for your new web service, which is designed to handle 50,000 simultaneous users. The performing organization stated you could have a custom-designed system and sit down with an architect to do that, however, they have a catalog of 10 systems that they can build from the simplest to the most complex. If you want to pick something from the catalog, the configuration is well known and well understood, and their installation time can literally be cut in half, saving you considerable funds. You selected one of the 10 catalog systems because there was one that coincided with your needs to a 99% level. You also assigned a senior project manager from your organization to coordinate all activities with the vendor for installation. A week later you hear the project manager having a heated discussion with one of the junior project managers about whether this installation constitutes a project or operations. The junior project manager maintains that the installation is time bound and delivers a unique product process or result and by definition, is a project. The Senior Project manager counters with the following argument: it is fundamentally operations because the performing organization does this all the time. The configuration selected came out of a catalog which means that the installation is a repetitive, predictable, and repeatable process which is why they could do it on such a narrow fixed-price basis. What is the *best* response you could give to the junior and senior project manager?
- a. The Junior Project manager is correct: this is a project
 - b. The Senior Project manager is correct: this is operations
 - c. This is a project that has elements of operations
 - d. It really depends upon from whose point of view the question is being asked
16. All of the following reasons elaborate why it is important for the project manager to consider stakeholder influence on a project, *except* for which of the following?
- a. The negatively impacted stakeholder can create significant road blocks for your project
 - b. All the stakeholders control your budget
 - c. Stakeholders may supply technical expertise or resources to your project
 - d. Stakeholders provide many of the key requirements that need to be fulfilled for the successful completion of the project
17. The organization wants you to manage a project with a very aggressive timeline. You have done an initial assessment of the statement of work, the timeline, resource availability, and the budget. Based on this

information you have reported back to senior management at their aggressive timeline is a fiction and it will be impossible to meet given the scope of work. Senior management then asks you what the most effective project phase approach would be employed to compress the timeline given that the project is fraught with many uncertainties, risks and is something that the organization has never tried before. The *most likely* response you would give to address this situation is:

- a. You recommend the overlapping phase approach. This would allow work on a subsequent phase to start before the predecessor phase had completed
 - b. You recommend a sequential phase approach with the standard workweek changing from 40 hours to 55 hours per week
 - c. You recommend the inverse-evolutionary phase approach. Since his project sounds more like an R&D project you have no idea what the real scope is or when you will be done. Innovation cannot be timed on a punch clock
 - d. You recommend the iterative phase approach. It addresses high-risk, high uncertainty projects effectively
18. Several junior programmers ask you about the difference between the product life cycle and the project life cycle. The *best* answer that you can give them in describing the difference between the two is:
- a. The product life cycle and the project life cycle coincide - the difference is that the product life cycle has to do with the product created whereas the project life cycle has to do with the work needed to create the product
 - b. The product life cycle addresses the entire life time of the product, whereas the project life cycle is to work needed to create the product
 - c. The product life cycle addresses the time that is needed to initially create the first iteration of the product, whereas the project life cycle endures for the lifetime of the product
 - d. The real answer addresses the sequence of the two: product life cycle completes before project life cycle begins
19. You have just collected project information from stakeholders and are analyzing their input with the project team. One stakeholder is worried about whether the organization has the proper skill sets in-house to deliver the product of the project. This can be best described in project management terms as:
- a. A constraint
 - b. A potential risk
 - c. An issue
 - d. A and C
20. You are the program manager for a large multimillion dollar program managing 10 projects, each with a project manager. Because of the varying complexity of the projects, there are at least three different project life cycle types are being used across the 10 projects. Some of the project managers are discussing whether the project management life cycle needs to change to adjust to different project life cycles. The *most correct* answer that you can give them is:
- a. The project management life cycle is applied to every project phase
 - b. The project management life cycle may change depending on the specific project life cycle being employed
 - c. There is no difference between the project management life cycle and the project life cycle
 - d. The project management life cycle changes for each project

Chapter 2 Test Answers

1. C – Initiating, Planning, Executing, Monitoring and Controlling, Closing. *PMBOK® Guide*, 4th edition, p 39.
2. D – Project coordinators have minimal decision authority on projects. Thus by PMI's definition of a PM, (you are authorized to commit resources and spend money) you are not an actual project manager. A resource coordinator is an HR function and' functional expediter' is a made-up term
3. D – High to almost total control on a project identifies a projectized organization
4. A – Scrum is an agile method that utilizes the iterative approach to development
5. C – The first part of the question is a red herring. The VP is asking about the lifetime of the deliverable i.e. the product. This is a question about the product status.
6. B – The key job of the project manager is to meet the organization's project objectives
7. D – Not having a home at the end of the project is one of the key disadvantages of the projectized organization
8. B – Taking a life cycle approach to the project is the best answer you can give. Answers A and C might be tactics you employ while managing the project. Answer D is meaningless
9. D – The director and the chief and an engineer have all the responsibility, therefore you are just a project expediter
10. C - Since the project team has done the same thing a hundred times before, this is an assembly line process, which makes it operations
11. D – This is the only possible answer, *PMP® Exam Prep* p 2-22
12. C – A portfolio can be a group of projects, programs, subprojects, or any combination of the previous. *PMBOK® Guide*, 4th edition, p 8
13. A – The PMO does not discipline project managers. Insubordination and other similar issues are the province of human resources, functional managers and senior management
14. A – The project life cycle changes for every organization. The *project management* life cycle consists of five distinct process groups. *PMBOK® Guide*, 4th edition, p 7
15. D - That was like reading *War and Peace* wasn't it? Sometimes you get long-winded questions on the exam. Point of view is the most important element in this question; to the customer it is a project, however to the performing organization it is operations (it's an assembly line process)
16. B – If *all* the stakeholders control your budget, you're in trouble. Funding primarily comes from senior management, who can be a potential stakeholder. *PMBOK® Guide*, 4th edition, p. 24
17. D - The project as described - a high-risk, high uncertainty project - is best addressed with an iterative phase approach.
18. B – Product lifecycle addresses the lifetime of the product; project life cycle is to work needed to create the product . *PMBOK® Guide*, 4th edition, pp 18-21
19. D – This is not exactly a trick question, but it's close. The scenario described is not only a constraint (no internal headcount with the skillset), but it is also an issue (if I need additional headcount, how do I go about obtaining it?)
20. A - The project management life cycle is *applied to every phase of your project life cycle* regardless what that project life cycle looks like. *PMBOK® Guide*, 4th edition, pp 18-21

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Chapter 3 Project Management Processes and Knowledge Areas

Topics Covered:

- ▶ Project Management Processes
- ▶ Project Management Process Groups
- ▶ Process Interactions
- ▶ Project Management Process Mapping

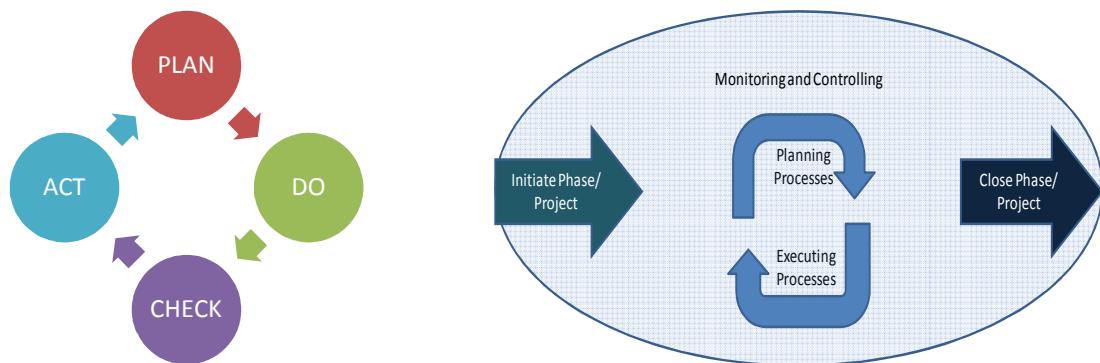
Section Objectives

- ▶ Identify the five stages of the PM life cycle
- ▶ List and define the 9 PMI knowledge areas
- ▶ Explain the processes and characteristics within each process group
- ▶ Elaborate the *PMBOK® Guide*, 4th edition 1) inputs, 2) tools and techniques, and 3) outputs are. What you need to know about them to pass the exam
- ▶ Map the 42 major processes by knowledge area

The Project Management Process Groups



The five process groups are based on a variant of the Shewhart-Deming Plan-Do-Check-Act Cycle:

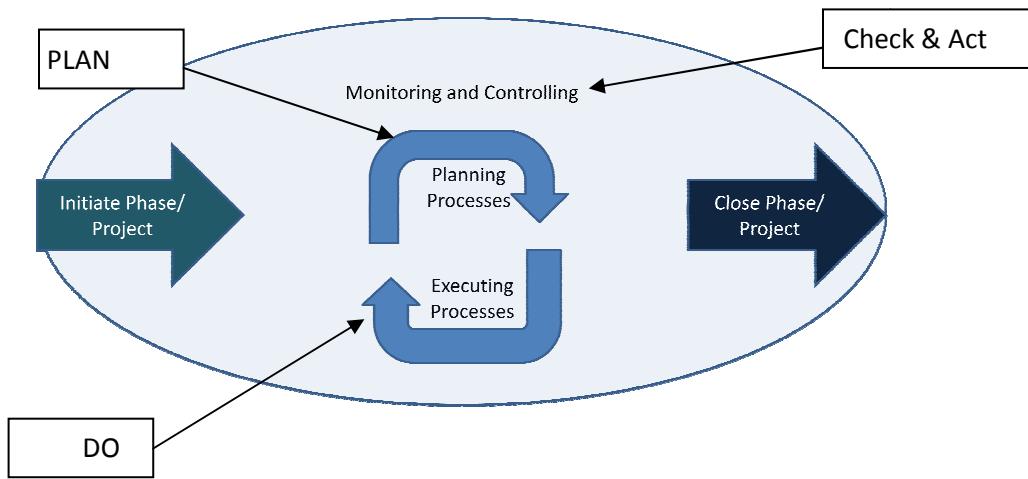


Notice that the Planning and Executing Processes are iterative⁵

The Shewhart-Deming plan-do-check-act cycle is the fundamental basis of incremental improvement for all manufactured product or business processes. The IPECC process is basically a variant on the Shewhart-Deming cycle:

- The initiating process is basically the entry point into the cycle
- The closing process is basically the exit point from the cycle
- The plan-do-check-act iteration maps in the following manner to the IPECC cycle:

⁵ PMBOK® Guide, 4th edition, p 40



Based on the *PMBOK® Guide*, 4th edition, p 40

A key point to understand in the IPECC cycle is that Planning and Executing processes are *iterative*. Notice also that monitoring and controlling processes are an 'umbrella' type of process, in that all the other processes within the IPECC cycle are in some way monitored and controlled. We are constantly checking the results of our work and making actionable decisions based on what we discover.

Initiating Process Group

The primary elements in initiating a project include:

Communications process

- Identify stakeholders / stakeholder identification techniques*

Integration processes

- Determine phase/project goals
- Obtain authorization to start phase/project
- Determine initial scope
- Identify constraints and assumptions
- Select/assign project manager
- Project statement of work
- Define high-level resource requirements
- Determine initial financial resources
- Verify success criteria
- Create project charter/ charter elements*
- Obtain formal approval of charter

Several other supporting actions that help to complete the initiating process include the following:

- Subdivide large projects into phases
- Document the business case and the cost-benefit analysis*
- Project selection criteria (e.g. cost, feasibility, impact)*
- Ensure the project scope is achievable
- Identify high-level risks and requirements/ risk identification techniques*
- Facilitate resolution of conflicting stakeholder objectives
- Create an order of magnitude budget and schedule estimate
- Determine critical success factors for the project

* These elements address specific knowledge and skills needed by the PM in the Initiating process

Exam tip: The primary goals of the Initiating process are:

1. develop the project charter and
2. identify stakeholders

Exam tip: In the Initiating processes, understand the following:

- Staffing levels are low
- Costs are low
- Chance of success is low
- Risk is high
- Stakeholder influence is high

Planning Process Group

While the main goal of the Planning process group is to create the Project Management Plan, other subsidiary management plans are also created here. This includes subsidiary management plans for scope, schedule, budget, quality, human resources, communications, risk, and procurement knowledge areas defined in the *PMBOK® Guide*, 4th edition. Below is a listing of the major elements you can expect to find as part of the Planning process:

- Create scope statement
- Create scope management plan
- Create WBS (work breakdown structure)
- Create network diagram
- Estimate activity durations
- Estimate costs
- Determine project schedule
- Refine time and cost estimates
- Create communications plan

- Develop Human Resource Plan
- Create Staffing Management Plan
- Develop Communications Management Plan
- Determine project budget
- Develop quality management plan
- Identify risks
- Qualitatively and quantitatively rank risks
- Develop risk response plan
- Adjust estimates as necessary
- Develop procurement management plan
- SOW (procurement statement of work)
- Create procurement documents
- Develop PM plan
- Obtain approval of plan
- Hold kick-off meeting⁶

Additional knowledge and skills needed by the PM for planning activities also include:

- Describing each work package in the WBS dictionary
- Evaluating other projects for potential positive or negative impacts on this project
- Identifying quality metrics for the project
- Requirements gathering techniques
- WBS tools and techniques
- Time budget and cost estimation techniques
- Scope management techniques
- Resource planning process
- Workflow diagramming techniques
- Type and uses of org charts
- Elements, purpose and techniques of:
 - Project planning
 - Communications planning
 - Quality management planning
 - Risk management planning
 - Procurement planning
 - Change management planning

With the planning process group, it is critical to understand that neither the project management plan nor any of the subsidiary management plans are finalized until a thorough risk assessment and identification has been performed.

The primary goal of the Planning process is to develop the project management plan.

⁶ PMBOK Guide, 4th edition pp 47-55

Executing Process Group

The processes in this group are performed to complete the work in the project management plan that was designed to satisfy the project specifications. As the project manager, you are responsible for coordinating the activities of human resources as well as infrastructure resources and integrating the activities of both in accordance with the project management plan.

As a result, several or all of the plans created in the planning process may require replanning, updates and re-baselining during project execution. A large portion of the project budget is normally expended during the Executing Process Group processes.

The primary elements in the Executing process group include:

- Complete work packages
- Use a work authorization system
- Collect status information
- Hold meetings
- Acquire, develop and manage project team
- Distribute project information
- Obtain bids from outside vendors
- Select a vendor
- Negotiate vendor contract
- Manage contracts
- Perform quality assurance
- Manage Stakeholder Expectations

Additional knowledge and skills needed by the PM for executing activities also include:

- Project monitoring tools and techniques
- Elements of a statement of work
- WBS interaction elements within the project schedule
- Project budgeting tools and techniques
- Quality standard tools
- Continuous improvement process

The primary goal of the Executing process is to direct and manage project execution.

Monitoring and Controlling Process Group

The focus in the monitoring and controlling process group is to measure the performance of the project and address change requests, recommended corrective and preventive actions, and implement defect repairs.

The elements in the Monitoring and Controlling process group include:

- Performance measuring
- Performance reporting
- Identify and control changes
- Verify and control scope
- Control schedule
- Control cost
- Control quality
- Risk monitoring and control
- Take corrective action
- Update PM plan
- Update actions and changes
- Inspections
- Accept/Reject work
- Identify & analyze trends
- Look for new risks
- Assess variances for change or corrective action
- Manage Stakeholders
- Contract administration
- Use quality control tools
- Project performance appraisals
- Perform earned value calculations

Additional knowledge and skills needed by the PM for monitoring and controlling activities also include:

- Performance measurement and tracking techniques (e.g. PERT, EV, CPM)
- Project control limits and thresholds
- Project performance metrics
- Cost analysis techniques
- Project plan management techniques
- Change management techniques
- Integrated change control processes
- Risk identification and analysis techniques
- Risk response techniques
- Problem solving techniques (e.g. root cause analysis)
- Reporting procedures

The primary goals of this process group are: Monitor and Control Project Work and Integrated Change Control

Typically, this is one of the lowest scoring process groups on the PMI exam. Make sure you spend adequate time studying and understand the concepts and actions taken in this area. You may see exam questions regarding the following actions required to complete the monitoring and controlling process group:

- Perform root cause analysis
- Secure additional funding, if needed
- Perform validated defect repair
- Calculate the ETC (estimate to complete)
- Reassess project control systems for effectiveness

Exam Tip. For the exam assume that:

- The project management plan and subsidiary plans are complete and realistic
- You measure the project against defined metrics to determine how well the project is performing
- You implement corrective actions for any variances
- If there are deviations from the project management plan, that is the responsibility of the project manager, and the Project manager is responsible for correcting those deviations without issuing a change request. CRs should be used only as a last resort in this instance.

Closing Process Group

The primary elements in the Closing process group include:

- Perform final product verification
- Deliver final contract performance reporting
- Audits of all procured service/merchandise
- Obtain formal contract acceptance
- Create a contract archive
- Complete final performance reporting
- Obtain formal acceptance of project
- Document and lessons learned
- Create the project archives
- Release all project resources

Additional knowledge and skills needed by the PM for closing activities also include:

- Contract closure requirements
- Basic project accounting principles
- Close-out procedures
- Feedback techniques
- Project review techniques
- Archiving techniques and statutes
- Compliance
- Transition planning techniques

The project is only complete when administrative closure of the project has been completed. Whether the project has completed all scope elements, has completed a specific project phase, or is canceled, the project is not officially closed until Administrative Closure has been completed.

If the scope of the project has been completed, the listing above is generally a good guide to the administrative closure process. However, if the project was terminated or stopped after a specific phase, you want to document the reasons for the early termination in your closeout documentation.

If your project was successful, and of course it will be because you are an excellent project manager, there is one final step you must never forget:

CELEBRATE!

Cross-Cutting Skills

PMI has defined what is described as cross-cutting skills needed by the PM that apply to all process groups. These skills include:

- Active listening
- Brainstorming techniques
- Conflict resolution techniques
- Cultural sensitivity and diversity
- Data gathering techniques
- Decision making techniques
- Facilitation
- Information management tools, techniques, methods
- Leadership tools, techniques
- Negotiating
- Oral and written communication techniques, channels, applications
- *PMI's Code of Ethics and Professional Conduct*
- Presentation tools and techniques
- Prioritization/time management
- Problem-solving tools, techniques
- Project management software
- Relationship management
- Stakeholder impact analysis
- Targeting communications to intended audiences
- Team motivation methods

CRITICAL NOTE:

Review the high level elements in the Initiating, Planning, Executing, Monitoring and Controlling and Closing process groups from pages 3-4 thru 3-10 regularly. As you review each knowledge area, specifically review the process groups that apply to the knowledge area. This is critical for maintaining a high level perspective for the PMP examination.

Knowledge Area Logistics

There are nine key knowledge areas contained in the *PMBOK® Guide*, 4th edition. Each key knowledge area along with its subsidiary processes all follow the same format when describing deliverables for each process:

- **Inputs** - these are the documents and processes that contain the data and information from the project which are then acted upon by:
- **Tools and Techniques** - which can include formal analysis, the use of mathematical models and templates to produce:
- **Outputs** - which are the desired results of the process

In this manual these elements will be represented in the graphic below:

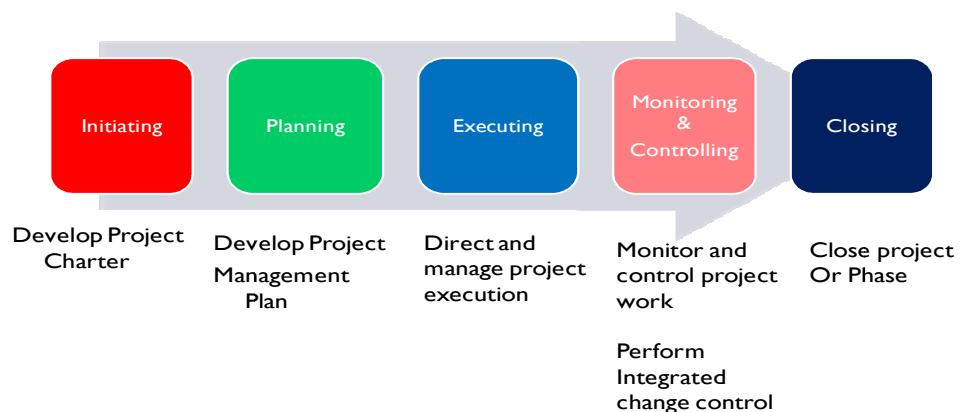


The Nine PMI® Knowledge Areas:

Project Integration Management	Project Human Resources Management
Project Scope Management	Project Communications Management
Project Time Management	Project Risk Management
Project Cost Management	Project Procurement Management
Project Quality Management	

On the next pages we will show the general processes that apply to each of the nine PMI knowledge areas.

Project Integration Management

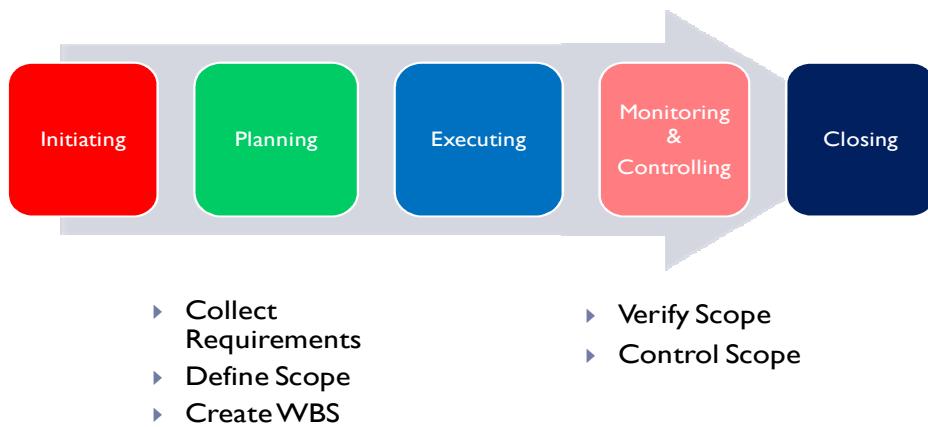


For the purposes of the exam, the primary job of the project manager is to assemble all the parts and pieces of the project into a coherent whole. The way the project manager does this is through Project Integration activities.

The Project Integration is the only area that has activities in all five of the PMI process groups. The following six processes and the primary goals of these processes are listed below:

- Develop project charter. Goal: the project charter
- Develop project management plan. Goal: the project management plan
- Direct and manage project execution. Goal: deliverables
- Monitor and control project work. Goal: updates, requested changes
- Perform integrated change control. Goal: change requests, updates
- Close project or phase. Goal: Final product, service, or result transition

Project Scope Management

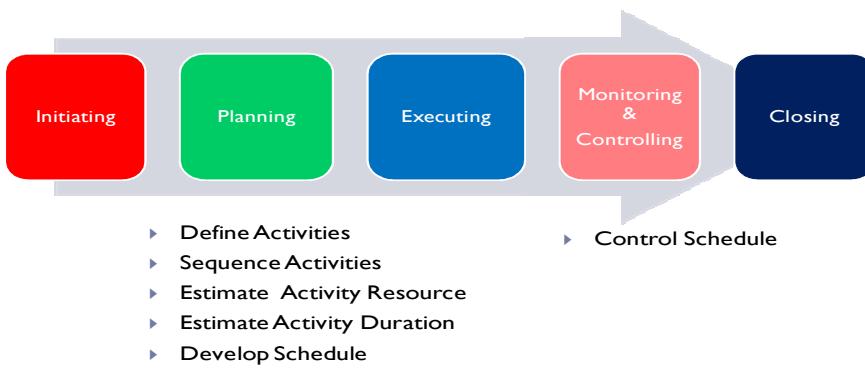


Project scope management focuses on the processes that are needed to ensure that the work of the project, and only the work required, is performed to deliver project success.

The following processes and the primary goals of project scope management are defined below:

- Collect requirements. Goal: requirements documentation
- Define scope. Goal: Project scope statement
- Create WBS. Goal: the WBS
- Verify Scope. Goal: accepted deliverables
- Control scope. Goal: updates and change requests

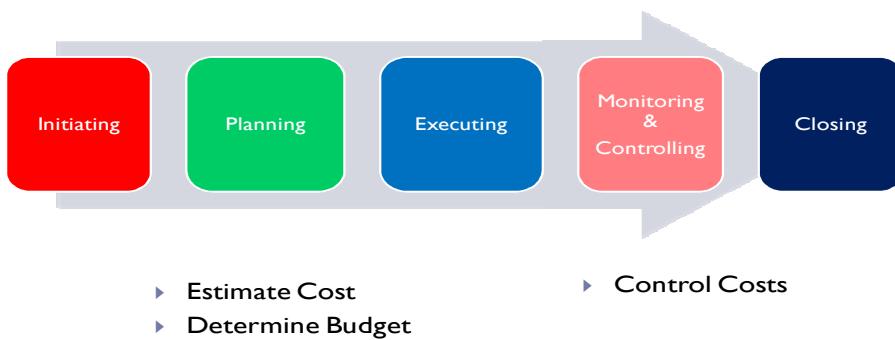
Project Time Management



Project Time management includes all the activities necessary to complete the project in a timely fashion. The following processes and the primary goals of project time management are defined below:

- Define activities. Goal: activity list
- Sequence activities. Goal: project schedule network diagrams
- Estimate activity resources. Goal: activity resource requirements
- Estimate activity durations. Goal: activity duration estimates
- Develop schedule. Goal: project schedule
- Control schedule. Goal: work performance measurements, change requests, updates

Project Cost Management

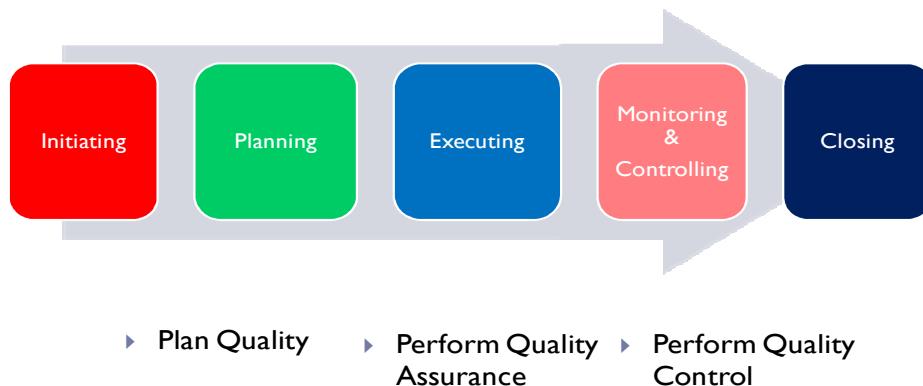


Project cost management involves the processes that are needed to estimate, budget, and control costs, so the project can be completed within the approved budget.

The following processes and the primary goals of project cost management are defined below:

- Estimate costs. Goal: activity cost estimates
- Determine budget. Goal: cost performance baseline
- Control costs. Goal: budget forecasts, change requests

Project Quality Management

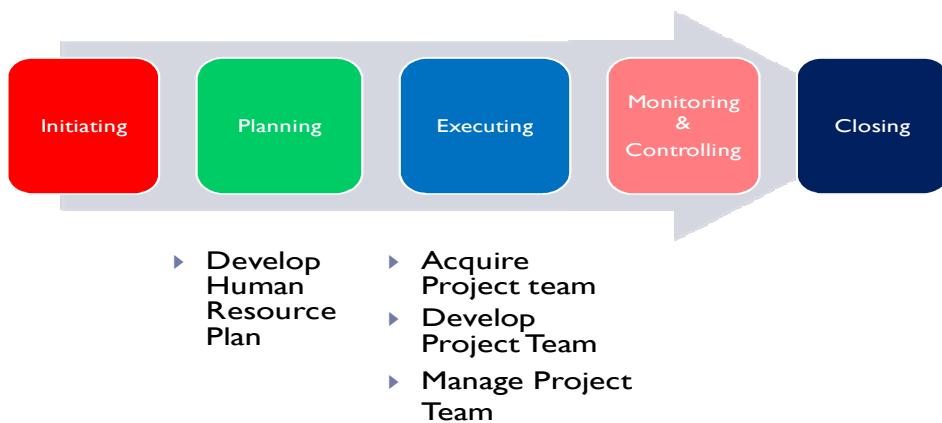


Project quality management focuses on the activities, quality policies, objectives, and measurements required to satisfy the needs of the project and ultimately the customer.

The following processes and the primary goals of Project quality management are defined below:

- Plan quality. Goal: quality management plan
- Perform quality assurance. Goal: change requests
- Perform quality control. Goal: validated deliverables, change requests

Project Human Resource Management

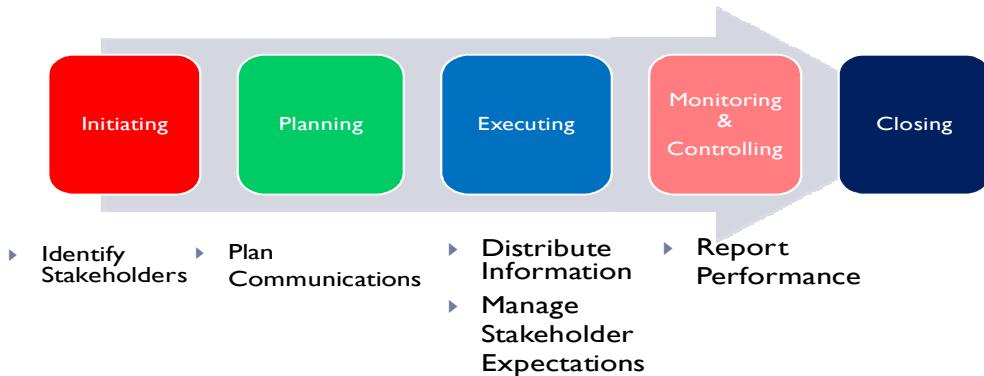


Project human resource management includes the processes that organize, manage, and lead the project team. The following processes and the primary goals of Project human resource management are defined below:

- Develop human resource plan. Goal: human resource plan
- Acquire project team. Goal: project staff assignments

- Developed project team. Goal: team performance assessments
- Manage project team. Goal: updates

Project Communications Management

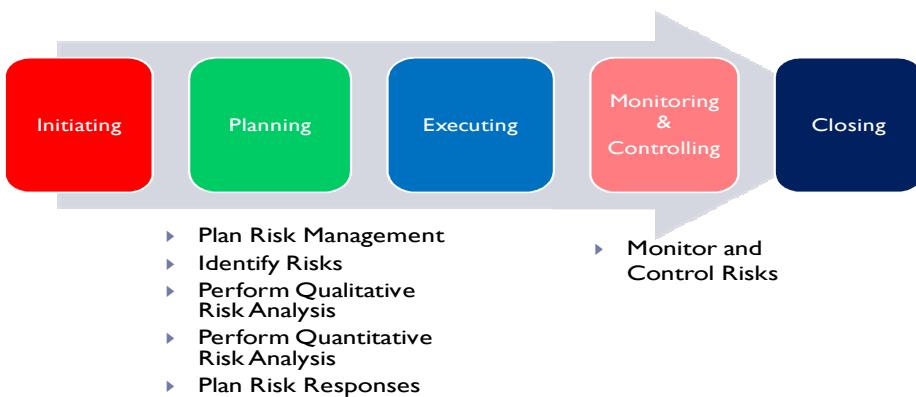


Project communications management focuses on the processes to deliver, collect, distribute, store, and retrieve project information to all internal and external project organization environments.

The following processes and the primary goals of Project communications management are defined below:

- Identify stakeholders. Goal: stakeholder register
- Plan communications. Goal: communications management plan
- Distribute information. Goal: organizational process assets updates
- Manage stakeholder expectations. Goal: change requests
- Report performance. Goal: performance reports

Project Risk Management

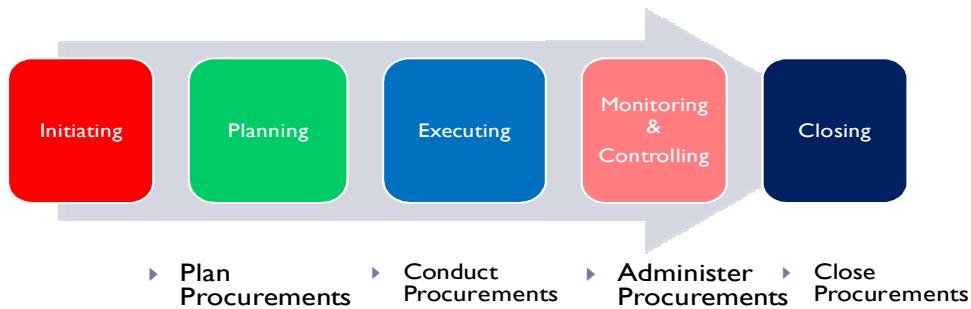


Project risk management focuses on the planning, identification, analysis, response planning, and monitoring and control of risk on a project.

The following processes and the primary goals of Project risk management are defined below:

- Plan risk management. Goal: risk management plan
- Identify risks. Goal: risk register
- Perform qualitative risk analysis. Goal: risk register updates
- Perform quantitative risk analysis. Goal: risk register updates
- Plan risk responses. Goal: risk register updates
- Monitor & control risks. Goal: risk register updates, change requests

Project Procurement Management



Project procurement management focuses on the processes needed to purchase or acquire products, services, or results from outside the project team or the organization.

The following processes and the primary goals of Project procurement management are defined below:

- Plan procurements. Goal: procurement management plan, procurement SOW
- Conduct procurements. Goal: select sellers, contract award
- Administer procurements. Goal: procurement documentation, change requests
- Close procurements. Goal: closed procurements

Mapping Knowledge Areas to Process Groups

	Initiating	Planning	Executing	Monitoring & Controlling	Closing
Project Integration Management	Develop Project Charter	Develop Project Management Plan	Direct and Manage Project Execution	Monitor and Control Project Work Perform Integrated Change Control	Close Project or Phase
Project Scope Management		Collect Requirements Define Scope Create WBS		Verify Scope Control Scope	
Project Time Management		Define Activities Sequence Activities Estimate Activity Resources Estimate Activity Durations Develop Schedule		Control Schedule	
Project Cost Management		Estimate Costs Determine Budget		Control Costs	
Project Quality Management		Quality Planning	Perform Quality Assurance	Perform Quality Control	
Project HR Management		Develop Human Resource Plan	Acquire Project Team Develop Project Team Manage Project Team		
Project Communications Management	Identify Stakeholders	Plan Communications	Distribute Information Manage Stakeholder Expectations	Report Performance	
Project Risk Management		Plan Risk Management Identify Risks Perform Qualitative Risk Analysis Perform Quantitative Risk Analysis Plan Risk Responses		Monitor and Control Risks	
Project Procurement Management		Plan Procurements	Conduct Procurements	Administer Procurements	Close Procurements

Graphic above based on the *PMBOK® Guide*, 4th edition, p. 43

It is strongly recommended that the process groups, knowledge areas, their subsidiary processes and primary goals of the processes be well understood for the examination.

Understanding Process Interactions

IMPORTANT NOTE: on the PMI, PMP exam, you will be assessed by process group, *not* by Knowledge Area. You will be graded as, ‘proficient’, ‘moderately proficient’ or ‘not proficient’ in each of the project management lifecycle process groups:

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

While it is important to understand the processes in each knowledge area, it is more important to understand the interactions of the processes as they occur between the process groups. Many of the questions on the exam will test your understanding of what happens in each of the process groups. Notice on page 3 – 3 that the planning and executing processes iterate, and that this occurs under an umbrella of monitoring and controlling processes. In other words, all three process groups are occurring simultaneously, however, there are specific processes within those groups that occur in a cyclical fashion. Use the charts below to help you understand the process interactions. The specific interactions by knowledge area will appear at the beginning of each knowledge area chapter.

The table below outlines the specific, key output/deliverables by process group and knowledge area. You will find that if you address each knowledge area thoroughly, the contents of the table below will become committed to memory as you progress through this manual.

Initiating	Planning	Executing	Monitoring and Controlling	Closing
Integration: -Select Project manager -Create project charter	Project Management (PM) Plan	Deliverables Work Performance Information	-Change request status updates -Approved CRs -Validated changes	Final product OPA updates
	Scope: -Requirements Management Plan -Requirements Traceability matrix -Scope Statement -Scope baseline		-Accepted deliverables -CRs	
	Time: Activity list/attributes Network diagrams Resource requirements Duration Estimates Schedule/baseline		-Work Performance Measurements -CRs	
	Cost: -Cost estimates -Cost performance baseline		Budget forecasts	
	Quality: -Quality Management Plan -Metrics / checklists -Process Improvement Plan	EEF updates	-Validated deliverables -Work Performance Measurements -QC measurements	
	HR: Human Resource Plan	-Staff assignments -Team performance assessments -Resource calendars		
Communications: Identify stakeholders	Communications Management Plan	Distribute Information	Performance reports	
	Risk: -Risk Management Plan -Risk register/updates -Risk related Contract decisions -PM plan updates		Updates to: -Risk register -CRs	
	Procurement: -Procurement Management Plan -Procurement SOW -Make-or-buy decisions -Source election criteria	Select Sellers Contract Award	Procurements docs	Closed procurements

In Summary...

- ▶ This section mapped the nine PMI knowledge areas:
- ▶ The five PM process groups and the importance in understanding the steps within each process group for the exam
- ▶ The definition of the 42 process areas contained within each of the nine knowledge areas
- ▶ How those processes fit into the PM process groups

Chapter Three Memory Check

1. The five process groups that comprise the project management life cycle are: _____, _____, _____, _____, and _____
2. The two primary outputs of the Initiating process are the project _____ and identify _____
3. The primary goal of the planning process group is to produce the _____, _____, _____.
4. The nine Knowledge Areas of the *PMBOK® Guide*, 4th edition are, in short, _____, _____, _____, _____, _____, _____, _____, _____, and _____
5. Almost half of the processes that occur in the nine knowledge areas of the *PMBOK® Guide*, 4th edition occur in the _____ process group
6. Only the _____ knowledge area has processes in all five of the process groups of the project management life cycle
7. Two primary goals of the Monitoring and Control process group are to _____, _____, _____ project work and to perform _____, _____, _____
8. Early in the project the _____, and the _____ of _____ are low – the _____ and _____ are high
9. PMI defines how a project will tighten its estimates for budget and timeline as more is learned about the project as a _____, _____
10. There are _____ processes spread across the nine Knowledge Areas in the *PMBOK® Guide*, 4th edition

Chapter 3 Test

1. You are managing a project in which the organization utilizes the 'waterfall approach' in executing projects. They have adopted the PMI 'methodology' and the IPECC approach has become the foundation for their internal project methodology. Senior management has approached you and has insisted that you use the phased approach as defined by PMI in delivering the project: initiate, plan, execute, monitor and control, and close (IPECC). What is the *most factual* information you can give senior management regarding IPECC process groups?
 - a. You will follow the PMI methodology to the letter
 - b. You will follow the PMI methodology if the specific project warrants its use
 - c. The process groups are not project phases
 - d. IPECC will only work if you use all the processes in the nine key process areas
2. What is the primary goal of the Initiating process group?
 - a. Determine the project goals
 - b. Create the project charter
 - c. Determine the initial budget
 - d. Identify processes and standards
3. Verify Scope is part of what process group?
 - a. Planning
 - b. Executing
 - c. Closing
 - d. Monitoring and Controlling
4. The completion of work packages, holding meetings, distributing Project information, negotiating contracts and performing quality assurance are all part of what process group?
 - a. Executing
 - b. Planning
 - c. Initiating
 - d. Closing
5. The Planning process group touches all nine of the key knowledge areas in that planning has to occur in each of these areas. Which of the following is *not* part of the planning process?
 - a. Creating the WBS
 - b. Develop the project management plan
 - c. Estimate activity durations
 - d. Identify stakeholders
6. You are a senior project manager at a company that has just hired several junior project managers. Part of your job is to mentor these junior project managers so that they can rapidly become effective in the organization. Each of these junior project managers is a PMP® so you are reasonably sure that they understand the PMI framework. You decide to find out how deep their knowledge goes and ask them, "How many of the processes in the key knowledge areas do we use all the time?" Which junior PM gave the *best* answer?
 - a. Jr. PM#1: All the processes have to be used all the time; otherwise you're not following the PMI methodology.
 - b. Jr. PM#2: All the Planning processes have to be used all the time; you have some flexibility with the other process groups
 - c. Jr. PM#3: The Project manager is responsible for determining which processes are appropriate for the specific project

- d. Jr. PM#4: **All** processes in the Planning group that address the triple constraints of cost, time, and budget, along with risk planning must be done on all projects. The remaining processes are at the discretion of the project manager
7. In the Monitoring and Controlling process group, one of the primary goals of that group is to monitor and control the project work. What is the second equally important, major goal of the monitoring and control process?
- Quality control
 - Change control
 - Scope control and verification
 - Corrective action
8. You are just initiating a project for your organization. Which of the following is a true statement regarding the Initiating process?
- Risk is low but stakeholder influence is high
 - Staffing level is high while chance of success is low
 - Risk is high but the chances of success are also high
 - Stakeholder influence is high while costs are low
9. Your project is in the planning phase and many of the stakeholders are excited about the product that will be delivered once the project is done. You have solicited input from the stakeholders, addressed technical issues with the technical team, estimated costs, determined the high-level project schedule, created a statement of work, created a work breakdown structure, identified and quantified risks, developed the project management plan and all subsidiary key knowledge area plans, and received stakeholder sign off of the plan. What is the *next* thing you will most likely do?
- Verify stakeholder input
 - Hold a kickoff meeting
 - Consult management for a go/no-go decision
 - Place the project management plan under configuration management
10. In the Executing process group the main goal is to direct and manage project execution. All of the following are elements in the executing process group with *one exception*:
- Complete work packages and use a work authorization system
 - Obtain bids from vendors, select vendors and negotiate the vendor contract
 - Collect status information and hold meetings
 - Validate the deliverables as the project is being executed
11. When does the Closure process occur?
- Closure occurs only at the end of the project
 - Closure activities can occur at the end of the project or at the end of a project phase
 - Closure occurs before the closeout of any contracts on the project
 - Closure occurs after the stakeholders have conducted user acceptance testing
12. The project you are managing includes many stakeholders, geographically distributed across the country. As part of the planning process you have put together a communications plan that will address the communications needs of all the stakeholders on the project, from the performing organization up to and including the sponsor. Part of this communications plan includes the distribution of information as well as reporting the performance of the team. The PMI process groups you are utilizing are:
- Information distribution and performance reporting occur in the Executing process group
 - Information distribution and performance reporting occur in the Monitoring and Controlling process group

- c. Information distribution occurs in the Executing process group while performance reporting occurs in the Monitoring and Controlling process group
 - d. Information distribution occurs in the Monitoring and Controlling process group while performance reporting occurs in the Executing process group
13. You are engaged in a large project that requires complex coordination between many departments in your organization. You have almost completed the planning phase and are looking for sign-off of the project management plan. You have addressed overall project integration activities, the budget, the timeline, the scope of the work, quality planning, resource acquisition, communications for a distributed team, and some procurement activities that require the use of external vendors. What has the project manager forgotten to do?
- a. Create a work breakdown structure
 - b. Risk assessment
 - c. Creation of a requirements traceability matrix
 - d. Creation of a change management system
14. There are many reasons for creating a lessons learned document in a project. All of the following represent reasons why you would create a lessons learned document with the *exception* of:
- a. Creates an archive to advise future project teams what types of projects and resources they should avoid when initiating similar projects
 - b. Serves as a historical record for what worked and what did not work in your project so that future project teams can make use of the information
 - c. Used as a phase-end review tool so the team can implement incremental process improvement activities for the subsequent phases
 - d. Gives all project stakeholders a chance to input what issue resolution approaches were most effective for them on the project
15. You have been brought into a project for a 'project rescue'. Management had issues with the previous project manager and dismissed him from the company. You sit down with the project team for the first time and discover that there is a lot of activity going on and that the project is well under way: the requirements have been completed and design work is about half way done. However, there is a lot of contention between the members of the performing organization. A number of people are arguing about who should handle what activities, how long they are going to take, and in what order the activities should occur. From listening to these arguments it becomes clear to you that the prior project manager *probably* did not do what?
- a. Obtain formal approval of the project charter
 - b. Identify processes and standards
 - c. Determine the project schedule
 - d. Create a project management plan
16. The team has completed all design work and is ready to start creating a product of the project. There are construction and IT elements in this project, and the project manager has leaned heavily on the subject matter experts in the organization for their technical expertise and know-how. You have determined that some of the work needs to be contracted to an external vendor who has the necessary expertise to deliver what is needed for the project. You are in the process of selecting a vendor. What process group are you in?
- a. Planning
 - b. Initiating
 - c. Monitoring and Controlling
 - d. Executing

17. All the following happen in the Initiating process with the *exception* of:
- Choose the project team
 - Determine stakeholders
 - Identify processes and standards
 - Create the project charter
18. You are deep in the planning process for your project and have created a human resource plan in which you have identified what skill sets are needed, when they are needed, and when they will roll off the project. You are now focused on the process of acquiring, developing, and managing the project team. Which of these processes occur in the monitoring and controlling process group?
- Acquire project team only
 - Manage project team only
 - Develop and Manage project team only
 - This is a trick question - none of them do
19. Within the Project Time Management knowledge area, in what order do the planning activities occur before you can develop the project schedule?
- Define activities, estimate activity duration, estimated activity resources, sequence activities
 - Define activities, estimate activity resources, sequence activities, estimate activity duration
 - Define activities, sequence activities, estimate activity resources, estimate activity duration
 - Define activities, estimate activity duration, sequence activities, estimate activity resources
20. One of the Junior Project managers you're mentoring has come to you for help. She just started the planning process and sat down with the key stakeholders to begin the requirements collection activities for her project. At the end of the meeting the stakeholder who will be receiving the deliverable stated that he wanted to see a definitive budget estimate for the project within one week of the completion of the requirements collection process. She explained that might not be possible because the team will not have had enough detail at that point to construct a solid estimate. He said he didn't care and that he needed the estimate for the capital budgeting meeting that is occurring at the end of the month - two weeks from now. What is the *best* advice you can give your Junior Project manager?
- Take your best guess and double it. Since it is too early in the project to deliver a definitive estimate you tell the stakeholder this is the best estimate you can come up with at this point
 - It is not possible to deliver a definitive estimate until the planning process is complete. The best you can do at this point is a rough order of magnitude estimate which goes from -50% to plus 50%
 - Escalate the issue to senior management as the stakeholder is obviously delusional
 - Sit down with the delivery organization, work through the weekend if you have to, and come up with the closest estimate you can deliver.
21. Where do lessons learned activities occur?
- In between the monitoring and controlling process and the closing process
 - Whenever there is an issue identified that needs to be addressed
 - In each phase-end closing process as well as the closing process at the end of the project
 - Only at the end of the project
22. What is a synonym for 'progressive elaboration'?
- Cyclical planning
 - Quantified elaboration
 - PERT estimates
 - Rolling wave planning

23. You are managing a program to recruit new project managers for your organization. You have just completed a training session in which you have identified the five process groups in the PMI framework and just asked the class the following question: "What is the purpose of the initiating process group?" Which of the student responses was the *best* answer?

- a. Initiating kicks off the project
- b. Initiating can kick off the project or a phase of the project
- c. Initiating can kick off a project, a project phase, or contract
- d. Initiating identifies the project manager and produces a project charter

24. What is the key primary benefit of the monitoring and controlling process group?

- a. It manages the change request process
- b. It plays a key role in measuring and managing procurement activities for the project
- c. You can observe project performance, measure it, and identify variances from the project management plan
- d. Insures, through metrics and measurement, that changes to the project management plan are prevented to eliminate scope creep

25. In an organization that uses 'hit or miss' project processes, they have come to you for advice on which of the five PMI process groups would be the best one to implement, if they had to boil it down to just one.

What is the *best* advice you could give them?

- a. Executing processes would serve you best
- b. Planning processes would serve you best
- c. Initiating processes would serve you best
- d. Monitoring and Controlling processes would serve you best

26. You are a project manager in an organization with a strong PMO. One of the newly hired project managers told you that he has been a PMP® since 1998. While perusing the PMI website looking for some standards documentation, you happen to do a lookup on this person and find out that they are not in the PMI repository of PMP®'s in good standing. What do you do?

- a. Call law enforcement and report the individual
- b. Report the individual to PMI
- c. Report the individual to his senior manager
- d. Report the individual to the PMO

Chapter 3 – Test Answers

1. C – In *PMBOK® Guide*, 4th edition, p. 41
2. B – Creating the project charter is the only correct answer. *PMBOK® Guide*, 4th edition, p. 73
3. D – Monitoring and controlling is the only correct answer. *PMBOK® Guide*, 4th edition, p. 104
4. A – Executing is the only correct answer. *PMBOK® Guide*, 4th edition, pp. 55-56
5. D – Identify stakeholders is part of the Initiating process
6. C – In *PMBOK® Guide*, 4th edition, p 38
7. B – Integrated Change Control is the only correct answer. *PMBOK® Guide*, 4th edition, p. 60
8. D – This is the only correct answer. *PMBOK® Guide*, 4th edition, p. 44
9. C – In phase gated process, when the planning work is completed and signoffs are received, we are looking for a go/no go decision from senior management
10. D – Validating deliverables is a monitoring and controlling process
11. B – Closure occurs at phase-end and project end activities
12. C – Information distribution occurs in the Executing process group while performance reporting occurs in the Monitoring and Controlling process group. *PMBOK® Guide*, 4th edition, p. 56
13. B – Risk assessment is the only remaining knowledge area that was not covered
14. A – Lessons learned are not used to torpedo resources you had issues with or steer you away from uncomfortable projects. They usually focus on performance and process improvement
15. D – Only a well documented project management plan (which includes the entire scope baseline) would help to organize the work
16. D – Vendor identification and selection occurs in the Executing process group. *PMBOK® Guide*, 4th edition, p. 56.
17. A – Choosing the project team is a Planning group activity. *PMBOK® Guide*, 4th edition, p. 53
18. D – It is a trick question; there are no processes in the Human Resources knowledge area that fall into the Monitoring and Controlling process group
19. C – This is the only correct answer. *PMBOK® Guide*, 4th edition, p. 131
20. B – Your job is to give management a reality check, not feed in to a management wish- fulfillment fantasy or turn yourself and the team inside-out attempting to meet an impossible demand. This eliminates answers A and D. Answer C is something you might wish to say ☺, but will always be wrong on the exam...
21. C – Lessons learned occur when ever the closure process occurs: phase-end and end of project
22. D – Rolling wave planning is the correct answer. A and B are non-existent terms and PERT is used for schedule estimating
23. B – This is the most inclusive answer. A and D are both true but not complete. C is a red herring. *PMBOK® Guide*, 4th edition, p 44 “The Initiating Process Group consists of those processes performed to define a new project or a new phase of an existing project by obtaining authorization to start the project or phase”
24. C – *PMBOK® Guide*, 4th edition p 69
25. B – All the processes are important, but they all depend on Planning
26. B – Report the individual to PMI. The PMP® credential is issued by PMI, not your organization. Answer A is a red herring. Answers C and D, while seemingly appropriate, miss the point: the credential comes from PMI

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Chapter 4 : Project Integration Management

Knowledge Area Processes:

- ▶ Develop Project Charter
- ▶ Develop Project Management Plan
- ▶ Direct and Manage Project Execution
- ▶ Monitor and Control Project Work
- ▶ Integrated Change Control
- ▶ Close Project

Section Objectives

At completion you will know how to:

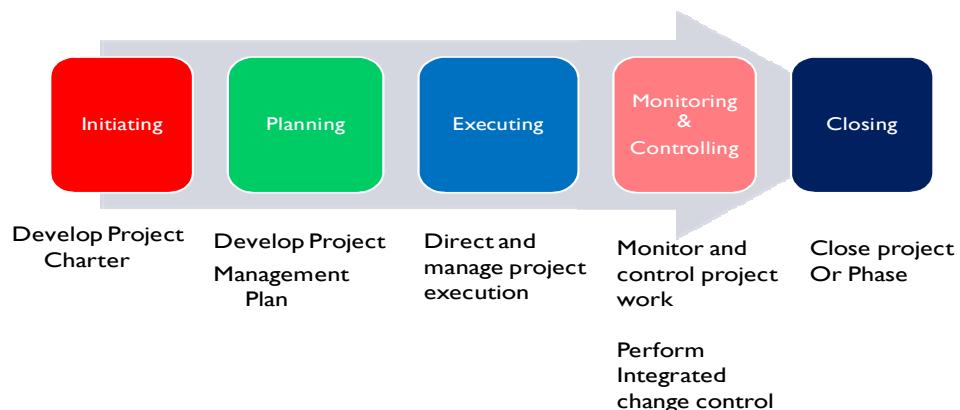
- ▶ Organize Integration management processes into the PM process groups
- ▶ List the elements and purpose of a project charter
- ▶ Describe the two fundamental project selection techniques
- ▶ Define a PMIS and its two key components
- ▶ List the components and importance of a project management plan
- ▶ Describe the components and importance of a change control system and a configuration management system
- ▶ Perform steps needed to implement changes

Integration Process Summary

The high level Project Integration Management outputs, by Process Group are:

Initiating	Planning	Executing	Monitoring and Controlling	Closing
Project Charter Select project manager	PM Plan	-Deliverables -Work Performance information -CR's	CRs Change Request Status Updates	Final Product
			Updates to: • PM Plan • Project Documents	OPA Updates

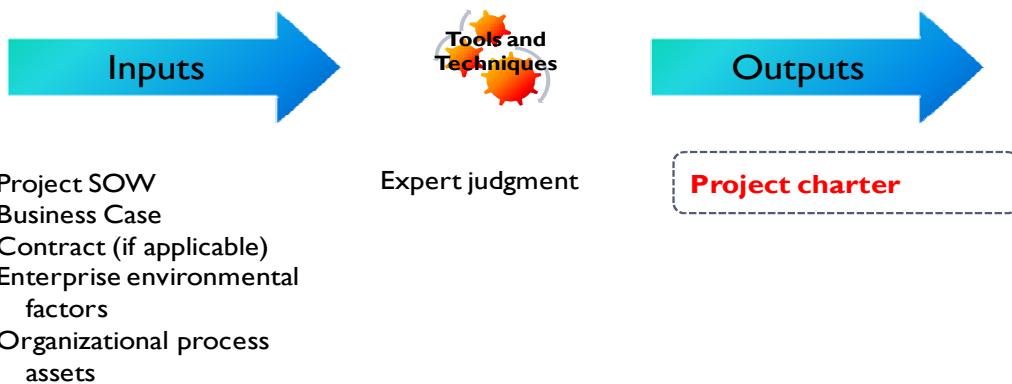
Project Integration Management



For the purposes of the exam it is important to know both the process areas within the Project integration management knowledge area, and which project management process group each of the processes fall into:

Process	Process Group
Develop Project Charter	Initiating
Develop Project Management Plan	Planning
Direct and Manage Project Execution	Executing
Monitor and Control Project Work	Monitoring & control
Perform Integrated Change Control	Monitoring & control
Close Project or Phase	Close

Develop the Project Charter



Contrary to how many businesses do this, a project charter is a brief two or three page document (at most) that imparts high-level information about the project: The project description, project manager and their authority level, a high-level business case, stakeholders, high-level deliverables list, high-level project risks, defined project objectives, project approval requirements and formal sign off are all part of the project charter.

In one sense, the project charter functions as an excellent executive summary of the project. For the exam, know that a charter is a required element that must be completed and signed off before further project work can begin.

Charter Elements

Key charter benefits - elements for the exam:

- Formally recognizes existence of the project
- The PM is authorized to spend money and commit resources to the project (most commonly described benefit)
- Describes high-level requirements
- Links the project to other work in the organization

The charter elements may include, but are not limited to:

- ▶ Project title
- ▶ Project manager assigned and authority level
- ▶ Business need
- ▶ Project justification/business case
- ▶ Initial resources pre-assigned
- ▶ Stakeholders
- ▶ Initial scope and requirements
- ▶ Project/product description and deliverables

- ▶ Initial constraints and assumptions
- ▶ May include S.M.A.R.T. goals (Specific, Measurable, Agreed, Realistic, Time-bound)*
- ▶ High level budget estimate
- ▶ Sponsor Signature/signoff

*There are many variants on the SMART acronym. A few appear below⁷:

S - specific, significant, stretching

M - measurable, meaningful, motivational

A - agreed upon, attainable, achievable, acceptable, action-oriented

R - realistic, relevant, reasonable, rewarding, results-oriented

T - time-based, timely, tangible, trackable

Project Statement of Work

The project SOW is a high-level description of the products or services the project will create. It is usually created by the customer/sponsor.

Fundamental elements of an SOW:

- Business need
- *Product* scope description
- Strategic plan

Usually a summary if the work is being performed internally – the detail is developed in the WBS

For external services procured, the SOW is called the 'Procurement Statement of Work' (Details will be addressed in Section 12 on Procurement)

In regards to the project charter, the Project Statement of Work is more of a high-level summary. According to PMI, it is a narrative that describes products or services that are delivered by the project. (*PMBOK® Guide*, 4th edition, p. 75). For an internal project, work is actually detailed in the work breakdown structure (WBS) and the WBS dictionary. The Project Statement of Work references:

- Business need
- Product scope
- Strategic plan

A *contract* or procurement statement of work is a legal document that requires a legal review and review by contract administration professionals. Contract statements of work can run many thousands of pages on a large project, and legally obligates the vendor to deliver exactly what is in the contract statement of work. Details on the contract statement of work will be addressed in the Project Procurement Management section (Section 12).

⁷ <http://www.projectsmart.co.uk/smarter-goals.html> Duncan Haughey, PMP

Enterprise Environmental Factors

Enterprise Environmental Factors (EEF) are a recurring input to over 20 of the processes primarily in the Planning Process Group. The key elements involving enterprise environmental factors include:

- Organizational culture and structure
- Government and industry standards
- Existing human resources
- Personnel administration
- **Company work authorization system***
- Marketplace conditions
- Stakeholder risk tolerances
- Commercial databases
- _____ – _____ e.g., an automated tool suite, such as a scheduling software tool, a configuration management system, an information collection and distribution system, or web interfaces to other online automated systems).

***Exam Tip:** A work authorization system is designed to ensure that work is approved before it begins, and to ensure the work is done at the right time and in the correct sequence. Use of a work authorization system also helps to prevent scope creep as well as goldplating.

Organizational Process Assets

Includes the organization's processes, such as:

- Standards and policies
- Performance measurement criteria
- Templates
- Communication requirements
- Project closure guidelines
- Procedures for:
 - Financial controls
 - Change control
 - Issue and defect management
 - Risk control
- Approving and issuing work authorizations
- Includes organization's knowledge base, such as:
 - Project files
 - Historical information
 - Lessons learned
 - Databases for financials, configuration management, issues, and defects

Project Selection Methods

Benefit Measurement Methods include the following six approaches:

- Murder Board
- Weighted Scoring Models
- Internal Rate of Return (IRR)*
- Benefit Cost Ratio (BCR)*
- Present Value (PV)/Net Present Value (NPV)*
- Payback Period*

* These elements help to determine ROI (Return on Investment)

Constrained Optimization methods include the following five approaches:

- Linear programming
- Nonlinear programming
- Dynamic programming
- Integer programming
- Multi-Objective Programming Algorithms programming

EXAM TIP: due to changes in the exam content since August, 2011, PMI has stated that project selection methods are *outside of the scope* of the duties that the project manager performs on a project. However, you still may see questions on the exam relating to project selection methods. Some of these key project selection methods are described briefly below.

The Murder Board

Historically, a **murder board** is a committee of questioners set up to help someone prepare for a difficult oral examination. The term originated in the U.S. military but is also used in academic and government appointment contexts.

When applied to project selection, the murder board looks for projects that:

- May not meet the organization's strategic objectives
- Might be a stakeholder's pet project
- Are impractical
- Are unrealistic
- Are beyond the organization's capability
- Do not add much value to the organization's project portfolio

Weighted Scoring Models

Weighted scoring models are used when we are attempting to compare projects for selection based upon critical project criteria. Use of the model assumes that the model criteria, as well as the scoring for those criteria, can be accurately quantified.

This model can also be used as a project screening method. For example, certain criteria can be highlighted as 'showstopper' criteria, meaning that if a project does not achieve specified minimum scores on specific criteria, the project will be eliminated from consideration.

For the exam assume that a formal process exists that allows you to choose between projects.

Computing Present Value and Net Present Value

You will not be asked to compute present value or net present value for the exam; however you do need to understand the concepts.

Present value is the specific value today of an amount of money in the future. It reflects the diminishing value of a fixed amount of money over time.

Stated a little differently, a dollar today will not be worth a dollar three years from now. A dollar three years from now may be worth \$.79 in today's money value.

Net Present Value is defined as the *total* present value (PV) of a time series of cash flows

Exam Tip: Choose the project with the highest NPV

Present value can be computed not only for income but for costs as well.

Future Value

Future value is another way of looking at present value but from the opposite perspective: **Future value** measures the future sum of money that a given sum of money is worth at a specified time in the future assuming a certain interest rate, or a constant rate of return.

Exam Tip: Choose the project with the highest Future Value

Future value can be computed not only for income but for costs as well.

Internal Rate of Return (IRR)

Stated simply the internal rate of return is the interest that you get paid for an investment on a yearly basis.

A bond returning an annual 16% interest rate on a \$100K investment will return 16% or \$16 K per year for the duration of the investment.

Payback Period

The payback period is the number of complete time periods needed to recover your investment in the project before you start seeing a return on the investment. If the investment is paid back, for example, in three years and 4 months, the payback period is always rounded up to the next whole year. In this case the payback period is 4 years.

Exam tip: Always choose the project with the shortest payback period when given an option.

Benefit Cost Ratio

This option compares the benefits of doing a project in relationship to its costs.

For the exam, you always choose a project with the highest benefit cost ratio. If the BCR is > 1 , select the project; if the BCR is < 1 , reject the project.

Exam Tip: Understand that *the benefit does not always equate to profit*. A benefit cost ratio of 1.6 does not mean that after you pay your costs, profit equals 60%. What this means is that the payback is 1.6 times the costs. In this case the payback can relate to total revenues or include non-financial benefits.

It may also represent EBIDTA: Earnings Before Interest, Depreciation, Taxes and Amortization. You must know how the company computes BCR and what percentage of the BCR represents profit.

Opportunity Costs

The amount of money you give up on one opportunity to pursue another is called the opportunity cost.

For example, three projects are under consideration:

- Project A has an NPV of \$25,000.
- Project B has an NPV of \$82,000.
- Project C has an NPV of \$41,000.

What is the opportunity cost of choosing projects A and B?

Opportunity costs refer to the amount of return you are giving up on one project to pursue another. In the example above, the customer has chosen projects A and B (for whatever reason). Even though project C had a positive NPV of \$41,000, the organization decided not to pursue it. Thus the opportunity cost for not pursuing project C is \$41,000.

Project Cost Selection Methods: Quick Quiz

Method	Project I	Project 2	Project 3
IRR	15%	25%	21%
NPV	\$65k	-\$12k	\$125k
Payback	16 months	8 months	24 months
BCR	1.2	1.0	.8
Opportunity Costs: P1&P2	\$55,000	\$27,500	\$38,000

Try your hand at selecting the correct project based on the numeric comparisons shown onscreen.

- IRR?
- NPV?
- Payback Period?
- BCR?
- Opportunity costs of selecting Projects 1 and 2?

Constrained Optimization Methods



The constrained optimization methods delineated above are sophisticated mathematical models that require sophisticated software to run them. You will not be expected to know how to perform the

calculations contained in the constrained optimization methods. You simply need to know the names of the methods.

Project Selection Summary

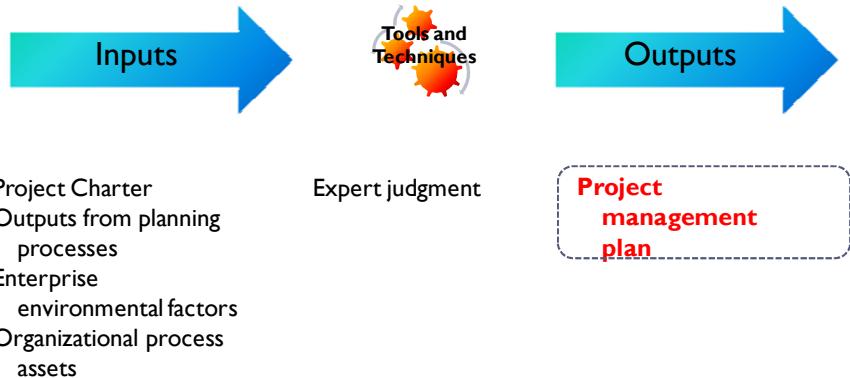
- NPV – most precise and most conservative
- IRR – accurate if there are not negative cash flows
- NPV and IRR – should result in the same decision
- Payback period – least precise, simplest to compute

Additional Financial Terms

Know what these terms mean for the exam:

- **Sunk costs** – what you have spent. Should not be considered when deciding whether to continue with a troubled project
- **Law of diminishing returns** – the more you put in, the less you get in return
- **Working capital** – assets minus liabilities; what the company has to invest in projects
- **Depreciation** – know these for the exam
 - Straight-line depreciation
 - Accelerated depreciation
 - Double declining balance
 - Sum of the Years Digits
- **Categories of cost**
 - Direct – attributable to the project
 - Indirect – overhead items shared by multiple projects
 - Variable– costs that change with the level of effort
 - Fixed – rentals/leases
- **Economic value added:** added value produced by the project above the costs of financing the project
- **Alternative forms of NPV:** there are several methods used to compute NPV based on certain financial conditions. These approaches are called, a) Adjusted present value (APV), b) Flows to equity (FTE), and c) Weighted average cost of capital (WACC). You will not need to know how to compute these methods, but they may appear as part of an answer set on the exam.

Develop the Project Management Plan



Notice that the Project charter as well as organizational process assets (how the organization does projects) and enterprise environmental factors (what the organization is like) are the major inputs to the creation of the project management plan.

The project management plan essentially defines how you will execute, monitor and control, and close the project. When the project management plan is complete, it requires signoff by all key stakeholders on the project.

A critical element to remember is that the project management plan is not 'etched in stone'. If the project is managed as PMI recommends, as a progressive elaboration, adjustments to the project management plan will occur as the team learns more about the project - it is developed through all the integrated processes until the project is closed.

Project Management Plan Defined

- Always written out - *NOT* an MS Gantt chart (!)
- A repository for subsidiary plans needed for the project
- Created by the PM with input from stakeholders
- A formal document approved by designated stakeholders
- Progressively elaborated

The project management plan integrates all of the nine Knowledge Areas into a unified whole and serves as a repository for the subsidiary plans in the remaining knowledge areas. However, this does not mean that all the subsidiary plans are always used on every project. PMI clearly states:

"This does not mean knowledge, skills, and processes described should be applied uniformly on all projects. For any given project, the project manager, in collaboration with the project team, is always responsible for determining which processes are appropriate, and the appropriate degree of rigor for

each process... Project managers and their team should carefully address each process and its constituent templates and outputs... This effort is known as tailoring.⁸

The project management plan represents a consolidation of all the subsidiary management plans from all the other process groups as well as from Integration Management. Subsidiary plans can include the following:

- Scope management plan
- Requirements management plan
- Change management plan
- Configuration management plan
- Schedule management plan
- Cost management plan
- Quality management plan
- Process improvement plan
- Human resource plan
- Communications management plan
- Risk management plan
- Procurement management plan

Why the Project Management Plan Is Needed

- How the selected processes will be used to manage the specific project, including the dependencies and interactions among those processes, and the essential inputs and outputs
- How work will be executed to accomplish the project objectives
- How changes will be monitored and controlled
- How configuration management will be performed
- How integrity of the performance measurement baselines will be maintained and used
- The need and techniques for communication among stakeholders
- The selected project life cycle and, for multi-phase projects, the associated project phases
- Key management reviews for content, extent, and timing to facilitate addressing open issues and pending decisions

Bullet points above described some of the major reasons why the project management plan is needed on a project; however there are several other critical reasons why you need a documented project management plan:

1. If there are changes to the project, that information will need to be captured in the plan. Changes may necessitate a change in direction or possibly a change in the schedule, budget, or scope of the project.
2. Capturing versions of the project management plan as the project changes can help identify trends or issues as the project management plan is executed.

⁸ PMBOK® Guide, 4th edition, p 38

3. Most importantly of all, the documentation is key to understanding what we did, why we did it, and, in the case of issues, what we did to correct problems.
4. Last and most simple is this: **if it is not written down it doesn't exist.** On a large project with many complexities it would be careless and unprofessional to trust critical project elements to memory. A formal written record is essential if we are to evaluate our actions and whether they were successful or not. "How can you fix the problem if you don't know what's broken?"

Project Management Plan Components

- Baselines for cost, schedule, and scope
- Scope statement
- WBS (work breakdown structure)
- Cost estimates, schedule, and responsibility (ownership) for each deliverable
- Performance measurement baselines
- Staff requirements with cost estimates
- Subsidiary management plans for scope, schedule, cost, quality, communications, risk, configuration management, change management, requirements management, process improvement and procurement

Bullet points listed above describe some of the major components in a generic project management plan, however there are a number of other components that can be included. For example, on a software project, you might consider the following additional elements to include in your project management plan:

- Management philosophy
- Development philosophy
- Waivers
- Services
- Non-deliverable products
- Computer systems support
- Peer reviews
- Test philosophy
- Training needs
- Automated aids
- And others...

"The project management plan integrates and consolidates all of the subsidiary management plans and baselines from the planning processes..."⁹

⁹ PMBOK® Guide, 4th edition, p. 81

Baselining the Project Management Plan

The project plan is baselined:

- When all stakeholders have completed and signed-off on all the elements in the Project Planning Phase
- The baseline is the starting point by which all subsequent changes to the project are measured
 - The baseline represents the starting point of **progressive elaboration** activities
 - Critical for managing change against the reality of the project
 - Also key in defining Lessons Learned at the phase/project close

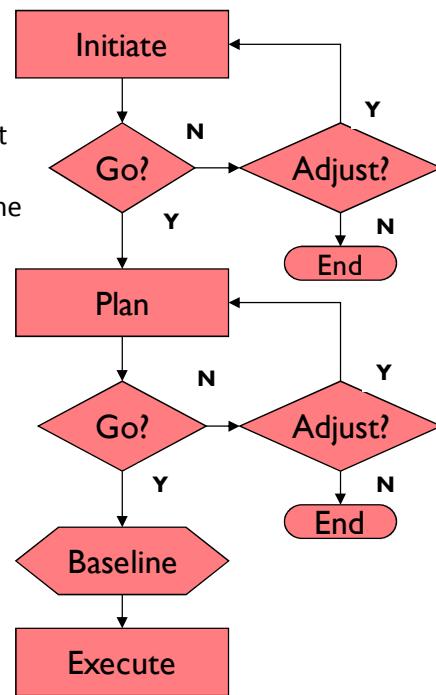
The graphic below shows a generic phase-gated process for baselining a PM plan.

Once the project management plan is complete and all the stakeholders have signed off project management plan, the project management plan is ' baselined'. This means that we use the baselined project management plan as a yardstick against which we measure all subsequent changes to the plan. This information is captured in the performance measurement baseline (PMB):

"The performance measurement baseline is an approved plan for the project work to which the project execution is compared, and deviations are measured for management control"¹⁰

If there are significant changes to the project management plan - for example if there are major discovery elements that add significant scope, time, and budget to the plan - we can re-baseline the project management plan to accommodate those changes. Re-baselining the project management plan generally means that we are working to a new completion date, additional budget and sometimes additional scope elements as well.

If we are applying the project management life cycle for each phase of the project, we can capture lessons learned at the end of each phase and enter these elements in the project management plan as the plan is progressively elaborated.



Configuration Management

- A key element in the project plan that works hand in hand with the change control system
- Used to document all versions of:
 - Project documentation
 - Schedule

¹⁰ PMBOK® Guide, 4th edition, p 267

- Scope
- Deliverables (hardware, software, etc)
- Completed project components

All this information is contained in the PMIS (Project Management Information System) – an EEF

Configuration management is a key element for both manufactured product as well as software products. As various versions of products are released in the marketplace due to improvements or corrective action, the configuration system must capture these changes so that the customer receives the correct version of the product at all times.

Failing to keep a proper configuration file on a 15,000 BTU air conditioner and installing a replacement for a failed capacitor might cause the air conditioner to catch fire (or explode!) upon startup, if the configuration file does not reflect the correct hardware list for that specific model of air-conditioner.

Sending an incorrect software patch to a customer for a specific version of software could cause the software to fail catastrophically, if the software configuration system is not keeping track of the specific version of the software, and all concomitant components being used by the customer.

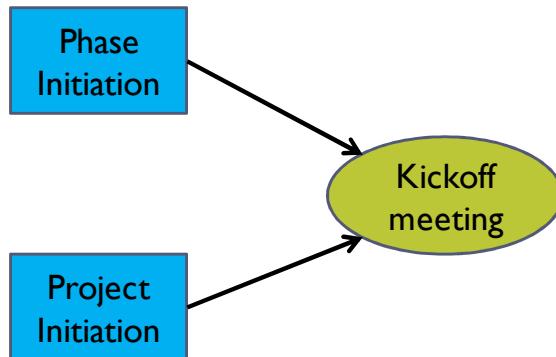
Project Management Information System (PMIS)

The PMIS includes:

- ▶ The Configuration Management System
 - Identifies and documents the functional and physical characteristics of a product or component
 - Controls any changes to such characteristics
 - Records and reports each change and its implementation status
 - Supports the audit of the products or components to verify conformance to requirements
- ▶ The Change Control System
 - The change control system is a collection of formal documented procedures that define how project deliverables and documentation are controlled, changed, and approved
 - The change control system is subsumed within the configuration management system - while the change control system tracks approved and rejected changes, the approved changes become part of the product and, as such, are maintained in the configuration management system.

The PMIS is usually an automated system, although it can also be manual. It is used by the project management team to support generation and versioned storage of all project documents and subsidiary documents feeding the PM Plan.

Project Kickoff Meeting

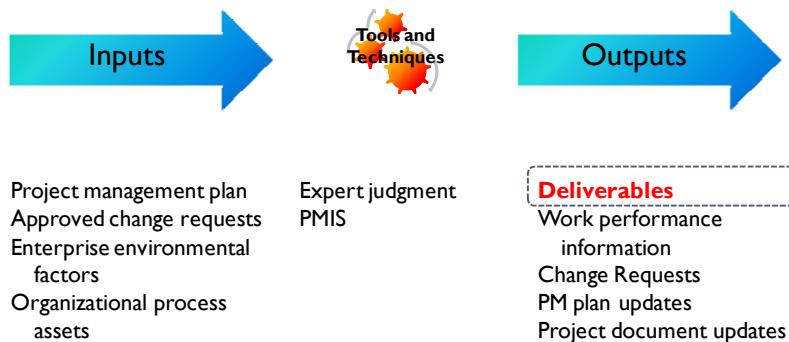


The kickoff meeting is called by the project manager and formally introduces the project team and all stakeholders to the project.¹¹ Optimally, it is best if the kickoff meeting can be held face-to-face with all participants. Due to the distributed nature of teams in the current business environment, this is not always possible. Therefore it is strongly recommended that use of videoconferencing or minimally conference calls with electronic support can be viable alternatives. Kickoff meetings can also occur at the beginning of project phases as well as at different levels in the organizational hierarchy e.g. business kickoff meeting, technical kickoff meeting, infrastructure kickoff meeting, etc. Some of the elements that need to be established in the kickoff meeting include, but are not limited to:

- **Project Review** - review the high-level details of the project including project risks, approximate schedule, approximate budget, high level scope, project constraints or any other required element.
- **Responsibility Assignment Matrix** - for any issues or risks that come up in the project a responsible party will need to be identified along with a due date for resolution.
- **Participation of Key Stakeholders** - it is important to determine upfront what kind of information your stakeholders need, when they need it, how frequently, and in what format
- **Escalation Path** - in the event there are project issues beyond the control of the project manager or the immediate performing organization, a clear escalation hierarchy for problems is required.
- **Frequency and Need for Meetings** - establish immediately the frequency of team meetings and their necessity. Status can be handled via e-mail or posted on an intranet - it may not require valuable team time to hold a meeting simply to report status. Also, decide the criteria for conducting a meeting.

¹¹ www.cioarchives.ca.gov, 1997.

Direct and Manage Project Execution



This process performs the work described in the project management plan to achieve the project objectives. This includes managing the schedule, the budget, scope, quality, communications, human resources, risks, and procurements for the project. Because the primary job of the project manager is an integration function, we must keep all the knowledge areas constantly in mind throughout the project.

Exam Tip:

Change requests can include preventive actions, corrective actions or defect repairs. Keep this in mind as *change requests are a frequent output of most Executing and Monitoring & Controlling processes.*

Project Execution Actions

- Staff, train, and manage the project team members assigned to the project
- Obtain quotations, bids, offers, or proposals
- Select sellers by choosing from among potential sellers
- Implement the planned methods and standards
- Create project deliverables
- Manage risks and implement risk response activities
- Manage sellers
- Adapt approved changes into the project's scope, plans, and environment
- Establish and manage project communication channels, both external and internal to the project team
- Collect project data and report cost, schedule, technical and quality progress, and status information to facilitate forecasting
- Collect and document lessons learned, and implement approved process improvement activities

One of the key aspects of Direct and Manage Project Execution involves the implementation of the approved changes. These changes usually fall into one of the following three categories:

- **Corrective action.** Designed to bring future project work in line with the project management plan.

- **Preventive action.** Designed to reduce the probability of a negative result associated with project risks
- **Defect repair.** Designed to detect any defect in a project process or component with recommendations to repair and or replace the process or component

Work Performance Information: Can be an input or an output. Typically addresses:

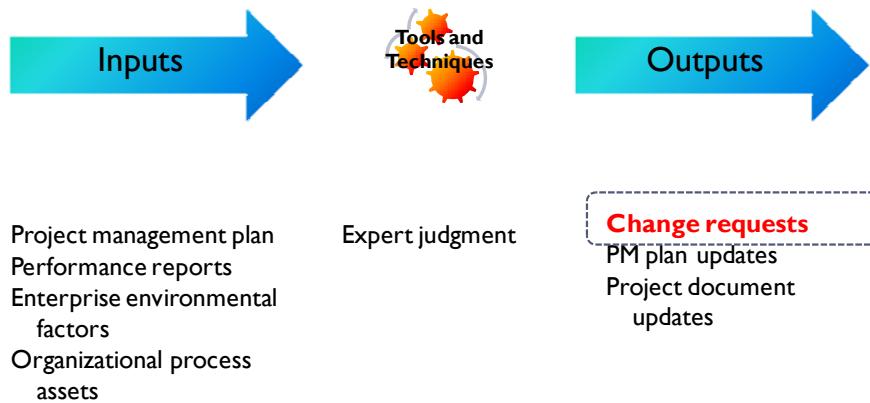
- Deliverable status
- Schedule progress
- Costs incurred

Other concepts that may be covered in the exam but not covered in the *PMBOK® Guide, 4th edition* are the concepts of "Ensuring Common Understanding and Being of Service".

Ensuring Common Understanding means that the project manager ensures everyone is kept up to date on all management plans, project schedules, elements that are in or out of scope, and more. In short it means 'keeping the project team and the stakeholders on the same page'.

Being of Service means the project manager assists the team to help find solutions to problems, facilitating technical meetings, removing roadblocks to project work, and others. In short it means 'how can I help you'.

Monitor and Control Project Work



The monitor and control project work process is one that is done from the beginning of the project through the close of the project. It not only applies to the project at a macro level, but it also applies to each phase of the project as one of the five basic project management life cycle process groups. For the exam, understand that when the subject is discussed, you need to be able to put it in context. It could be referencing one of the five process groups OR monitoring and controlling within the Integration process.

It is in this process group that you are consistently measuring deliverables and outputs against the project management plan.

Corrective Action

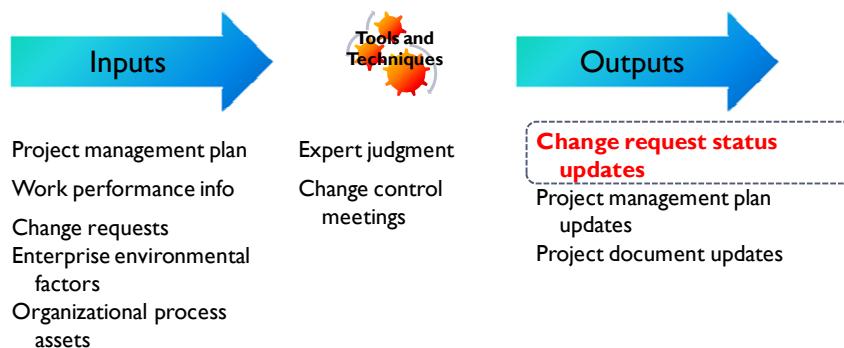
Any action needed to bring future project performance in line with the project management plan is called a corrective action. The three basic steps of Corrective Action:

- Identify the need to take corrective action
- Take corrective action
- Measure the result to determine if additional action is necessary

Corrective actions, preventive actions, and defect repair are recurring themes throughout the *PMBOK® Guide*, 4th edition. The key aspects of these actions for the purpose of the exam, appear below:

- **Corrective Actions.** This presumes you have metrics in place and that you are using these metrics to evaluate the current state of your project against the project management plan. You must be able to seek out root causes of issues and identify potential triggers that will let you know when the project is heading off track. Once the correction is implemented, you need to have measurement tools in place that will validate the effectiveness of the corrective action.
- **Preventive Actions.** These actions can occur as a result of implementing a corrective action. The focus here is on implementing process controls that will obviate the need for a future corrective action.
- **Defect Repair.** According to PMI, defect repair is included in PMI's definition of *Rework*: "Action taken to bring a defective or nonconforming component into compliance with requirements or specifications."¹² **PMI strongly promotes defect prevention over defect repair.** The primary issue with defect repair is that there are only two options when considering defect repair:
 - **Rework.** The output does not meet the project specifications and needs to be brought back into compliance. Rework is always more expensive than preventive action.
 - **Scrap.** This represents the total loss of the work investment and is the most expensive of any of the previous actions

Perform Integrated Change Control



Integrated change control is one of the more challenging areas in the exam. There can be up to 20 questions on the subject, so it is important that you grasp the concepts. The area is important because

¹² *PMBOK® Guide*, 4th edition, p. 438

it impacts all aspects of your project; from the scope, timeline, and budget to the quality, human resources, risks and procurement aspects of the project.

There have been a number of studies done on software projects that show that a change in a project to correct a defect at the unit testing level, which costs a dollar, can cause the business up to 1000 times that amount if the defect is missed in user acceptance testing and actually delivered to the customer. Key reasons for excessive changes on a project are due to, but not limited to, the following:

- Missed requirements
- Failing to engage a key stakeholder at the start of the project
- Stakeholder misunderstanding on what the project is designed to deliver
- A poorly designed WBS
- Inadequate risk assessment

Exam Tip: Work performance information is a frequent input to most M&C processes across the 9 knowledge areas.

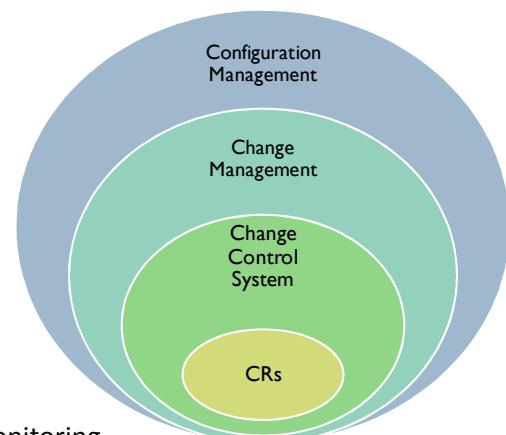
Change Requests

Project changes must be tracked using a formal change management process. These changes also impact your configuration system and the configuration of the project's product. The graphic below shows where change requests sit in the configuration hierarchy. Ensure that you:

- **Identify the configuration items** - labeling and tracking of the configuration items
- **Implement configuration status accounting** - all appropriate data about the configuration item, including status to propose changes and the implementation status of approved changes
- **Perform a configuration verification and audit** - validation that the configuration item has been registered, approved, tracked, and correctly implemented

The steps needed to implement change:

- Identify actual need for change
- Impact assessment: cost, time, resource availability
- Identify change and response alternatives
- Create a documented CR (change request)
- Meet with internal stakeholders
- Meet with the customer, if required
- Submit to change control board (CCB) for ultimate approval (optional if no CCB exists)



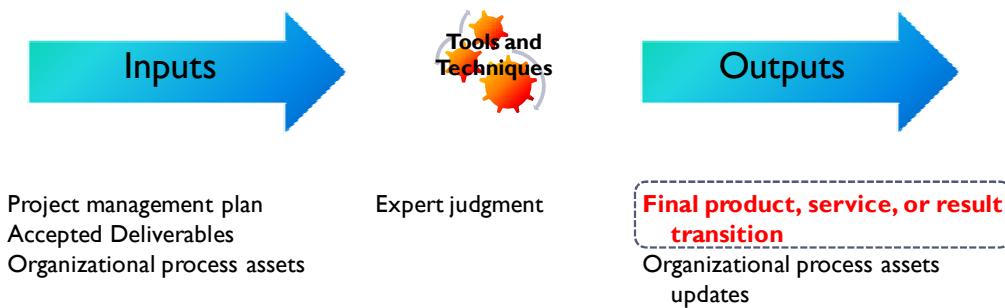
Exam Tip: Changes can be *requested* by Executing or Monitoring & Controlling processes, *approved or rejected* in Integrated Change Control, or *implemented* by Executing processes

Who Authorizes Changes? Quick Quiz...

- ▶ Changes to the Project Charter?
- ▶ Changes to the Performance baselines?
- ▶ Changes to the High Level Constraints?
- ▶ Changes to the Project Plan?

NOTE: While the selections above do not represent every situation, they generally represent change authority levels on a large project. (Answers: Sponsor, Sponsor or CCB, Sr. Management, the PM)

Close Project or Phase



The key element in this section is obtaining formal acceptance to close out the project phase or the entire project. Key elements to remember them in project or phase closure are the following:

- Validate the work was done to requirements for the phase or project
- Formal acceptance of the phase or project
- Complete all performance reporting for the phase or project
- Close any outstanding procurement contracts for the phase or project, if applicable
- Document and archive lessons learned for the phase or project
- Delivery of product increment or product for the phase or the project
- Specific updates to the organizational process assets include: project files, project or phase closure documents and historical information

Understand what the first sentence means - that administrative closure occurs not only at the end of the project, but also at the end of the specific *phase* of your project. Administrative Closure will also occur if the project is abruptly terminated.

Administrative Closure Activities

The high level steps in administrative closure of a project consist of:

1. Perform product verification
2. Complete final project performance reporting
3. Obtain formal acceptance of project
4. Perform lessons learned
5. Create project archives
6. Release resources
7. Celebrate!

Administrative closure can occur at the end of a project phase or at the end of the project itself. Administrative closure will be performed if the project is abruptly terminated for whatever reason. In any case, the following steps are part of administrative closure activities:

- Perform a product verification in order to satisfy the exit criteria for the phase of the project or the project itself
- Outline via a documented process, all the actions and activities necessary to perform a handoff of the product or service to production or operations management
- Complete and archive any final project performance reporting, which can include; phase records, lessons learned, whether the project met success criteria, etc.
- Gain formal acceptance of the project via a formal sign off from all designated stakeholders. If there were procurement activities within the project or the phase, ensure all procurement documentation signoffs have occurred prior to administrative closure

Contract Closure

The high level steps in the contract closure process consist of:

1. Perform product verification
2. Complete final contract performance reporting
3. Conduct procurement audits
4. Complete formal contract acceptance
5. Create a contract file

Contract closure occurs prior to administrative closure on a project. Why do you think this is the case?

- a. It is a Gartner Group best practice for project management
- b. Who will work on the contract if you close the project before the contract?
- c. It gives the vendor time to submit final bills before the project closes
- d. It gives the project manager one less thing to think about before closing the project

One of the more important aspects of contract closure is to perform a procurement audit of the final result. This requires a careful review of the contract statement of work and all of the deliverables.

(Answer: c)

The procedures for procurement contract closure are very similar to those of administrative closure with one or two differences:

- An evaluation of vendor performance on a contract may result in additional fees being paid to the vendor for outstanding performance. The incentive criteria are usually documented at the beginning of the procurement so that the vendor understands what they have to do to secure an incentive fee.
- If there are any outstanding claims against the vendor or the buyer due to disagreements or different interpretations of the statement of work - these elements must be resolved prior to contract closure.

Lessons Learned

Make sure Lessons Learned are reviewed at the end of each project phase and ask:

- What's working?
- What's not working?
- What still puzzles us?
- Where can we improve our performance and what improvements can we implement?

Final Lessons learned at the project close can be used to review:

- Did we effectively address project issues?
- How effective were our performance improvement efforts?
- What would we do differently the next time?
- What new processes need to be institutionalized to improve the project process?
- And more...

Most organizations perform a lessons learned activity at the end of the project - this is the *only* time they perform such an activity. The problem with this approach is that lessons learned collected at this point can never be applied to the current project; your project is already done...

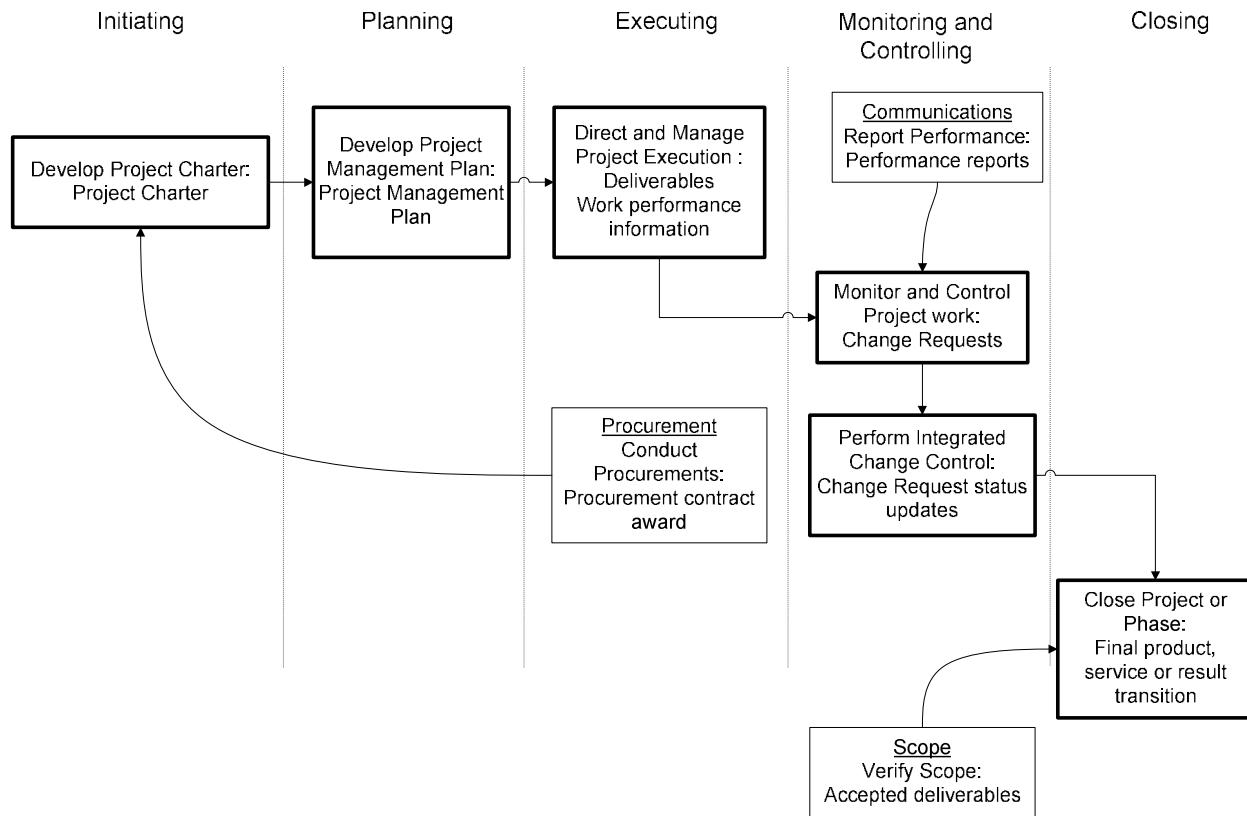
A key feature of the lessons learned activity is that it provides a checkpoint at which we can evaluate our progress to see how well we are performing and make adjustments moving forward. Elements that can be reviewed in a lessons-learned activity may additionally include some of the following:

- Why there were so many change requests and what can we do about it?
- Some stakeholders are very difficult to engage. This threatens certain project deliverables. What can we do better to engage them?
- Our unit testing needs improvement - let's identify activities and changes that can make it more effective.

A phase-end lessons learned review usually takes about an hour and can be of enormous benefit to the project team and stakeholders alike.

Project Integration Management – Key Process Interactions

The key inputs from the other Knowledge Areas to Project Integration Management processes are shown below. *Know these process interactions for the exam.*



In Summary...

This section discussed project integration management, including:

- ▶ The similarities and differences between a project charter and PM plan
- ▶ BCR, opportunity costs, payback period, NPV, PV, FV, and IRR
- ▶ Work authorization systems
- ▶ Definition and importance of baselines
- ▶ The iteration of recommended, approved, and implemented actions
- ▶ Change request documentation and evaluation
- ▶ Authority to make changes
- ▶ The similarities and differences between administrative closure and contract closure

Chapter Four Memory Check

1. _____ basically describe the organization's culture while _____ describe how the organization does projects
2. The key benefits of the project charter are;
 - a. _____
 - b. _____
3. Two project selection methods are known as: _____, and _____
4. The enterprise environmental factor (EEF) that ensures that the correct work gets done in the correct sequence is called a _____, while the EEF that keeps track of information storage and distribution in an automated fashion for the project is called a _____
5. Templates, historical data, lessons learned, and financial databases are all _____
6. The tool that is used to eliminate impractical, impossible or unrealistic projects is called a _____
7. The term that addresses the diminishing value of money over time is called _____
8. The term that addresses the value of an investment at some point in the future is called _____
9. The percentage return on an investment is called the _____
10. The length of time it will take to recoup the investment in a project is called the _____
11. The benefit that you give up on one opportunity to pursue another is called the _____
12. Dynamic, Integer, and multi-objective programming algorithms are all _____ methods
13. Two forms of accelerated depreciation are known as _____ and the _____
14. The costs on a project that have already been expended are called _____
15. The four categories of costs you can experience on a project are: _____, _____, _____, and _____
16. The key outputs of Direct and Manage Project Execution are work performance information, change requests and _____
17. An action needed to bring future project performance in line with the project management plan is called a _____
18. Defect repair is another name for _____
19. One of the critical jobs of the project manager is to _____ unnecessary changes on the project
20. When performing closure on the project or a project phase _____ occurs before _____
21. The key output of Closure is the _____, _____ or _____

Chapter 4 Test

1. Your project team is assembling a business case for the current project you have been assigned. You and the team are discussing various benefit measurement approaches for the project. Which of the following benefit measurement methods will help you build the *strongest* business case?
 - a. Benefit Cost Ratio
 - b. Weighted Scoring Model
 - c. Net Present Value
 - d. Payback Period
2. The project has been running smoothly; initiation phase is complete and the team is working on all aspects of planning. You had meetings with stakeholders several times to collect requirements and as a result, requirements documentation is almost complete, as are high-level and detailed design documents. As construction begins on the project, several stakeholders have indicated the need for changes to the requirements set. They are claiming these elements were missed in the initial requirements collection process, and they want you to add these elements to the project immediately. You perform an impact assessment and get it back to them only to hear that they are not going to allow any changes in the project budget or the timeline to complete these additional elements. What is the most effective tool that you could use to prevent this instance of scope creep?
 - a. Change control system
 - b. Configuration management system
 - c. Murder Board
 - d. Work Authorization System
3. Opportunity costs are defined as:
 - a. What the organization will spend to pursue an opportunity
 - b. What the organization will give up by not pursuing an opportunity
 - c. What the organization will spend on infrastructure and human resources to pursue an opportunity
 - d. What the organization will spend on sales and marketing in order to pursue an opportunity
4. Which of the following is true about change requests that result in corrective or preventive actions?
 - a. They result in changes to scope
 - b. They result in changes to the project plan
 - c. They significantly increase risk
 - d. They do not usually affect project baselines
5. The project you are managing involves 11 different teams scattered geographically across the country. The project sponsor is worried about how the work of 11 non-co-located teams is going to be coordinated for the project. You assure the sponsor that all relevant documentation will be captured in the corporate PMIS (project management information system). Within what key input does the PMIS reside?
 - a. Project Management Plan
 - b. Enterprise Environmental Factors
 - c. Organizational Process Assets
 - d. Work Authorization System
6. The *most critical* activity of the project manager on the project is to:
 - a. Manage the project team
 - b. Protect the Project from unnecessary changes
 - c. Perform Integration
 - d. Create the project management plan

7. You are managing a high visibility project with an aggressive deadline. The team has been burning extra hours every week in order to bring in the project on time - everyone is tired and is looking forward to a break after the product is delivered to the client. The deliverable was finally completed and passed through user acceptance testing at your location without a hitch. The product was handed off to the installation team and the installation team installed the product at the client site. Unfortunately when they attempted to use the product, there was a major system crash that caused an abrupt halt in their production cycle. This installation represented a major upgrade from a previous installation of the same product, and while the first installation worked very well, this installation 'crashed and burned'. What is the *most likely* cause of the problem at the client site?
- Adequate configuration controls were not observed
 - The project manager failed to control scope creep
 - User acceptance testing was flawed
 - The installation team did not install the software properly
8. All the following statements about Approved Change Requests are true *except* which of the following?
- Approved change requests are an input to Direct and Manage Project Execution
 - Approved change requests are scheduled and implemented by the project team
 - Approved change requests are an output of the Perform Integrated Change Control process
 - Approved change requests can result in changes to the cost baseline, sequence of activities, resource requirements or changes to risk response alternatives (including changes to the project management plan)
9. You are working as a PMP® for a company that typically does not implement charters for projects. As a result, an unusually high number of projects in this organization fail on a yearly basis. You've just been placed on a high visibility project as the senior project manager and begin to work on elements of the charter with the project sponsor. Senior management doesn't understand why you're wasting your time on this activity. What is the *best* thing you can do in this situation?
- Tell PMI about a fundamental breach in the PMI framework
 - Review the benefits of a well-defined project charter with senior management
 - Refuse to take on the project as you know this will most likely result in a project failure
 - Continue to work on the charter with the project sponsor. Demonstrate to senior management, on completion of the charter, how this benefited the project and have the data and fact to back it up
10. The project management plan is complete and is ready to be baselined. However, a key stakeholder just discovered a critical omission and requests an adjustment to the PM plan. What should you do next as the project manager?
- Implement a formal CR
 - Make the adjustment
 - Consult the change control board
 - Inform the stakeholder that this constitutes scope creep and refuse to make the change
11. The project management plan is baselined when:
- The requirements and detailed scope statement are completed
 - Senior management has reviewed the project management plan via a gated process and given you a 'go' authorization to proceed with the next phase of the project
 - All the required stakeholders have signed off on it
 - The required business and technical reviews of the proposed solution have been verified and validated by all stakeholders

12. Senior management has asked for an update on your project's budget and deliverables. This information will be contained in:
- Work performance information
 - Status reports
 - Progress reports
 - Variance and trend analysis
13. Who can approve of changes to any of the primary constraints on your project such as scope, budget, or timeline?
- The Change Control Board
 - The sponsor
 - Senior management
 - Key stakeholders
14. All of the following actions occur in the Direct and Manage Project Execution process *except* which of the following?
- Adapt approved changes into the project's plans
 - Collect and document lessons learned
 - Determine the project life cycle for the project
 - Staff, train, and manage project team members assigned to the project
15. One of the key activities in The Monitor and Control Project Work Process is to implement corrective actions to bring future project performance back in line with the project management plan. What is the *best* explanation regarding PMI's philosophy on defect repair?
- It is considered rework
 - Defect repair is essential to bring nonconforming elements in the project back in line with performance standards
 - It is a nonessential corrective action due to missed requirements
 - It is most effective when it works hand-in-hand with inspection processes
16. You represent one of five project teams that are sharing a facility to deliver a high visibility project for your organization. Since you are sharing a facility, your teams share the expenses for heat, light, electricity, and technical support. What type of cost does this represent?
- Fixed
 - Direct
 - Variable
 - Indirect
17. Your organization has decided to train project managers on the use of the tool Microsoft Project, in the hopes that this will help them manage their projects more efficiently. Some of the more technically savvy people on the project management team have become very adept at many of the features contained in this tool - performing what-if analyses, earned value measurements, network diagrams, resource calendars and more. One of the stakeholders asked to see the project management plan for their project and the project manager opened up Microsoft Project to show him the plan. PMI considers a tool like Microsoft Project to be *closest* to:
- The equivalent of a project management plan
 - A bar chart
 - A critical tool to help manage all project logistics
 - A necessary supplement to the project management plan
18. You and your project team have done a thorough analysis of the project and have computed the benefit cost ratio of the project at 1.7. In simplest terms this means:

- a. You are achieving \$1.70 in return for every dollar you spend
 - b. You are achieving a profit of \$.70 for every dollar you spend
 - c. You have no idea how the BCR relates to profit unless you evaluate BCR criteria
 - d. You can compute profitability for the benefit cost ratio by applying weighted average cost of capital principles
19. When deciding whether to do a project or not, computing NPV and IRR are supposed to result in essentially the same decision on whether to accept or reject the project. In fact, NPV and IRR are so closely related that IRR can be derived when NPV equals zero through the use of the following formula:

$$\sum_{t=0}^N \frac{C_t}{(1+r)^t} = 0.$$
 There is, however, one instance when computing IRR may deliver conflicting results with NPV. How would you define such a situation?
- a. Because IRR is fixed over a multiple year investment, IRR does not account for inflation
 - b. For a multiyear investment, if there are negative cash flows in any one of those years, there can be two distinct internal rates of return (IRR) when NPV equals zero
 - c. IRR does not account for collateralized debt in the long term
 - d. IRR conflicts with the Flows to Equity valuation method when computing NPV
20. You have delivered a product to a client on time, on budget, and to specification, however the client is not happy with the result. What is the *next* thing that should happen?
- a. Schedule a meeting with the team to and propose a potential remedy for the client
 - b. Inform senior management of the client's unhappiness and discuss potential options to resolve the situation
 - c. Close out the contract - submit final billing to the client.
 - d. Quantify the client's issues and offer to address these issues in a subsequent release
21. In terms of integrated change control, the project manager's primary responsibility is to do all the following *except*:
- a. Ensure all changes are tracked and documented for the project
 - b. Ensure that only authorized changes are entered into the change management system
 - c. Ensure that all authorized changes are coordinated with Change Control Board (CCB)
 - d. Ensure that all requested changes are made to the project baselines
22. Which of the following is true regarding the project management plan?
- a. Integrates and consolidates the subsidiary plans
 - b. It is always highly detailed and focused
 - c. It cannot be changed unless senior management authorizes the change
 - d. B and C together
23. The *most commonly described key benefit* of the project charter is:
- a. Definition of the project goals
 - b. The project manager can expend funds and commit resources
 - c. Formal recognition of the project within the organization
 - d. Description of high level requirements, risks, and constraints
24. You are analyzing the benefits of potential projects for your organization and have sat down at a meeting with the CFO and the rest of the finance team. In the course of the discussion one of the finance team members mentions that the organization has started to take a long view of project benefits. In other words, they are very concerned about the value of the projects not just in the immediate future, but 5 to 10 years from now. They want to make sure that an investment made now will be worth more 10 years from now than it is in today's dollars. What financial calculation would help them determine this?
- a. Net present value
 - b. Payback period

- c. Future value
 - d. Sum of the year's digits
25. A project at your organization is in trouble. Management has reassigned the project manager on the project and has given you the job of bringing it back in line. You have analyzed the prior project manager's project management plan, WBS, scope baseline and found that he actually did a good job. The problem was that there was an unusual amount of discovery on this particular project; it seems that management failed to address that the project had a high degree of risk and uncertainty - greater than 40% - risks that the prior project manager had raised on the project. When the PM raised those issues, management's position was "well, just do the best you can". This is a \$5 million project which is approximately at its halfway point, but the budget expended is close to \$3.5 million dollars at this point. The project is \$1 million over budget and 10% behind schedule. Management is alarmed at the budget burn rate and is thinking of canceling the project, even though what has been accomplished so far is high quality work that has exceeded customer expectation. What is the *best* advice you can give management at this point?
- a. With big budget overrun, talk with the team and then with the client about what scope elements can be removed and thus reducing overall costs
 - b. Do not include the sunk costs as part of your decision process
 - c. Discuss with management the most effective way to close the project down and see what part of the work effort can be salvaged
 - d. Swap out high cost resources with lower cost resources to bring the budget in line

Chapter 4 Test - Answers

1. C – NPV produces the most accurate estimate over benefit cost ratio, payback period and weighted scoring model.
2. D – One of the defined uses of a work authorization system is for the control of scope creep
3. B – This is the definition of an opportunity cost.
4. D – They do not normally affect the project baselines. *PMBOK® Guide*, 4th edition p 97.
5. B – The PMIS is an enterprise environmental factor
6. C – All the answers are correct – a PM does all these things. However the most critical aspect is the PM functioning as an integrator: putting all the parts and pieces of the project into an integrated whole
7. A – If the system tested out OK prior to the site installation, that is a sure signal that the internal system and the client system are configured differently
8. C – ‘Approved change requests’ are not an output of ANY process. Per *PMBOK® Guide*, 4th edition p 73. A is true- (*PMBOK® Guide*, 4th edition p. 73) B is true-(*PMBOK® Guide*, 4th edition p 85) and D is true- (*PMBOK® Guide*, 4th edition p. 94)
9. B – You always want to show the stakeholder the effects of their actions/inactions. C and D are wrong – the PM does not take unilateral action unless authorized to do so by the organization. Answers like A are usually wrong – this is the equivalent of “I’m telling the teacher what you did!”
10. B – Prior to baseline, the PM plan can be adjusted without a CR, consulting the change control board, or addressing a scope creep issue. *PMBOK® Guide*, 4th edition p. 82.
11. C – While the other answers may occur in the planning process, baselines require stakeholder sign-off
12. A – Work performance information is where this data is contained. Per the *PMBOK® Guide*, 4th edition, p 83, 87.
13. C – Senior management must be consulted regarding high-level constraints
14. C – Determining the project life cycle occurs in planning. Per the *PMBOK® Guide*, 4th edition, p 83.
15. A – Defect repair is considered rework
16. D – Shared facility expenses are indirect costs
17. B – It is closest to a bar chart
18. C – Unless you know the BCR criteria, you have no way of determining how much profit you're making on the project. Benefits can be financial or non financial. They can be the total revenues or EBIDTA. It depends on how your organization computes BCR.
19. B – This one probably falls into the category of something you've never seen before. Be ready for questions like this on the exam. If there are negative cash flows when computing IRR over a multiyear investment, you can actually create a chart where there are two IRR values when NPV equals zero
20. C – You're done. PMI assumes that as the project manager, you have been obtaining customer sign-off for every intermediate deliverable on the project and that the customer has accepted those deliverables.
21. D – Changing the project baselines are not part of Integrated Change Control.
22. A – It integrates and consolidates all the subsidiary management plans. *PMBOK® Guide*, 4th edition, p. 81
23. B – This is the most commonly described benefit
24. C – The future value of investment is what we're after here. Net present value will tell you overall return over a period of time. Payback period is simply the time to produce ROI, and sum of years digits is an accelerated payback method
25. B – The sunk costs are never considered as part of your decision process. You have to decide where the project stands now, whether it is beneficial to complete what has been accomplished so far, and whether you can reach the goals of the project. This is a standard GAAP rule.

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Chapter 5 : Project Scope Management

Section Topics:

- ▶ Collect Requirements
- ▶ Define Scope
- ▶ Create WBS
- ▶ Verify Scope
- ▶ Control scope

Section Objectives

In this section you will be able to:

- Assign the scope management processes to the PM process groups
- Explain the components and importance of a detailed scope statement and scope management plan
- Define the difference between requirements and scope
- Define the differences between product and project scope
- Describe decomposition
- Define and create a WBS

Scope Process Summary

The high level Project Scope Management output elements, by Process Group are:

Initiating	Planning	Executing	Monitoring and Controlling	Closing
	-Requirements Management Plan -Requirements documents -Requirements traceability matrix		Accepted deliverables CRs	
	Project Scope statement		Work performance measurements	
	Scope baseline		Various document updates	

What is Scope Management?

For the exam, there are two aspects of scope that you need to understand: the product scope and the project scope. What this means is:

- Product Scope. What requirements do I have to fulfill to create the product of the project?
- Project Scope. What activities and processes do I have to perform to deliver the product scope?

One of the key elements in managing scope is to prevent ‘scope creep’. This is a term that was coined by the United States Air Force to describe conditions in which additional scope elements are added to a project without any means or method for controlling such additions – i.e. any uncontrolled change to a project. In some instances, customers and stakeholders will add scope to a project, yet will not allow for additional time or budget to accommodate the changes. This is a classic scope creep situation.

Gold plating is a subset of scope creep. These are elements added to the project by the performing organization because a team member thinks it's a good idea or that the customer will appreciate the extra work. The problem with gold plating is that added scope elements from the project team may cost the project money that was never contained in the project budget. If you're adding elements to the project that the customer never asked for, they may wonder what you are doing with the rest of their budget!

Scope Baseline

In terms of scope, we will address two aspects of the scope management process:

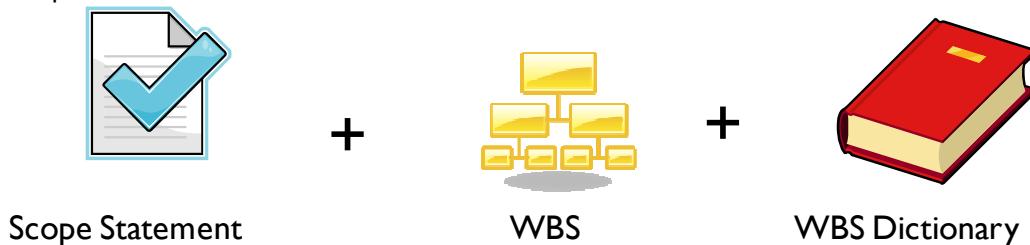
- ▶ Product Scope: the requirements that relate to the product of the project

- ▶ Project Scope: The work done needed to deliver the product of the project

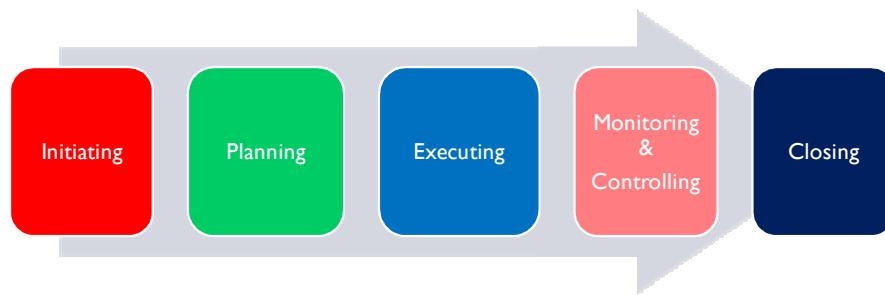
There may be questions on the exam that reference the scope baseline. It is critical that you know that the Scope Baseline consists of the Scope Statement plus the WBS plus the WBS dictionary.

The scope baseline provides much of the input needed to create a Scope Management Plan. The three elements of the scope baseline; the scope statement, the WBS, and the WBS dictionary, will be addressed in detail in the upcoming pages.

The Scope Baseline:



Scope Management

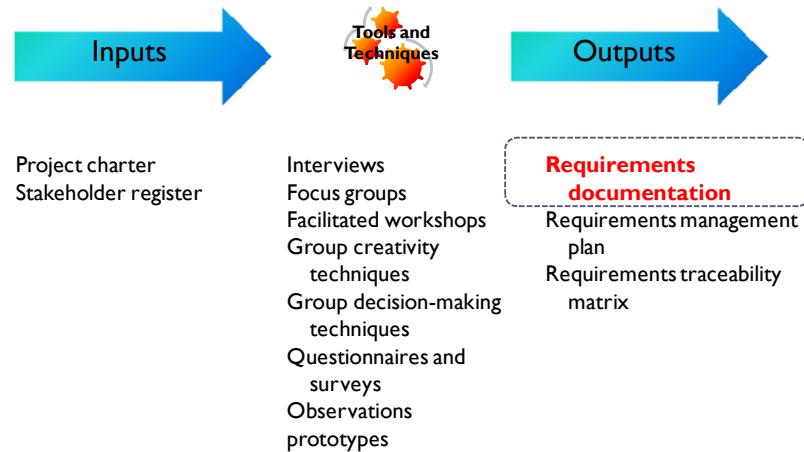


- | | |
|--|---|
| <ul style="list-style-type: none"> ▶ Collect Requirements ▶ Define Scope ▶ Create WBS | <ul style="list-style-type: none"> ▶ Verify scope ▶ Control Scope |
|--|---|

The process of scope management is performed to ensure that the project contains all the work and **only** the work necessary, to fulfill project objectives successfully. While the requirements of the project are outlined in a requirements management plan, the scope management plan typically contains the following elements:

- How changes to scope will be managed on the project
- Escalation hierarchy in the organization to resolve potential scope issues
- Description of any control systems that are used to manage scope and changes to scope

Collect Requirements



PMI defines a requirement as:

"A condition or capability that must be met or possessed by a system, product, service, results, or component 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."¹³

In short, you are establishing, *from the customer's perspective*, what the customer needs from the project in order for the project to be successful.

Unfortunately this is the first place in the project where the 'wheels start coming off the wagon'. In the upcoming section we will address what specific tools and techniques can be implemented to ensure a detailed elaboration of customer requirements.

Requirements Management Plan

The requirements management plan describes how requirements collection will be planned, executed and changes to requirements will be managed.

Some of the elements in a requirements management plan include but are not limited to the following:

- What specific techniques are being used to collect requirements?
- How to handle stakeholder disagreements about requirements.
- To what level of detail will users describe their requirements?

¹³ PMBOK® Guide, 4th edition, p. 437

- Determination of how requirements will be prioritized for the project.
- Process for addressing missed requirements.

Requirements Collection Tools

There are numerous tools for helping the project team get their arms around user requirements. A few are mentioned here and will be elaborated in the proper level of detail for the purposes of the exam.

1. **Interviewing.** On the exam also called 'expert interviewing'. The project manager and team members interview stakeholders or subject matter experts regarding the needs of the product or process. These interviews can be conducted face-to-face, via a video conferencing, over the phone, e-mail, or any other available method.
2. **Focus Groups.** Focus group is generally run by a facilitator and concentrates on a specific subject area. Usually the members of the focus group are selected based on similar interests or other identifying criteria.
3. **Facilitated Workshops.** This assembles different stakeholders who may have various perspectives on the product of the project. The workshop is facilitated by a moderator who engages the stakeholder team to talk about the project and arrive at a consensus around their requirements. Two key techniques are QFD; used to capture the voice of the customer (VOC), and JAD; used to facilitate design on a software project. QFD will be detailed in the chapter on Quality Management.
4. **Group Creativity Techniques:**
 - a. **Brainstorming.** This is a group creativity technique for the purpose of generating ideas focusing on a specific problem. Using this approach as a requirements collection technique the idea is not to capture every idea from every participant, but to congeal the ideas into an actionable plan.
 - b. **Nominal Group Technique.** Based on brainstorming but adds a voting process to rank ideas for further brainstorming or to prioritize ideas.
 - c. **Mind-mapping** -created by Tony Buzan in the 1970s is a graphical representation of words, ideas, or other items arranged around a central keyword or idea. Mind maps are used as an aid for study, organization, problem solving, and decision making.
 - d. **The Affinity Diagram.** Using a technique developed by Japanese anthropologist Jiro Kawakita, the KJ method as it is called, is designed to help people organize their ideas around how they think about the work. The steps in order are:
 - I. Rapidly group ideas that seem to belong together.
 - II. It isn't important to define why they belong together.
 - III. Clarify any ideas in question.
 - IV. Copy an idea into more than one affinity set if appropriate.
 - V. Look for small sets. Should they belong in a larger group?
 - VI. Do large sets need to be broken down more precisely?
 - VII. When most of the ideas have been sorted, you can start to enter titles for each affinity set.

- e. **The Delphi technique.** This technique was developed by the Rand Corporation in the 1960s. It requires that a group of experts participate in the decision process. It is most useful when there is contention or hostility in the decision process due to 'bandwagonism' or experts with widely varying opinions. In this case, all participants are anonymous to each other and all evaluations are funneled through a facilitator who distributes the result of the decision. Multiple rounds are used until the decision process narrows to a single solution or a solution set.

NOTE: For the exam, this approach is listed as a 'Group Creativity Technique', however, the creator of the technique, the RAND Corporation, states that the Delphi is actually a *group decision making technique*:

"This report deals with one aspect of RAND's continuing methods for improving decision making. It describes the results of an extensive set of experiments conducted at RAND during the spring and summer of 1968. The experiments were concerned with evaluating the effectiveness of the Delphi procedures for formulating group judgments"¹⁴ (Emphasis, mine)

5. Group decision-making techniques.

- a. *The Analytic Hierarchy Process.* Developed by world renowned mathematician Thomas L. Saaty at Wharton in the 1970s. The process is especially useful when extremely complex or difficult decisions need to be made. The AHP was first referenced by PMI in the *PMBOK® Guide*, 2nd edition, p. 54.
 - b. *Voting methods-* uses the **unanimous** approach - everyone agrees, the **majority** approach - more than 50% agree, the **plurality** approach - largest percentage not a majority, or the **dictatorship** approach - one person makes the decision for the group
6. **Questionnaires and surveys.** Typically used when a large group of individuals need to be contacted for their input.
7. **Observation.** One of the most effective of the requirements gathering techniques that has been used for years at Toyota and other Japanese companies is called, 'gemba' (where the action is or where the work occurs). The process is called 'going to gemba'. This is a key tool in the **QFD** process and is used in capturing the voice of the customer (VOC). In the United States this is frequently called 'shadowing'. The purpose is to discover how the customer actually uses your product or how they actually get their jobs done.
8. **Prototypes.** The prototype is a mockup or working model of the product. The prototype can be presented to users for feedback, suggestions, and recommendations and to give the users tangible evidence of what they think they asked for from the project team.

Requirements Traceability Matrix

The Requirements Traceability Matrix tracks requirements and identifies:

- Source of the Requirement
- Responsibility for managing
- Work status
- Completion status

¹⁴ "The Delphi Method: An Experimental Study of Group Opinion" Dalkey, Norman C, p.iii, RAND Corporation, June 1968

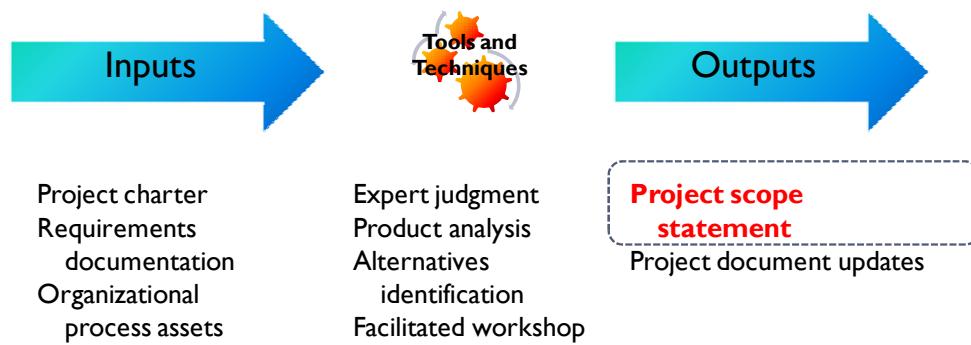
For a software project:

- Traces each requirement to one or more technical specifications needed to complete the requirement
- Ensure each development task traces back to a user requirement
- Critical for developing the test plans

This information is usually loaded into a table that lists the requirement, from the user's perspective, and traces that requirement to the work packages or activities needed to fulfill the requirement from the performing organization.

The key element to remember here is that the requirement addresses a user need for the project. Usually these stated needs are not technical in nature, and it is the job of the technical team to translate a user need expressed in plain English into the technical specifications that enable delivery of the customer's requirement. The requirements traceability matrix tracks all the technical specifications back to the originating requirement and can be supported by the WBS dictionary. This is an effective approach for ensuring that all your technical requirements track back to a specific user need.

Define Scope



The process of defining scope outlines the boundaries of what will be and what will not be included in the project to deliver the product of the project, and also includes detail on project risks, constraints, and assumptions. It is the project manager's job to deliver the project management's expectations regarding time, cost, and scope. After the initial analysis, the resulting budget and schedule may not meet management's expectations for the project. Therefore it is the project manager's job to develop options for meeting the schedule, cost and scope objectives for the project.

For example, if management wants the project completed in a year and your analysis shows, based on all project constraints, that the realistic project completion date is 18 months, it is the project manager's responsibility to offer senior management options for the one-year completion time line. These options may involve various schedule compression techniques as well as negotiating a reduced scope.

One of the tools of Define Scope includes Product Analysis, which can use a process called ‘value engineering’. Value engineering will be discussed in greater detail in the Project Cost Management chapter.

Scope Statement

A Detailed Scope Statement will include but is not limited to:

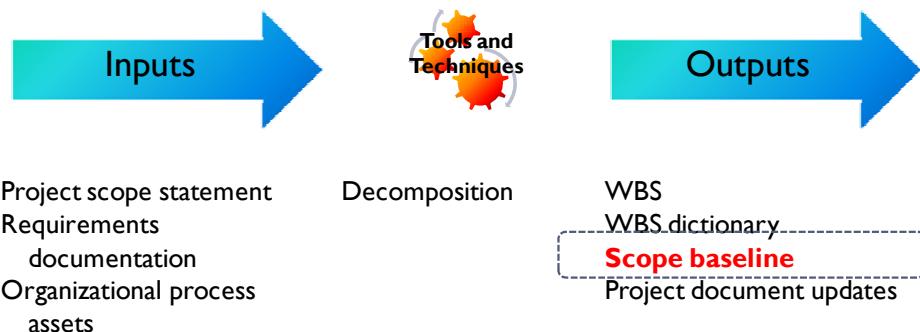
- Project objectives
- Product scope description
- Project requirements
- Project boundaries
- Project deliverables
- Product acceptance criteria
- Project constraints
- Project assumptions
- Initial project organization
- Initially-defined risks
- Schedule milestones
- Fund limitation
- Cost estimate
- Project configuration management requirements
- Project specifications
- Approval requirements

The key output from the Define Scope process is the Project Scope Statement. The scope statement details what is included in the project, what is not included in the project and requires input from stakeholders and subject matter experts alike.

The details outlined above are a partial listing of what can be found in the project scope statement - these details can be as unique as the project or the industry in which the project is being implemented.

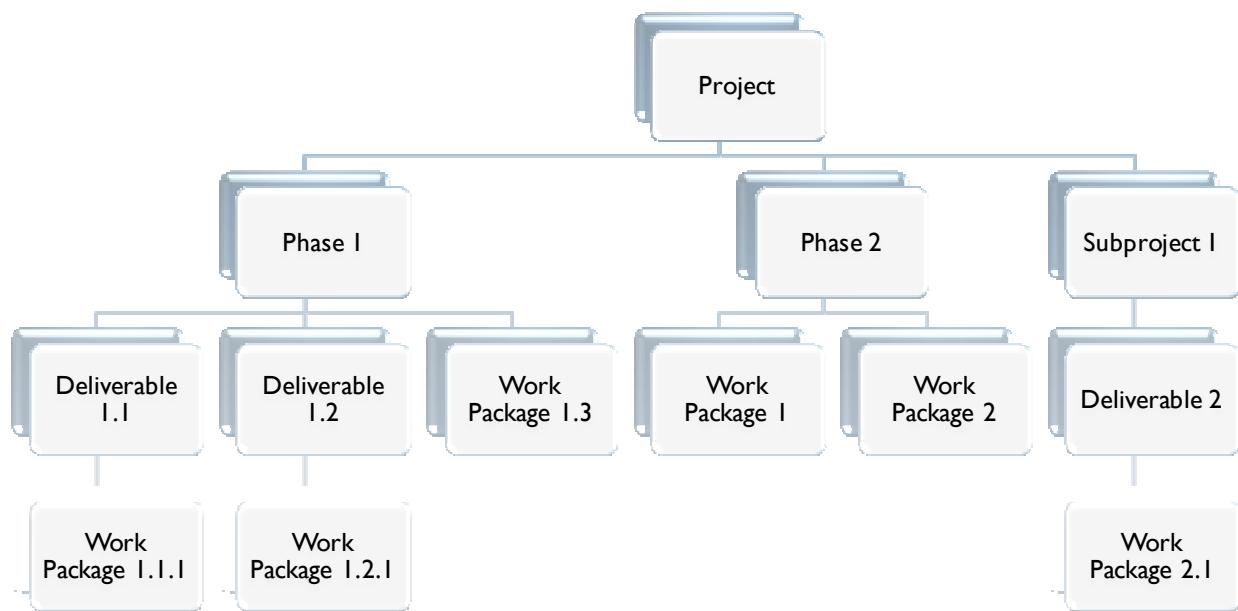
Exam Tip: The Project Scope Statement includes the requirements and the work needed to deliver the requirements

Create WBS



One of the most important tools in your project management arsenal is the creation of a WBS. If you have not created one before, this can be one of the most misunderstood aspects of the project management process. The WBS is not simply a list of activities that need to be performed, but a structured hierarchy created by the performing organization and stakeholders that keeps work from ‘falling through the cracks’ and allows for team buy-in of all the work.

WBS Defined



The picture above shows a generic version of the WBS. Notice that it resembles an org chart in its construction. There are any number of software tools that can help you programmatically create a WBS. In outline form, the WBS can become a template and something that is part of your organizational process assets. This template can be customized for use on different projects without having to design it from scratch each time you start a project.

If you work in an organization that does not use a WBS on its projects, do yourself a favor and do it for yourself. While other people are losing sleep over project deliverables your project will be well under control because you have effectively utilized this critical tool.

Exam tips:

A higher level above a work package is called a '**control account**'. PMI states a control account is a control point where scope, cost, and schedule are compared to earned value for performance measurement. While a control account can contain multiple work packages, a work package can only be associated with only one control account.¹⁵

Code of accounts: Any numbering system that uniquely identifies each component in the WBS¹⁶

Chart of accounts: A list of all account names and numbers used in a company's general ledger.

WBS Benefits

The purpose of a WBS includes the following:

- Graphical hierarchy approach clearly identifies all work and allows for clear understanding
- Serves as communication tool among stakeholders
- Allows team to get their arms around the project and promotes team buy-in
- Becomes the foundation for planning
- A tool for evaluating scope changes
- Possibly useful as a template for future similar projects
- Allows team members to understand how their work fits in the project

While the WBS resembles an org chart, it is really a structure that defines, at the highest levels, how the organization thinks about the work:

- Successive drill downs occur until work packages are created
- Work packages are *deliverable* focused

Exam tip: substitute your concept of 'tasks' with the term 'activity'

Exam Tip: Decomposition is what you do to break down work to manageable work packages. The WBS is the tool you use to do it.

Exam tip: the WBS does **not** show cross-functional dependencies between work packages

WBS Dictionary

The WBS Dictionary contains:

¹⁵ PMBOK® Guide, 4th edition, p. 121

¹⁶ PMBOK® Guide, 4th edition, p. 421

- Description of the work to be done
- Who is responsible for delivering the work
- Quantified deliverables
- Activities and milestones
- Schedule for the work
- Assumptions
- Cost estimates
- Acceptance criteria
- Interdependencies

The WBS dictionary is one of the most important documents you can create outside of the project management plan. It outlines in specific detail the elements in the work breakdown structure defining ownership, due dates, dependencies, and acceptance criteria, and other elements. An example of a WBS Dictionary template is shown on the following page.

Notice that in addition to the fundamental information (name, owner, resources, due date, cost, duration, and acceptance criteria, etc), this page also has information about cross-functional activity dependencies; dependencies on the prior activity or dependencies involving the successor activity. These dependencies can be identified here and detailed in the Activity Attributes of the activity.

“The development of the WBS Dictionary often uncovers ambiguity or other errors in the WBS itself, and results in revisions to the WBS”¹⁷

¹⁷ Practice Standard for Work Breakdown Structures, Second edition, p 16, PMI® 2006

Name of Work Package or Activity	WBS Number	Due date
Owner	Dependencies	
	Predecessor	Successor
Assigned Resources	Cost	Duration
Work Package Description		
Work Package Deliverables		
Acceptance Criteria		
Assumptions		

Delivered by _____ *Date* _____ *Approved by* _____ *Date* _____

Verify Scope



Project management plan
Requirements documentation
Requirements traceability matrix
Validated deliverables

Inspection

Accepted deliverables
Change requests
Project document updates

The Verify Scope process is what you do to gain formal acceptance of the work product(s) and deliverables on the project from the stakeholders. Verify Scope occurs in the Monitoring & Control process group.

What do you need to verify scope? Below are some key inputs that will help you:

- Requirements Documentation
- Requirements traceability matrix
- The detailed Scope Statement
- Validated Deliverables from Perform Quality Control
-

Exam Tip - exam questions will rarely ask you directly about scope verification, however they will use phrases such as:

- Obtaining customer sign off
- Review of deliverables
- QC inspection/audit
- Requirements validation
- Work product verification

These are all scope verification questions.

When Scope Verification Occurs

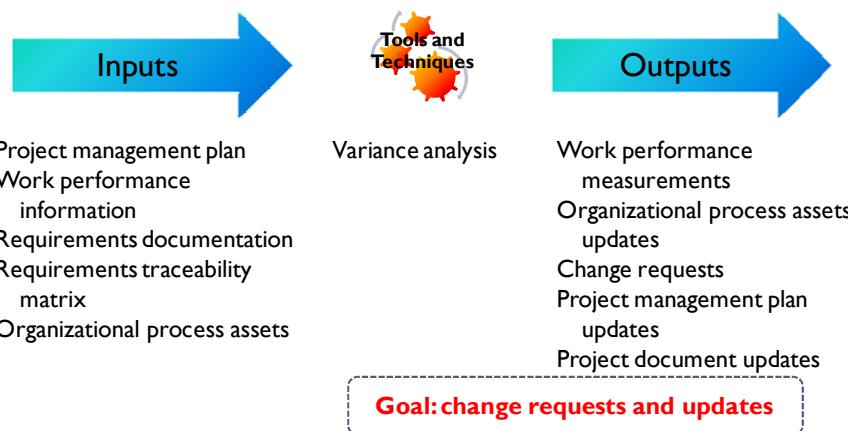
How do you know when you are 'done'?

Scope verification primarily concerns itself with formal acceptance of deliverables by the customer. As such, it can occur not only at the end of the project, but also at the end of every project phase. As a result, delivered scope elements can be verified progressively as the project unfolds. This avoids the 'one-shot deal syndrome', where the product is only verified at user acceptance testing just prior to release into production. Constant scope verification of deliverables allows the project manager and the project team to make incremental course corrections as the project progresses to ensure successful delivery.

Exam Tip: Understand that Verify Scope is similar to Perform Quality Control. The difference is that:

- **Verify Scope** is the process of formalizing acceptance of the completed project deliverables by the customer
- **Perform Quality Control** is the process of monitoring and recording results of executing the quality activities to assess performance and recommend necessary changes. Perform quality control usually occurs first because we generally verify the quality requirements prior to verifying with the customer that we are 'done'.

Control Scope



For the purposes of the exam, controlling scope means that you are measuring the work product against the scope baseline and that you are doing so frequently to ensure that the project stays on track.

This means that:

- You have a clearly defined scope baseline from project management plan
- You have verified the scope against the requirements traceability matrix
- You are measuring project performance against the scope baseline using variance analysis techniques to determine whether preventive or corrective actions are required.
- You are determining the impact of scope changes against the timeline, budget, quality and product configuration

Since the process is fundamentally proactive, the project manager's job is also to focus on preventing unnecessary changes to the project - prevention of 'scope creep' is a big factor here.

Work Performance Measurements: For scope, addresses planned vs. actual technical performance.

Scope Control Methods

A key to controlling scope on a project is to determine where changes on the project are coming from, and how to limit the effect.

Preventing or eliminating scope creep on a project demands the implementation of an enforced change control system that requires:

- All requested scope changes must be documented
- All requested scope changes must perform an impact assessment
- All requested scope changes must be reviewed by the customer, the performing organization and the CCB (change control board)
- All requested scope changes can be either accepted or rejected

A key element in controlling scope is to have an enforced change control system that does not allow for undocumented, unapproved changes. In organizations that have large complex systems, undocumented changes can wreck havoc and cost millions. As organizations increase in size and the complexity of their systems increase, it becomes more important to have a documented and enforced change control process. The control of 'scope creep' and gold plating becomes a key process in scope control.

Quick quiz:

As the project manager on a large global hardware and software deployment, senior management feels that one of the best risk avoidance strategies is to have a firm grasp on change control. As a result, they want you to control scope creep and keep it to an absolute minimum. When discussing this with stakeholders, it turns out that the stakeholders have very different ideas on what constitutes scope creep. Which of the following is the *BEST* definition of scope creep?

- a. Changes to the project through the change control system
- b. Any variance to the scope baseline
- c. Adding unapproved scope to the project while being held to your original time and cost estimates
- d. The performing organization decides to add features to the project that they think the customer will like without gaining formal approval first

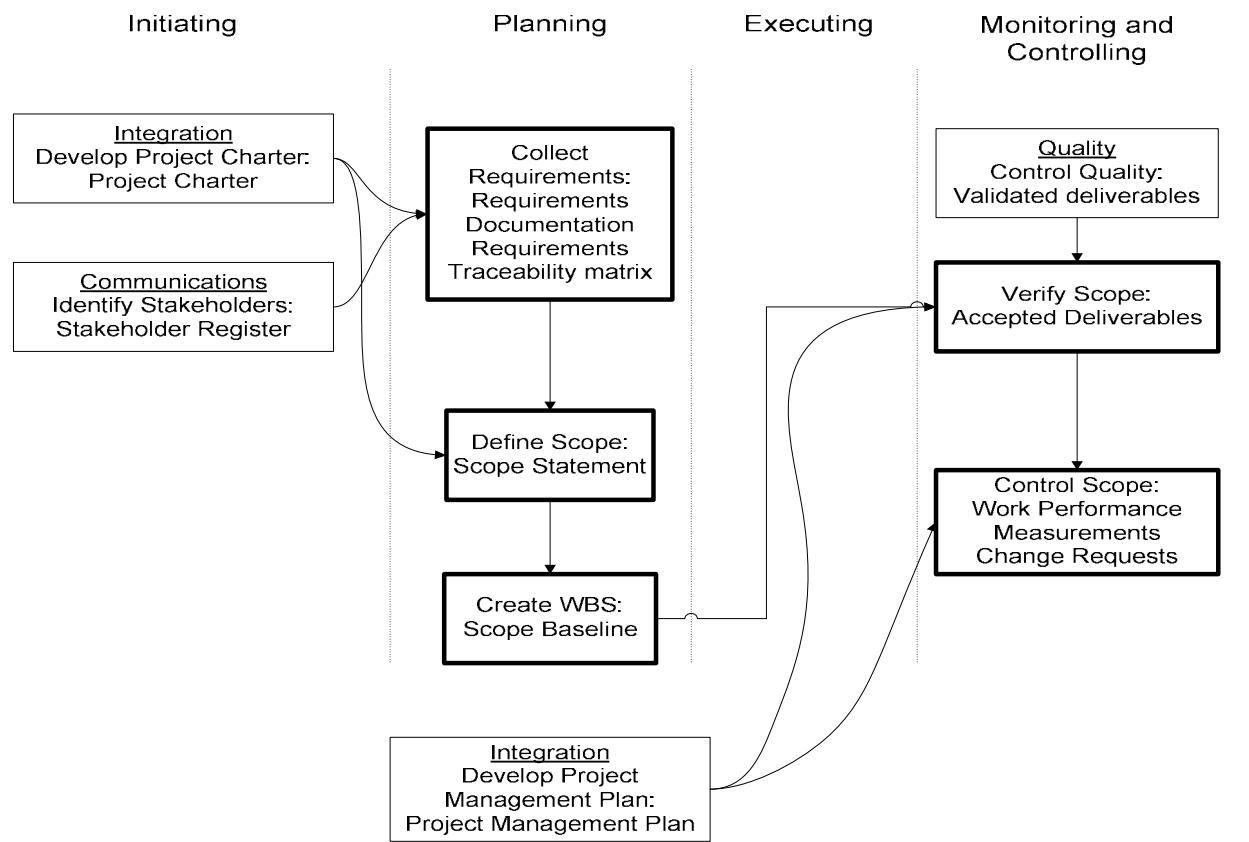
Exam Tip:

For the exam, the Project manager is responsible for controlling unnecessary changes to scope and for ensuring enforcement of the organization's change control system for the project.

Project Scope Management: Key Process Interactions

The key inputs from the other Knowledge Areas to Project Scope Management processes are shown below. *Know these process interactions for the exam.*

- The key tools and techniques:
 - Create WBS uses Decomposition as the only tool & technique
 - Verify Scope uses Inspection as the only tool & technique
 - Control Scope uses Variance Analysis as the only tool & technique



Summary...

This section discussed scope management, including:

- The components and importance of a detailed scope statement and scope management plan
- Requirements and requirements collection methods
- Requirements traceability matrix
- How and why a WBS is created
- The scope baseline
- The definition of scope terms, such as work package, WBS dictionary, and decomposition
- The process of scope verification

Chapter Five Memory Check

1. Adding features to a product that were never requested by the customer is called _____
2. Uncontrolled work added to a project by the customer without any adjustment for timeline or budget is called _____
3. The scope baseline consists of the _____, _____, _____, and the _____
4. The _____ scope are the requirements relating to the project deliverables, whereas the _____ scope refers to the work needed to create the deliverables
5. The key output that tracks requirements, the source of the requirement and the requirement completion status is called a _____
6. The output that is used by the team to get their arms around the project, serves as a communication tool for stakeholders, and is used by the team to see how their work fits into the project is called a _____
7. The lowest level in a WBS is called a _____
8. The _____ shows cross functional dependencies between work packages
9. The key output of the Verify Scope process is _____
10. The two processes in the Monitoring and Controlling process group for Scope are: _____ and _____
11. The process of breaking down work into manageable work packages is called _____
12. Formalizing acceptance of the completed project deliverables is called _____
13. The level above a work package is usually called a _____
14. The process of determining what will be and what will not be included in the project is called _____
15. The tool used to capture the 'voice of the customer' is called _____
16. The 4 group decision voting methods are called _____, _____, _____, and _____
17. The three processes in the Planning process group for scope are: _____, _____, _____

Chapter 5 – Test

1. The scope baseline consists of which of the following elements?
 - a. Project management plan, WBS, scope statement
 - b. Scope statement, risk management plan, WBS
 - c. WBS dictionary, project management plan, scope statement
 - d. Scope statement, WBS, WBS dictionary
2. The WBS is used for all of the following with the *exception* of:
 - a. Allowing for team buy-in of the project
 - b. Showing cross functional dependencies between work packages
 - c. A communication tool between stakeholders
 - d. Shows the team how their work fits into the overall project
3. Verify Scope defines a process that:
 - a. Allows the customer to verify what was built against the requirements
 - b. Occurs at the end of the project prior to closing
 - c. Formalizes acceptance of completed project deliverables
 - d. Verifies the scope management plan is aligned with the project management plan
4. Two team members are having a discussion about where certain project documentation should exist. They're discussing several elements of the WBS between which there are dependencies. Where can this information be found?
 - a. WBS
 - b. Detailed scope statement
 - c. Scope management plan
 - d. WBS dictionary
5. Your project team has come to you with an issue. It appears that during the requirements elaboration process there was a disagreement between the members of the technical team regarding what had to be built to satisfy a user requirement. As a result, some of the technical team members created features in the deliverable that the customer did not really ask for. What would have specifically helped to *avoid* this situation?
 - a. Requirements management plan
 - b. Requirements traceability matrix
 - c. Scope statement
 - d. WBS
6. Your stakeholders, a group of seven Ph.D.'s, have met to discuss the merits of moving forward with the project in a specific direction. The discussion started out fairly calmly until a point of contention was identified. At this point, the discussion began to escalate into an argument and finally ended in a shouting match between two of the Ph.D.'s. In addition, one of the members of the team had a differing opinion from his boss (one of the people engaged in the shouting match) and was reluctant to express his real views in the meeting. Which of the following would have been the best approach to avoid the previous scenario?
 - a. Delphi technique
 - b. Analytic hierarchy process
 - c. The KJ method
 - d. QFD

7. The team has been progressing ahead of schedule on their project deliverables. So far the customer is very pleased with the results and has commended the team for doing an outstanding job. At the last staff meeting one of the technical team members informed you that while he was working in the system, he noticed an issue that needed to be addressed. While it wasn't defined in the work breakdown structure, he ascertained that the fix would take at most an hour and wouldn't impact the deliverable. "In fact", he stated, "the customer will probably like what I did ". As the project manager, you talk to this technical team member off-line and inform him that what he has done is actually considered to be:
- Scope creep
 - An undocumented change
 - Gold plating
 - WBS anomaly
8. Your project team members need to know, in very specific terms, what work needs to be completed on the project. Which of the following is the *least useful* in describing what that work is?
- WBS dictionary
 - The product scope
 - The project statement of work
 - Requirements traceability matrix
9. What is scope decomposition?
- Breaking down the work into increments of less than 40 hours each
 - Breaking down the work to the work package level
 - Breaking down the work to the lowest level of detail possible
 - Breaking down the work by functional area
10. Who *ultimately* controls changes to scope on a project?
- The project manager
 - Senior management
 - The change control board
 - The customer
11. A key input to collect requirements phase is?
- The project management plan
 - The project charter
 - The scope statement
 - The risk register
12. A key stakeholder has been very difficult to manage on the project. He has been difficult to engage regarding his needed requirements for the project and frequently describes requirements in vague generalities. Then when something is delivered, he will complain that he was misunderstood or that the technical team 'screwed up' his requirement. Last week he demanded a change in scope and insisted that it be completed by the end of the week. After the change was implemented he was shocked at the price tag and immediately escalated to senior management, claiming that the technical team was 'raking him over the coals'. The project manager had provided him with all the necessary documentation to understand the nature and scope of the change. What was the *most likely* element that the project manager may have omitted in this case?
- CCB approval
 - Determining the need for change
 - Ascertaining cross dependencies for the change
 - An impact assessment
13. Who creates the scope baseline?

- a. The project team
 - b. The project manager
 - c. All the stakeholders
 - d. Senior management
14. What is the *best definition* below of the difference between the Collect Requirements process and the Define Scope process?
- a. Collect Requirements is really a part of Define Scope
 - b. Collect Requirements details stakeholder needs while Define Scope describes in detail, the project
 - c. Collect Requirements addresses all the detail necessary to deliver the product of the project, while Define Scope identifies project boundaries and constraints
 - d. Both Collect Requirements and Define Scope use facilitated workshops as a tool and technique
15. The project management plan is an input to which of the following?
- a. Define scope
 - b. Control scope
 - c. Create WBS
 - d. Collect requirements
16. A project stakeholder identified a defect that they want fixed immediately. You raise the defect with the technical team at the next technical team meeting. After reviewing all the documentation in the configuration management system, you discover that the so-called 'defect' is really an enhancement request. What is the *next* thing you should do as the project manager?
- a. Report the stakeholder to senior management for a violation of company policy
 - b. Ignore the defect report. Treat it as a change request to perform a formal impact assessment. Show it to the stakeholder and ask him how he wants to proceed
 - c. Engage the stakeholder's manager to discuss what can be done to keep the stakeholder honest in future encounters
 - d. Meet with the stakeholder to discuss the discrepancy. The defect may simply be a missed requirement that needs to be addressed as a formal change
17. Collecting the voice of the customer is a tool and technique contained in which process?
- a. Define Scope
 - b. Create WBS
 - c. Collect Requirements
 - d. Verify Scope
18. One level above the work package that helps identify cost centers or a charge code for the purposes of project accounting is known as a what?
- a. Component level
 - b. Control account
 - c. Cost breakdown structure
 - d. Component package
19. The project team is tackling some work that they have never tried before - this represents groundbreaking work on the project you're managing. As a result they're looking for different ways of organizing the work, and specifically organizing the particular jobs needed to complete the project. They want to make sure these jobs are organized in the most efficient method possible. One of the *most effective* tools to help the project team organize how they think about the work is:
- a. QFD process
 - b. Nominal group technique

- c. Delphi technique
 - d. Affinity diagrams
20. The project you are managing is about 75% complete and at the monthly meeting with senior management, one of the key points is to review the variance analysis on the project. What is the purpose of the variance analysis?
- a. It measures project variances against scope baseline
 - b. It measures the variances between the requirements traceability matrix and the WBS dictionary
 - c. It measures variances between the scope statement and project management plan
 - d. It focuses on measuring cost variances only
21. You are working with a highly experienced technical team; each member has a minimum of 15 years experience. You are hosting a meeting for the team to discuss the best way to move forward with the project from a technical standpoint. There are number of different requirements that have been discussed, however one of the team members is behaving like a heckler - making fun of ideas he thinks are not viable or telling people flat-out that they're wrong. This is beginning to disturb some of the other team members who have started to visibly disengage from the meeting. You ask this individual what the problem is and he responds, "Who died and put you in charge?" Once the meeting adjourns, you pay a visit to this team member's manager and are prepared to write-up this individual for insubordination. However what is probably the *real* problem?
- a. Lack of a work breakdown structure
 - b. Absence of the requirements traceability matrix
 - c. No project charter
 - d. A flawed scope baseline
22. When performing the scope control process, which of the following statements is *correct*?
- a. Scope control validates the delivered scope for the project
 - b. The work performance measurements produced are part of the PMIS
 - c. The inspection process is a key tool and technique used in scope control
 - d. Scope control is performed in concert with other control processes
23. You are in the requirements collection phase of the project. While a number of JAD sessions were held with the customer, there were still a lot of unanswered questions. The technical team lead decided that implementation of the QFD process would be best to collect the 'voice of the customer'. The project team has decided it would be best to visit the customer's facility to understand how the customer performs their work. The process of going to where the work gets done to observe the customer is called:
- a. Ishikawa process
 - b. The Taguchi process
 - c. Gemba
 - d. The KJ method
24. The project management plan, validated deliverables, requirements documentation, and requirements traceability matrix are all considered:
- a. Outputs of the scope control process
 - b. Inputs to the verify scope process
 - c. Inputs to define scope process
 - d. Tools and techniques of the scope verification process
25. Your team has just completed some work on a project and has submitted it to the users for verification. Once the users verify the results of this phase of the project, the team can start planning the next phase of the project, and it appears that you'll be ahead of schedule and slightly under budget to everyone's

surprise! The customer reviews the work product and is satisfied that it will meet the needs of the project. This is called:

- a. An accepted deliverable which is an output of control scope
- b. An accepted deliverable which requires formal sign off and approval by the customer
- c. An accepted deliverable which is really an output of quality control
- d. An accepted deliverable which requires project manager approval

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Chapter 5 Test – Answers

1. D – Scope statement + WBS + WBS dictionary is the scope baseline
2. B – The WBS does not show cross functional dependencies between work packages
3. C – Formalizes acceptance of completed deliverables via a sign-off
4. D – The WBS Dictionary
5. B – The requirements traceability matrix tracks each feature and element in the deliverable back to a requirement. This is a useful approach for preventing gold plating – giving the customer something they did not request.
6. A – The Delphi technique is specifically designed to prevent bandwagonism and avoid head-to-head confrontations. It focuses the team on the facts and pulls the emotion out of the equation
7. C – This is a clear case of gold plating. While it falls under the general category of scope creep (answer A) and also an undocumented change (answer B), what the resource has done is a specific type of undocumented scope creep called gold plating
8. C – The project statement of work provides the least level of detail – it is an input to develop the project charter and is an Initiating activity. It is a “narrative description of products or services to be delivered by the project” *PMBOK® Guide*, 4th edition, p 75. It references the 1) Business need, 2) Product scope description (product characteristics) and 3) the Strategic Plan
9. B – Breaking the work down to the work package level
10. D – Of course it's the customer. Ask yourself, who is cutting the check for you to do all that work and what are they willing to pay for? The PM certainly doesn't and the CCB doesn't fund your project. Sr. Management can be subsumed under the customer heading.
11. B – The project charter. The ONLY input listed in the answer set to Collect Requirements is the Project Charter, *PMBOK® Guide*, 4th edition, p 104
12. D – With a clear impact assessment outlining the additional timeline, resources and budget, there would be no ‘sticker shock’ surprises.
13. A – Stakeholders have input but the actual scope baseline is created by the project team
14. C – The collect requirements process defines customer needs. The scope includes not only the requirements of the product, but the project scope including risks, constraints, and assumptions. *PMBOK® Guide*, 4th edition, pp 105, 112-115
15. B – Control scope is correct. *PMBOK® Guide*, 4th edition, p. 104
16. D – Answers A and C assume the stakeholder is dissembling. Answer B might shock the user. Discussing the issue with the user and providing options is the best approach
17. C – The voice of the customer is part of QFD, which in turn is considered a facilitated workshop technique, which it turn is a tool and technique of Collect Requirements
18. B – Control account is the only answer. *PMBOK® Guide*, 4th edition, p. 121. All the other answers are made up.
19. D – The affinity diagram is specifically designed for this function
20. A – It measures project variances against the scope baseline
21. C – The first part of the question is a red herring. The issue is that the team member doesn't recognize the PM's authority. This would have been addressed in the project charter
22. D – Scope control is performed simultaneously with the other control processes in the other knowledge areas. “Project scope control...is integrated with other control processes” *PMBOK® Guide*, 4th edition p 125.
23. C – Gemba is the only possible answer. QFD is a tool for “collecting customer needs, also known as the Voice of the Customer (VOC)”. *PMBOK® Guide*, 4th edition, p 107. The Gemba process is an integral part of QFD.
24. B – Inputs to the verify scope process. *PMBOK® Guide*, 4th edition, p. 123
25. B – The accepted deliverable requires signoff by the customer

Chapter 6 : Project Time Management

Section Topics:

- Define Activities
- Sequence Activities
- Estimate Activity Resources
- Estimate Activity Durations
- Develop Schedule
- Control Schedule

Section Objectives

In this section, you will be able to:

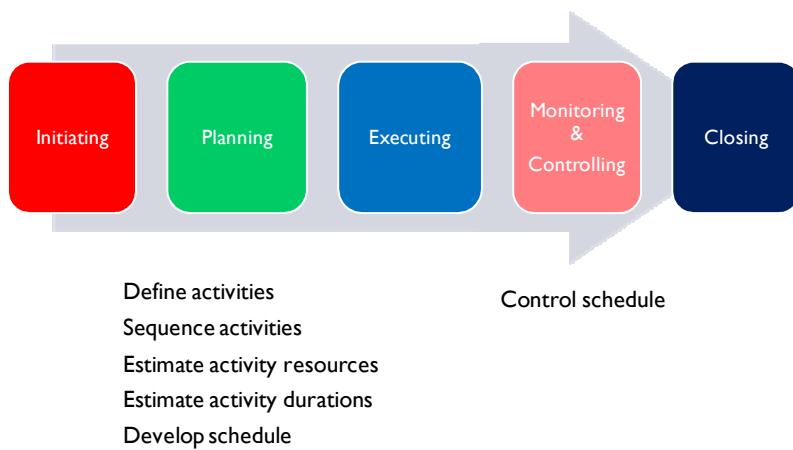
- Put the time management processes into PM process groups
- Define network diagrams and explain two ways to draw a network diagram
- List five techniques that can be used to estimate time
- Calculate critical path

Project Time Management Process Summary

The high level Project Time Management output elements, by Process Group are:

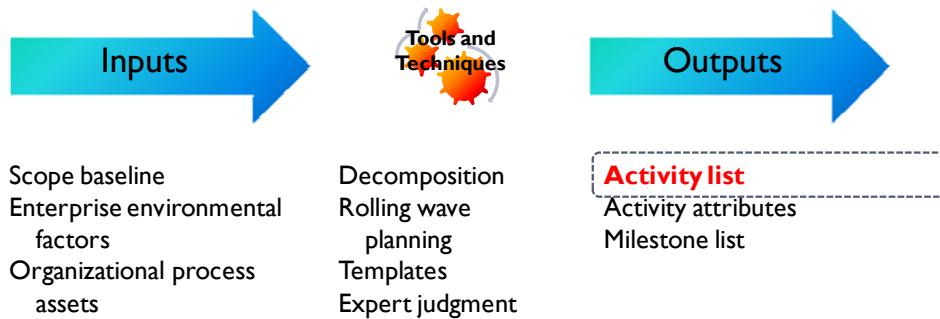
Initiating	Planning	Executing	Monitoring and Controlling	Closing
	-Activity list -Activity attributes -Milestone list		-Work performance measurements -CRs	
	Schedule Network Diagrams		Various document updates	
	-Activity Resource Requirements -Resource breakdown structure			
	Activity duration estimates			
	Schedule baseline			

Time Management



One of the key jobs of the project manager is to ascertain if the project can meet its required end date, and develop options to ensure this will occur. This must all occur before project execution begins. Therefore the predominance of the processes in Time Management occurs in the planning phase; each process occurring in logical order, culminating in the development of the schedule.

Define Activities



Defining activities essentially means we are defining *what* we are doing to implement the product of the project. It is here where we define what is being delivered for the project. While the WBS identifies deliverables down to the work package level, work packages are further decomposed into activities which identify the actual work necessary to complete the work package.

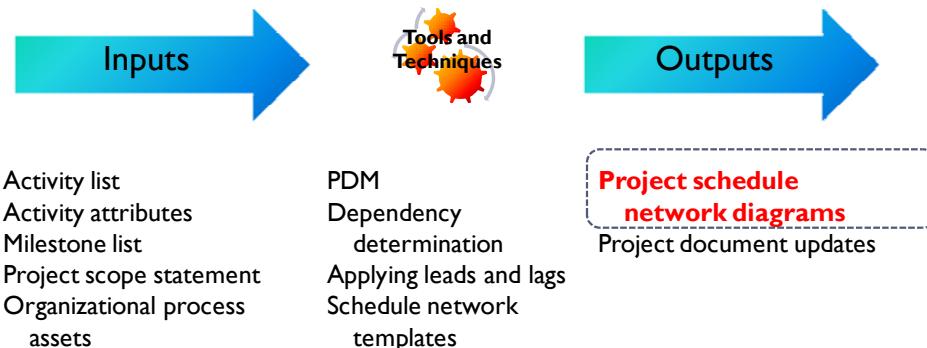
For the exam, understand that the term 'activity' is what PMI uses instead of the word 'task'. Activities are the foundation of providing estimates for budgets, scheduling, executing, and monitoring and controlling of project work.

The primary output from the process is the activity list; it describes what activities have to be performed to deliver the product of the project. Note at this point that it is simply an unordered list; no resources have been assigned, no durations have yet been developed.

The activity attributes give us detailed information about what is needed to fulfill the activity and details any functional dependencies between the activities.

The milestone list can be used to identify major or minor milestones of completion for the project.

Sequence Activities



After the activities are defined, they can be put in the proper order - this is called activity sequencing. We determine if there are activities that must occur earlier in the process versus later in the processes

and if there are any dependencies between the activities. The tool that we use to diagram these dependencies is called the precedence diagramming method (PDM) and will be detailed on the upcoming pages. There are various commercially available software tools that can be used to graphically identify the sequence of activities. These tools are called network diagramming tools. For the purposes of the exam we will address the key approach - the precedence diagramming method (PDM) - on the upcoming pages.

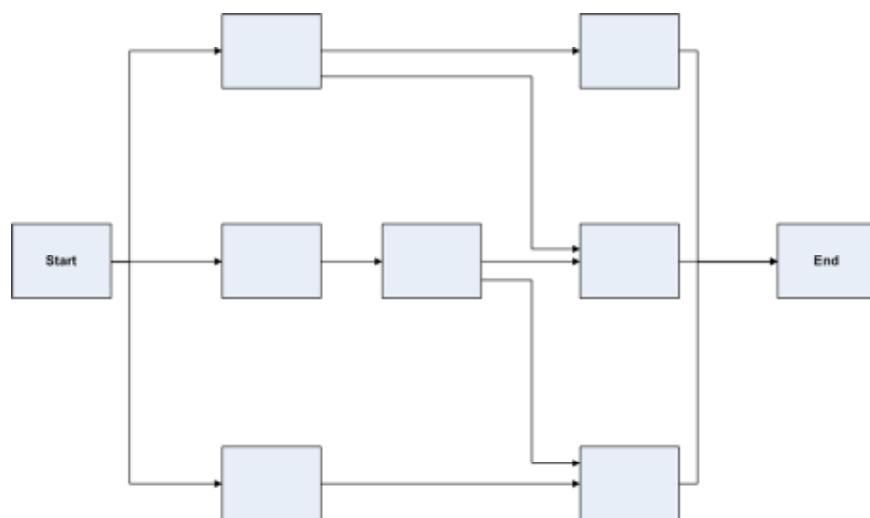
The key output from this process is to create a schedule network diagram.

Network Diagrams

A Network Diagram is similar in appearance to a flowchart, but there the resemblance ends very quickly. A network diagram is useful for the following reasons:

- Illuminates dependencies between activities
- Assigns durations to each activity
- Graphically identifies the workflow so the project team can understand the sequence of events
- Helps justify the time estimate for the project
- Identifies the critical path

An example of a network diagram appears below, minus any identifying markings.

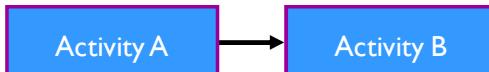


Notice that the diagram resembles a flow chart in design.

Precedence Relationships

There are four types of precedence relationships in the precedence diagramming method (PDM); also known as the activity on node (AON) approach:

1. **Finish-to-start:** I must complete activity 'A' before I can start activity 'B'. For example: I must drive pilings for the apartment building before I can start construction on the steelwork. About 95% of all relationships in a network diagram use the finish-to-start relationship:



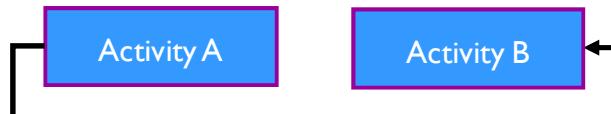
2. **Start-to-start:** I must start activity 'A' before I can start activity 'B'. For example: I must start clearing the driveway of snow before I start applying rock salt.



3. **Finish-to-finish:** I must complete activity 'A' before I can complete activity 'B'. For example: I must finish installing CAT 5 cable before I can complete hooking up PCs to the network. Most of the remaining 5% of network diagram relationships consist of the start-to-start, or finish-to-finish relationship



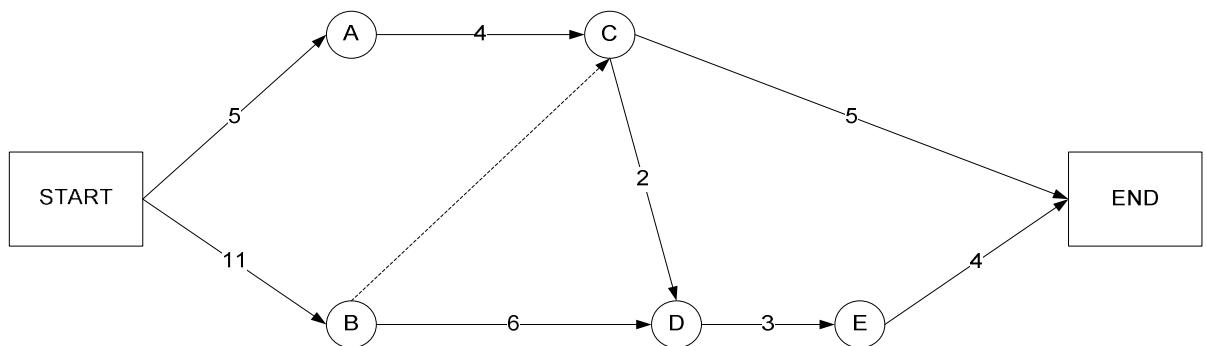
4. **Start-to-finish:** I cannot complete activity 'B' until I start activity 'A'. This approach is rarely used and you may wonder how this could possibly work. For example: let's say there was a lot of work you could complete in activity 'B' except one specific piece. A specific element is handled at the start of activity 'A'. Once activity 'A' has been started and the needed element has been completed, activity 'B' can also be completed



Activity on Arrow

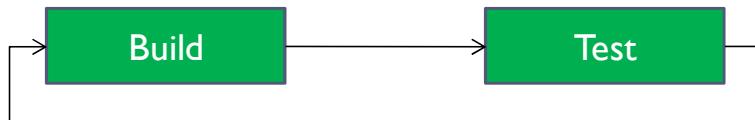
This is also known as the AOA diagram. **NOTE:** While this element is no longer mentioned in the *PMBOK® Guide, 4th edition*, it continues to appear on the exam.

Activities are defined on the arrow – thus an activity is read as A-C or C-D. The dashed line is a dummy activity – they are sometimes needed to show multiple dependencies. **Dummies carry a duration of zero.**



GERT

For the exam, you'll not see any questions about how to implement a GERT chart. You need to know what a GERT (Graphical Evaluation and Review Technique) chart is, that it allows for conditional branching and loops, and that's it.



Network Dependency Types

The activity sequencing process is determined based on the following three types of dependencies in your network diagram:

- **Mandatory Dependency** - the mandatory dependency describes the finish-to-start relationship. I must complete activity 'A' before I can start activity 'B'. This is also called 'hard logic'.
- **Discretionary Dependency** - in this case the dependencies are determined by the project team. This type of dependency can also be called 'preferred', 'preferential', or 'soft logic'. This type of logic is used based on how the organization prefers to handle specific dependencies.
- **External Dependency** - you are dependent on the needs of a third party or external organization, such as federal government, state government or a supplier.

Quick Quiz:

Q: You are working on a large financial project for a major international bank. The network diagram has been created for all of the major project activities: there are three parallel paths of development that all converge onto a single path. At the point of convergence there are some SEC regulations

that need to be addressed before you can continue with the project. What kind of dependency does this represent?

(answer: external)

Milestones

A milestone represents the completion of a key deliverable or of a phase in the project. Milestones are listed in the project management plan as well as the WBS dictionary and the detailed scope statement.

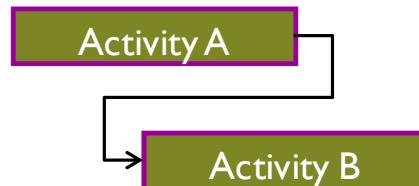
Milestones can also be used as checkpoints or as part of a high-level executive summary on the progress of the project. Milestones are frequently used as a mechanism for funding vendor activities. For example when the vendor reaches a milestone, some percentage of the contract funding is released as a partial payment.

A milestone list becomes part of:

- The project plan
- The project scope statement
- The WBS dictionary

Leads and Lags

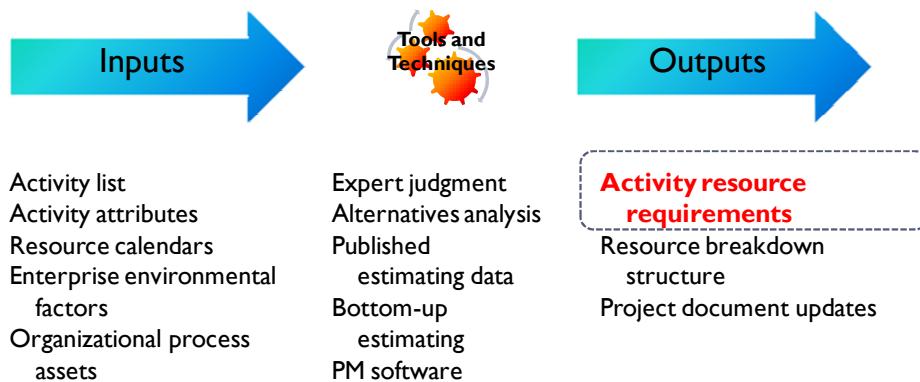
Leads can be applied on a project as a form of schedule compression also known as 'fast tracking'. For example: a software project may have requirements in a number of different components. As the requirements team completes the requirements for the first component, the development team can start working on its high-level design for the first component, while the requirement team starts requirements for the second component.



A lag is an imposed delay in starting a successor activity. The lag can be internally imposed or externally imposed depending on the situation. For example: there is a required lag between pouring concrete footing for a garage and starting to erect the walls of the structure. The concrete may require up to two weeks to 'cure' or set before the walls can be framed and a roof completed. In this case, the two weeks represents a lag in the project schedule.



Estimate Activity Resources



The estimate activity resources process matches human resources to activities. Think about why this is important. Who performs an activity will have a bearing on the activity's duration. A new resource may take 3 to 5 times longer to complete an activity due to:

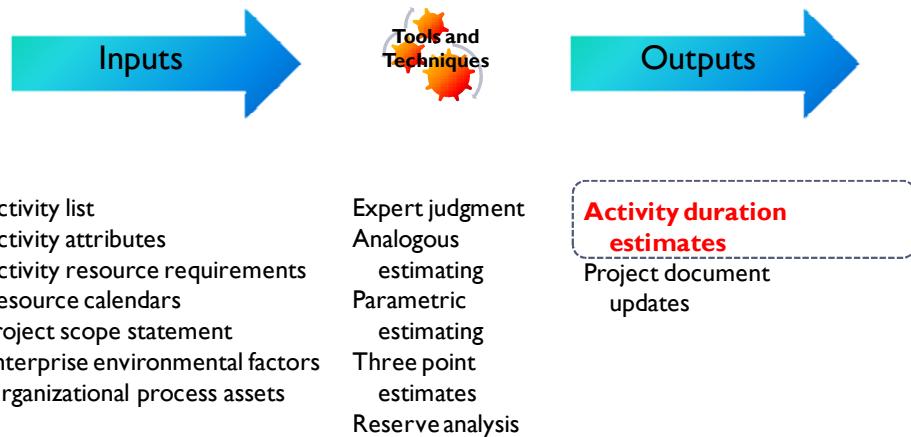
- Inexperience
- Lack of knowledge
- Unfamiliarity with the work environment
- Misinterpretation of stakeholder needs
- And others...

Quick quiz:

Q: Which of the following activities do you think involve Estimate Activity Resources?

- You develop a resource breakdown structure (RBS)
- Inquire of subject matter experts what resources will be needed
- Determine resource availability for the project
- Decompose activities into smaller parts to derive resource estimates
- Analyze the WBS and the activity list
- Perform an analysis of technical difficulty to build and deliver a project component
- Perform an analysis of the type of resources needed for the project
- Consult with HR on organizational resource use policies

Estimate Activity Durations



The Estimate Activity Resources process and Estimate Activity Durations are areas you need to understand very clearly for the exam. As the project manager, you are responsible for the following when estimating activity resources and activity durations:

- Obtaining historical information from past projects
- Coming up with your own estimates. If you are taking a project over from another project manager or there are management imposed constraints, your job is to assess the needs of the project and not take someone else's word for it.
- Periodically forecasting the end to come up with your own estimates to completion (ETC)
- Reviewing estimates to ensure they are reasonable and checking for duration padding and risks
- Looking for ways to shorten the project timeline through the mitigation, reduction, or elimination, of risks
- Basing the estimate on the WBS
- Ensuring that the resources who are actually performing the work (the subject matter experts) are delivering estimates, instead of a stakeholder who is telling you what they *think* the estimate should be.
- Managing the project to the schedule baseline
- Knowing when to implement a change if schedule problems occur
- Implementing a process to create the most accurate estimate possible
- Meeting any agreed estimates with stakeholders

The exam will mention a number of incorrect possibilities as answer choices for these two areas. Don't be fooled!

Quick Quiz:

You have received duration estimates for project activities based on inputs from the project team's subject matter experts. While the expert judgment of these individuals is valuable, the organization sees no value in creating a work breakdown structure (WBS). They are insisting on receiving the duration estimates within 48 hours and have set an aggressive schedule for completion that is three months sooner than the estimates from your subject matter experts. What will be your *BEST* course of action in this case?

- a. Since you have very little time to create an estimate, take your best guess and pad the estimate by 50%. This will handle any unexpected turns in the project and enable you to finish on time
- b. You create your own WBS irrespective of what management thinks. Create as much detail in the WBS as possible given the time constraints, and give management options for how to best address the aggressive schedule
- c. Management's aggressive schedule must be met at any cost. Let the team know you're a no-nonsense project manager and that you will expect them to deliver on management's demands.
- d. Tell management that you can meet their aggressive schedule demands. As the project progresses look for synergies and improvements that can bring the project in on time to meet the schedule demands

Duration Estimating Types

Knowledge of the following types of duration estimates is required for the exam:

- Analogous Estimating:
 - Project 'A' is like 3 previous projects we delivered
 - A form of expert judgment
- Parametric Estimating:
 - If it takes 1 day and costs x to build a widget then 1000 widgets will take 1000 days and cost 1000x.
- Three-Point estimating (PERT and Triangular Distribution)
 - PERT: A weighted average using statistical methods
 - Triangular Distribution: Non-weighted average of three data points
- Bottom-Up estimating:
 - A detailed estimate based on reliable historical values
- Expert Judgment: Subject Matter expertise
- Reserve Analysis: covered in Risk Chapter
- One-Point estimate: Based on expert judgment, but has numerous negative effects on the project:
 - Easy for team members to pad estimates
 - Resources try to please the boss instead of meeting the needs of the project
 - Estimates are highly unreliable and contribute to hidden risks
 - Schedules are at best, unrealistic and at worst, unattainable
- Heuristics: Problem-solving by experimental and especially trial-and-error methods – a rule of thumb

Accuracy of Estimating Methods

Method	Advantages	Disadvantages
Analogous	Quick, low cost	Very 'risky' – a form of expert judgment, if it's available
Parametric	Can be more detailed than analogous, faster than bottom-up	Parameters may not scale, accuracy can vary - may be more costly than analogous
Bottom-Up	More accurate Better team buy-in	Longer, higher cost, relies on WBS accuracy. Team may 'pad' estimates
Three-Point (PERT)	For well understood activities can be very accurate	Can be very inaccurate if ranges are based on unknown elements

The description of these methods will be thoroughly outlined in the Cost chapter.

Statistics for the Exam

You will not be asked to perform complex computations for the PMI examination. Everything will be either add, subtract, multiply, divide, and the occasional exponent. One element you must be very clear on is the concept of standard deviation (SD or 'sigma' level) and what percentage of a normal distribution of the sigma levels cover.

The diagram above shows a standard normal distribution, otherwise known as a bell curve. For the exam, understand the following:

- **'Average' or 'Mean'** - this refers to the arithmetic mean (*not* the geometric mean). To derive the average or mean of any group of numbers, simply total all the numbers in the group and divide that total by the sample count. Example - compute the average of the following set of numbers: 2,7,12,17,4,21,23. Adding up all the numbers totals 86. How many numbers were in the sample: 7. Then divide 86 by 7 to obtain the average: 12.29.
- **Standard deviation** - this is also called the 'sigma' value, usually represented by the Greek symbol ' σ '. Standard deviation is a measure of precision; the smaller the standard deviation the tighter the precision.

Approximately:

A range of 1 standard deviation ('1 σ ') above and below the mean equals 68% of the population.

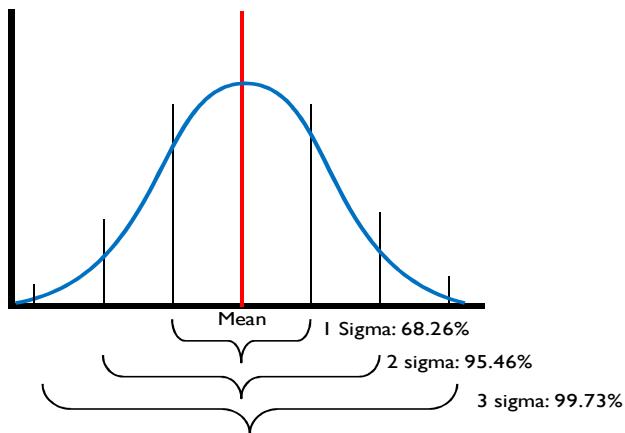
A range of 2 standard deviations ('2 σ ') above and below the mean equals 95% of the population.

A range of 3 standard deviations ('3 σ ') above and below the mean equals 99% of the population.



Brain Dump!

See the graphical example below for exact percentages:



Accuracy measures conformance to target values, while **standard deviation** measures the precision of the measurements. This will be discussed in greater detail in the Quality Chapter (Chapter 8).

For the exam you may see questions like this:

Q: You are managing a project with a schedule of 18 months. Based on your schedule calculation, you've determined the standard deviation on the schedule is six weeks. What is the range of the schedule computation to a 95% confidence factor?

- a. 60 weeks to 84 weeks
- b. 64 weeks to 80 weeks
- c. 66 weeks to 90 weeks
- d. it cannot be determined from the information given

Answer: C

Solution:

$$\begin{aligned}1 \text{ standard deviation} &= 6 \text{ weeks} \\2 \text{ standard deviations, (95\% confidence factor)} &= 12 \text{ weeks} \\18 \text{ months} &= 78 \text{ weeks } (52 + 26) \\78 - 12 &= 66 \text{ weeks} \\78 + 12 &= 90 \text{ weeks}\end{aligned}$$

PERT Calculation

PERT:

$$\text{Mean} = \frac{t_O + 4*t_{ML} + t_P}{6}$$

$$\text{Standard Deviation} = \frac{t_P - t_O}{6}$$

$$\text{Variance} = \sigma^2$$

Triangular Distribution

$$\text{Mean} = \frac{t_O + t_{ML} + t_P}{3}$$

$$\text{Standard Deviation} = \frac{t_P - t_O}{3}$$

$$\text{Variance} = \sigma^2$$

Key:

t - time
O- Optimistic
ML – Most Likely
P- Pessimistic



Brain Dump!

The PERT estimate can be calculated for time or budget. It is designed to accommodate a range of estimates from the most optimistic, to the most likely, to the most pessimistic, and then calculates an average.

The PERT estimate uses a weighted average – notice that the Most Likely estimate is multiplied by a factor of 4. This is because the PERT is weighted to accommodate the 95% confidence factor of 2 standard deviations. In other words, PERT assumes that the most likely estimate is the most accurate and should get the heaviest weight in the calculation. Estimates used for PERT can be derived from published estimating data or expert judgment.

Question –

Your team has gotten back to you with the following estimates for the project:

- Optimistic – 10 weeks
- Most likely - 16 weeks
- Pessimistic - 34 weeks

What is the PERT mean, standard deviation and variance for the schedule?

For the exam, from the example shown above, simply apply the correct formula for the mean to derive the PERT estimate:

$$(10+(4*16)+34)/6 = 18 \text{ weeks}$$

Use the second formula to compute the standard deviation:

$$(34-10)/6 = 4$$

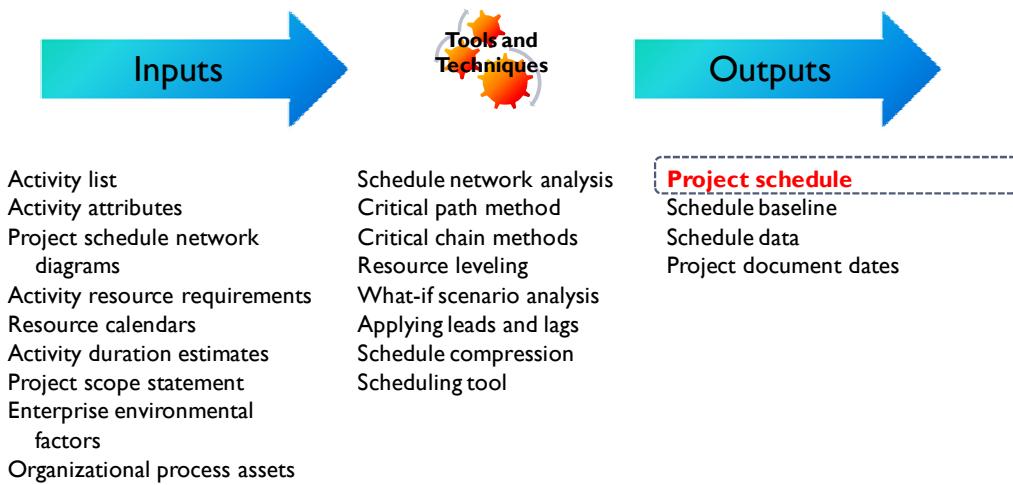
The variance is simply the square of the standard deviation:

$$(4)^2 = 16$$

Exam Tip: you simply need to memorize these formulas and answer the questions that appear.

Real World Note: In real world applications, the PERT estimate is simply a point estimate. In order to derive probabilities and confidence factors from this estimate, the PERT estimate is processed using the Monte Carlo analysis. This will enable the construction of a statistical model that will tie specific confidence factors to the PERT estimate.

Develop Schedule



The development of the project schedule is a culmination of the prior four steps we have just reviewed. In order to create the schedule we need:

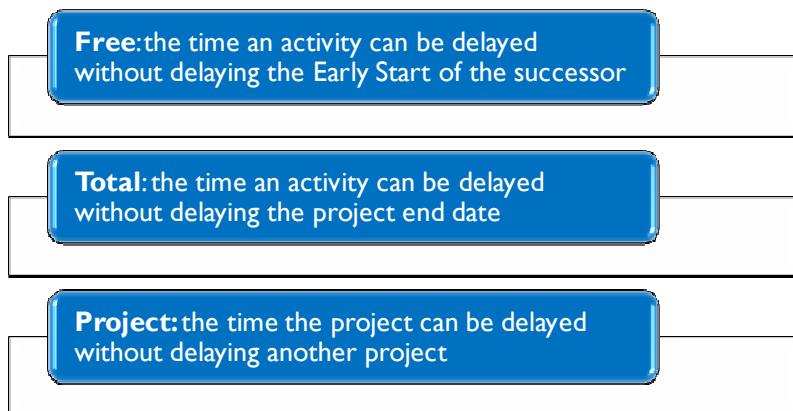
- An activity list
- Correctly sequenced activities
- Activity resource estimates
- Activity durations

The **schedule baseline** is a version of the project schedule and is a component of the project management plan. It is accepted, approved and signed off by the project management team. The schedule baseline documents the accepted schedule performance including start and finish dates.

Exam Tip: The difference between a time estimate and the schedule is that the **schedule** is calendar-based. Weekends, holidays, resource availability, vacation days and a host of other elements go into the final schedule. A **time estimate** for an activity simply relays how many hours or days it may take to complete the activity. The time estimate is also called **work effort** or **level of effort**.

Slack and Float

When constructing a network diagram, there may be activities that can be delayed without impacting the project schedule. These activities are said to contain **float** or **slack**. The terms 'slack' and 'float' are synonymous. For the exam, you need to know the definitions of the three types of slack/float that you can encounter on a project:



A number of activities in a network diagram occur in parallel. This is because different resources with different skill sets are able to perform their jobs independently. For example, the jobs of setting up a database, installing CAT 5 cable, developing a user interface, and installing a phone system all require different skill sets. It is quite possible to execute these activities in parallel as dependencies between them may be minimal.

Therefore, it is quite possible that while one path in the network diagram takes 10 weeks, a parallel path may only take 5 weeks. This is where we address the idea of slack or float in a project timeline.

Slack/float definitions:

- ES - early start, the earliest time in the network schedule an activity can begin
- LS - late start, the latest time in the network schedule an activity can begin without impacting the late finish (LF)
- EF - early finish, the earliest time in the network schedule an activity can end
- LF - late finish, the latest on the network schedule an activity can end without impacting the start of a successor activity

Float or Slack can be computed with the formulas shown below.

$$\text{Slack/float} = \text{LS} - \text{ES} \quad \text{or} \quad \text{LF} - \text{EF}$$

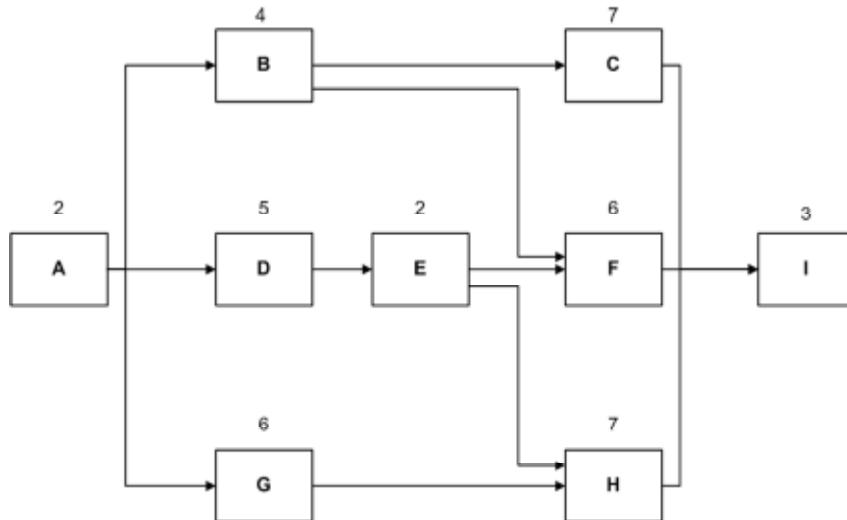
Critical Path Definition

The critical path in a network diagram is the longest path through the network that produces the shortest possible completion time for the project. It contains zero or negative float. The critical path outlines a series of mandatory dependencies in what is usually a series of finish-to-start relationships.

Critical Path Exam Tips:

- There can be more than one critical path
- The critical path can change
- The critical path has _____ float¹⁸
- A path with *negative* float means you are behind schedule. As the project manager, your job is to compress the schedule and eliminate negative float

Critical Path: Quick Quiz



Compute the critical path for the network diagram shown above. All durations are in weeks.

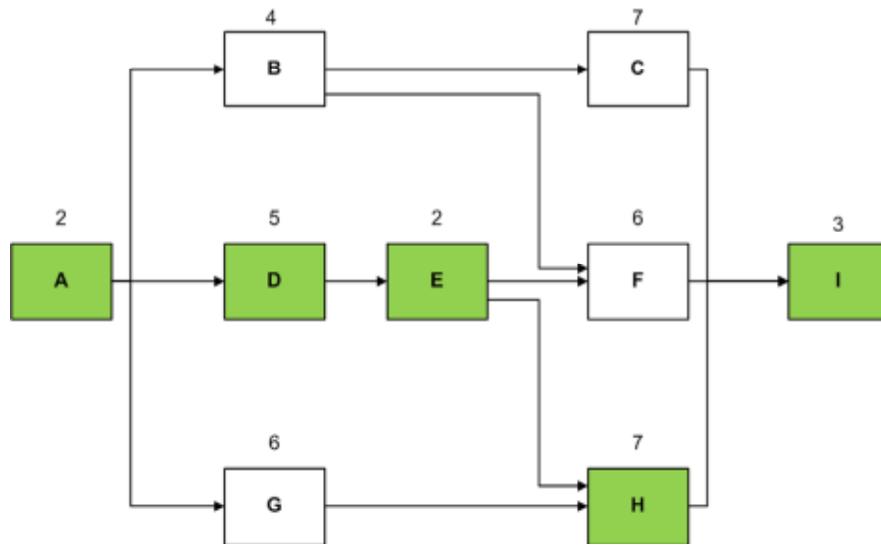
Considerations:

- Certain paths merge, for example:
 - Activities E and G merge into activity H
 - Activities B and E merge into activity F
- Merging paths create schedule dependencies based upon which path takes the longest to complete

The longest path through the network diagram shown above will be the critical path. The solution appears on the next page.

¹⁸ PMBOK® Guide, 4th edition p. 155

Critical Path Solution

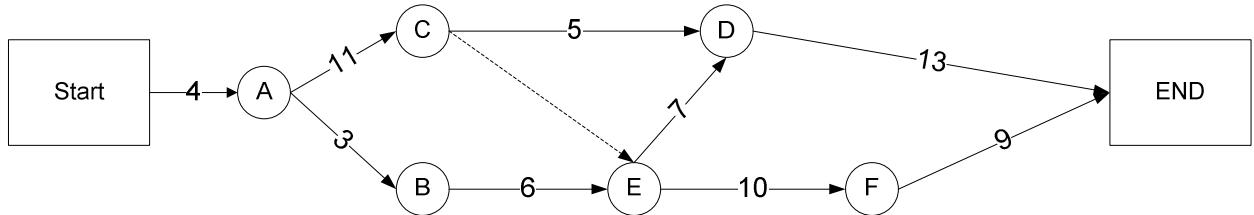


Notice that:

- Activities D and E are in a mandatory dependency relationship: activity D must complete before activity E begins.
- Since the combined time for activities D and E is 7 weeks, activity G is not on the critical path because it only has a duration of 6 weeks
- Notice that three paths converge into activity I. We determine the critical path by computing the duration of all possible paths to activity I:
 - A – B – C – I: 16 weeks
 - A – B – F – I: 15 weeks
 - A – D – E – F – I : 18 weeks
 - A – G – H – I: 18 weeks
 - A – D – E – H – I : 19 weeks**

Also notice that there are 2 ‘near critical’ paths, each at 18 weeks: A-D-E-F-I and A-G-H-I. As the project manager, you would keep an eye on these near critical paths to monitor for any schedule variances. Either one of these paths could become a parallel critical path or a new critical path if activities along these paths were delayed.

The diagram that appears below is called an AOA (Activity on Arrow) or ADM (Arrow Diagramming Method). While this approach is not referenced in the *PMBOK® Guide*, 4th edition, questions addressing AOA diagrams still appear on the exam, so we will cover the basics here.



Compute the critical path for the AOA above.

The key to understanding AOA diagrams on the exam:

- You may be given activity descriptions from which you will have to create an AOA diagram
 - AOA activities are always identified with two letters; A-B or A-C, etc. This is because the activity occurs on the arrow and not on the node
 - Dummy activities, if present, will be identified
- Dummy activities have no duration but do show schedule dependencies

The key to computing the critical path in the diagram above is to understand the impact of the dummy activity: completion of activity C-E.

The critical path is: **Start – A – C – E – D – End Duration: 35 weeks**

Network Diagram Setup

The standard approach to setting up a network diagram is to use what is known as the '7-box' method:

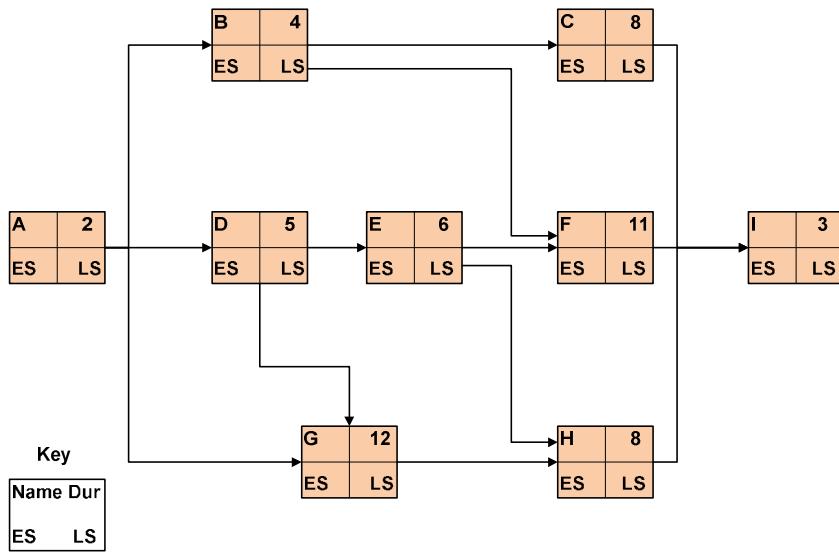
Description	
ID	Duration
ES	LS
EF	LF

The 7-box method includes a high level description of the activity, an activity ID, a duration, early start(ES), late start(LS), early finish(EF) and late finish(LF) data.

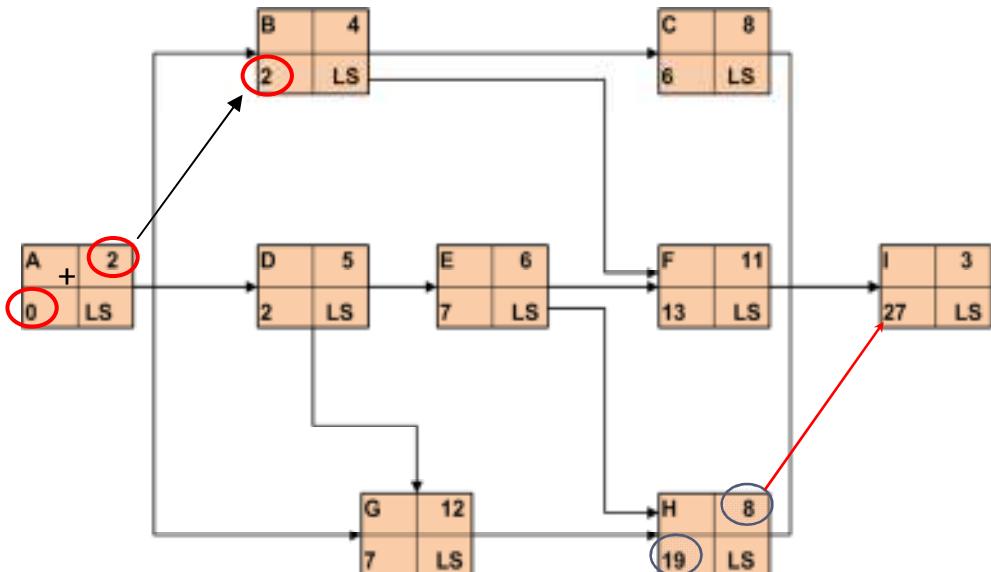
Since most project managers use software tools to create network diagrams, it is doubtful that you will ever have to perform this task manually except for the exam. Thus, a simplified way of setting up a network diagram is to use the '4-box' example shown below. Notice this is a new diagram with different durations.

For each activity, subdivide the box into a quadrant of four smaller boxes. The **activity identifier** appears in the upper left-hand corner of the quadrant. The **activity duration** appears in the upper right-hand corner of the quadrant. The **early start** for the activity is shown in the lower left-hand corner of the quadrant, while the **late start** for the activity is shown in the lower right-hand corner of the block. **If the early start and the late start of an activity are identical; that activity is on the critical path.**

By filling in the values for the early start and the late start, we will be able to compute not only the critical path for the network, but also show any float or slack in the network diagram. An example appears below:



Computing the Forward Pass



Computing the forward pass allows us to ascertain the critical path in the network diagram. Early start figures are computed for an activity by adding the early start to the duration of the predecessor activity. For example:

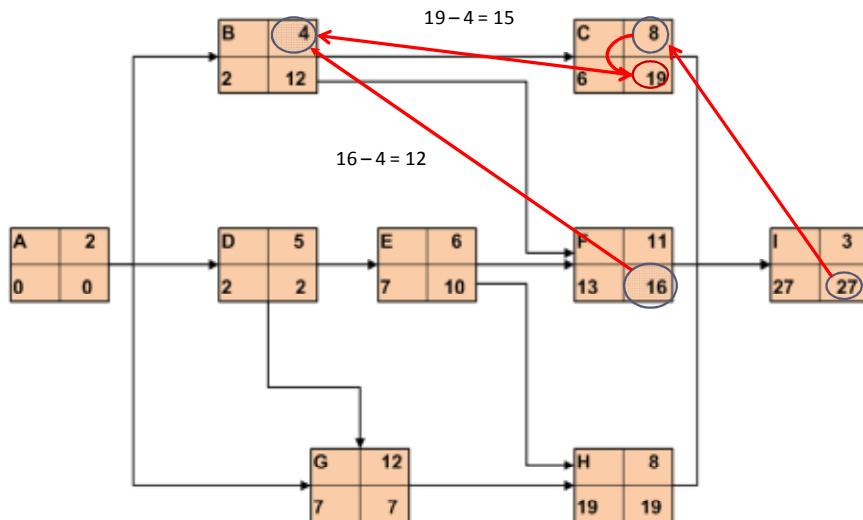
- The early start of activity 'B' is derived from taking the early start of activity 'A' (0) and adding it to the duration of activity 'A' (2). In this case $0 + 2 = 2$. The number 2 now goes in the early start of activity 'B'.

When an activity has two predecessors, how do we determine the early start of the successor activity? For example, activity 'G' has two predecessors: activity 'A' and activity 'D'. What is the early start of activity 'G'?

- Adding the early start of activity 'A' to the duration of activity 'A' yields the number 2.
- Adding the early start of activity 'D' to the duration of activity 'D' yields the number 7.

When merging paths for a forward pass activity, the largest number wins. In this case the number 7 goes into the early start of activity 'G'. Look at the diagram above and see where else this concept applies. The total duration of the network diagram is the early start of activity 'I' (27 weeks) plus the duration of activity 'I' (3 weeks), for a total of 30 weeks.

Computing the Backward Pass



The Backward Pass is used to complete the late start computations for the network diagram. In this case, we take a late start of the successor activity, subtract the duration from the predecessor activity and the result is placed in the late start of the predecessor activity. For example:

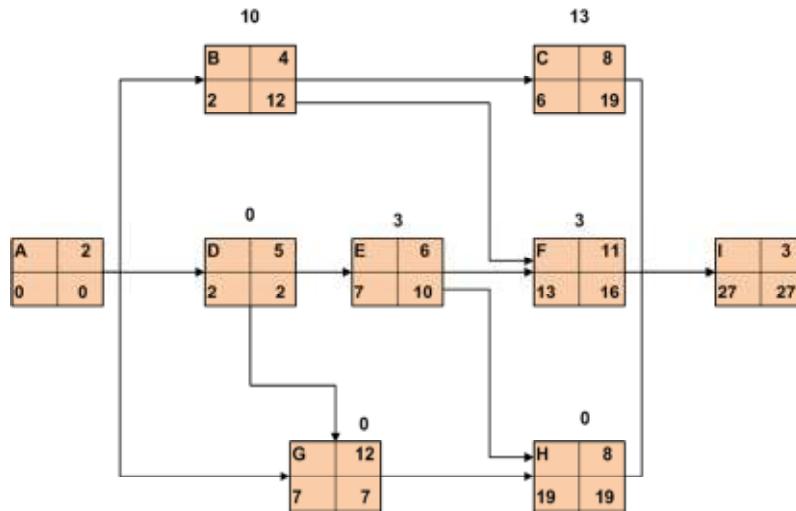
The project is 30 weeks in duration: Activity 'I' Early start (27) + Activity 'I' Duration (3). To derive the Late start of Activity "I", we take the project duration (30) and subtract the activity "I" duration (3): $30 - 3 = 27$. Thus, the late start of activity 'I' is 27. We derive the late start of activity 'F' by subtracting the duration of activity 'F' (11) from the late start of activity 'I' (27). $27 - 11 = 16$. And 16 is the value you see in the late start of activity 'F'. We derive the late start of activity 'C' by subtracting the duration of activity 'C' (8) from the late start of activity 'I' (27). $27 - 8 = 19$. And 19 is the value you see in the late start of activity 'C'.

When an activity has two successors, how do we determine the late start of the predecessor activity? For example, activity 'B' has two successors: activity 'F' and activity 'C'. What is the late start of activity 'B'?

- Subtracting the late start of activity 'F' from the duration of activity 'B' yields the number 12.
- Subtracting the late start of activity 'C' from the duration of activity 'B' yields the number 15.

When merging paths for a backward pass activity, the smallest number wins. In this case the number 12 goes into the late start of activity 'B'. Look at the diagram above and see where else this concept applies. For critical path activities, early start and late start numbers will be the same. For any activity that has float/slack, early start will always be less than late start. **All critical path elements will have identical ES/LS numbers (activities A, D, G, H and I are all on the critical path).**

Computing Float and Slack



The numbers above the activities in the network diagram showed the float for each activity. For the purpose of the exam be very careful how you answer the next questions:

- What is the total float for path A, D, E, F, I?
- What is the total float for path A, B, C, I?
- What is the total float for path A, B, F, I?

If your answers respectively were: 6, 23, and 13, none of your answers were correct. (!)

Exam Tip: when figuring the float for a path, the float values for each activity are not added together. The path float consists of the highest single value of float in the specific path.

Exam Tip: Critical path activities will have identical Early Start/Late Start dates

(The actual answers are 3, 13, and 10. The largest *single* path value is the float)

Schedule Compression Techniques

Schedule compression techniques may have to be used to address schedule constraints. There are two key tools in the project manager's toolbox that will allow the project manager to compress the schedule:

- Fast Tracking
- Crashing

Fast Tracking allows for the overlapping of activities or setting up activities to run in parallel. If the dependencies created by running activities in parallel are not managed correctly, this can result in rework and increased risk. Another issue is resource over-load which can occur if the same resources are used on an activity and its immediate successor activity. By overlapping these activities or running them in parallel, the resource can suddenly find themselves putting in a 16 hour day. It is the project manager's job to ensure this burnout scenario does not occur.

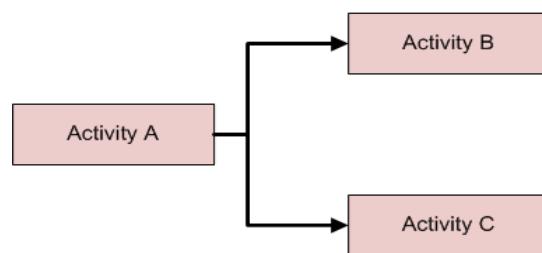
Crashing involves adding resources to critical path activities and always results in increased costs. This option can also result in having the team work overtime to achieve the project timeline constraints. This can result in team burnout, and unrealistic expectations regarding the actual time saved. Doubling the resource pool does not automatically mean that you will be getting twice as much work done in the same time. This is especially true on a software project. For further information, read the classic by Frederick Brooks entitled: *The Mythical Man Month*.

Below are two representations of fast tracking options compared to a current schedule:

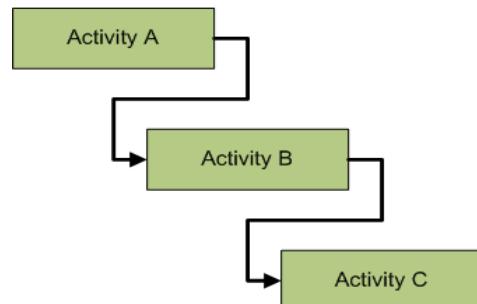
Current Schedule



Fast Tracking Option #1



Fast Tracking Option #2



Scheduling Techniques



CPM (Critical Path Method) is the technique we just reviewed that computes the forward and backward pass in order to determine the critical path and any possible float in the network.

The **Monte Carlo** analysis constructs a mathematical model based on statistical probabilities. The accuracy of the model is as accurate as the estimates delivered by expert judgment and /or historical data. There are any number of commercially available software spreadsheet tools and databases that allow for the construction of Monte Carlo analysis models.

Exam Tip: The Monte Carlo analysis can be used to generate ‘what-if’ scenarios, and is useful not only in describing uncertainties and probabilities in a project schedule, but also in identifying and quantifying risk on a project.

Critical Chain Project management (CCPM) is an extension of a process called the Theory of Constraints (TOC) developed by Eliyahu Goldratt, PhD physicist, and described in his book *Critical Chain*. In practical terms, organizations that have implemented CCPM as a project management process have experienced reductions in project schedules of between 10% and 50%.

Resource Leveling is used to adjust the variation in resource loading, which can vary considerably from one project phase or time period to the next. The idea is to stabilize the number of resources working in each time period to prevent resource over-allocation, or when a project phase needs more resources than are currently available. This can result in a change to the critical path or an extension of the project timeline. Here is where you can use resource leveling heuristics or guidelines for performing the resource leveling.

Monte Carlo Analysis

The Monte Carlo Analysis is used to generate ‘what-if’ scenarios. The process is performed by computing thousands of possibilities based on the generation of random variables to build a mathematical probability model of the scenario.

The Monte Carlo Analysis uses a combination of the PERT estimate and triangular distributions to create the model, and indicates where further discussion may be needed to minimize or eliminate schedule risks. The analysis can be performed using a tool such MS Excel® with relative ease, or with more sophisticated modeling tools such as @Risk®, Crystal Ball®, Minitab®, and others.

While the PERT estimate is useful in describing schedule variances, the primary issue with the PERT estimate is that it is only a point estimate. In order to get a clear picture of the probability distribution, the estimates in the model must be run thousands of times in order to draw the cumulative distribution of possibilities. For the Monte Carlo approach to work:

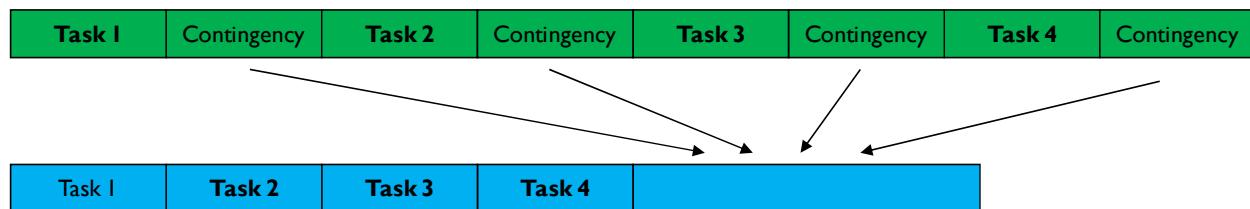
- It uses a set of random variables called *stochastic variables* to help generate the model
- It uses the triangular distribution to identify the end points in the model

Exam Tip: The graph of this function is known as an 'S' curve and will be outlined in greater detail in the risk chapter.

Critical Chain Method

The critical chain method is based on Eliyahu Goldratt's Theory of Constraints and described in some detail in the book *Critical Chain Project Management* by Lawrence P. Leach. It is a method of planning and managing projects that puts the main emphasis on the resources required to execute project activities. Contrasted to the Critical Path and PERT methods, which emphasize activity order and rigid scheduling, a Critical Chain project network will tend to keep the resources levelly loaded, but will require them to be flexible in their start times and to quickly switch between activities and activity chains to keep the whole project on schedule.

By cutting each task to its 50-50 estimate, we have reduced the project timeline by at least 50%. The project manager then adds a buffer to the end of the project timeline equal to 50% of the new timeline. The result is a project timeline that is automatically 25% shorter than the original critical path. See the example below:



Critical Chain project managers expect resources:

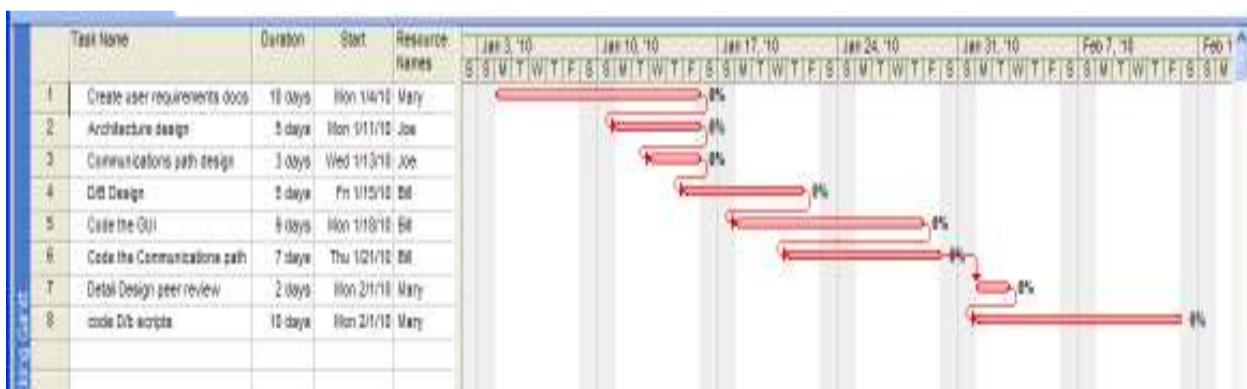
- To start the task as soon as input is received
- Work on the task 100% - no multi-tasking
- Pass on the task output as soon as it is completed

Critical Chain project managers expect 50% of the tasks to overrun (!)

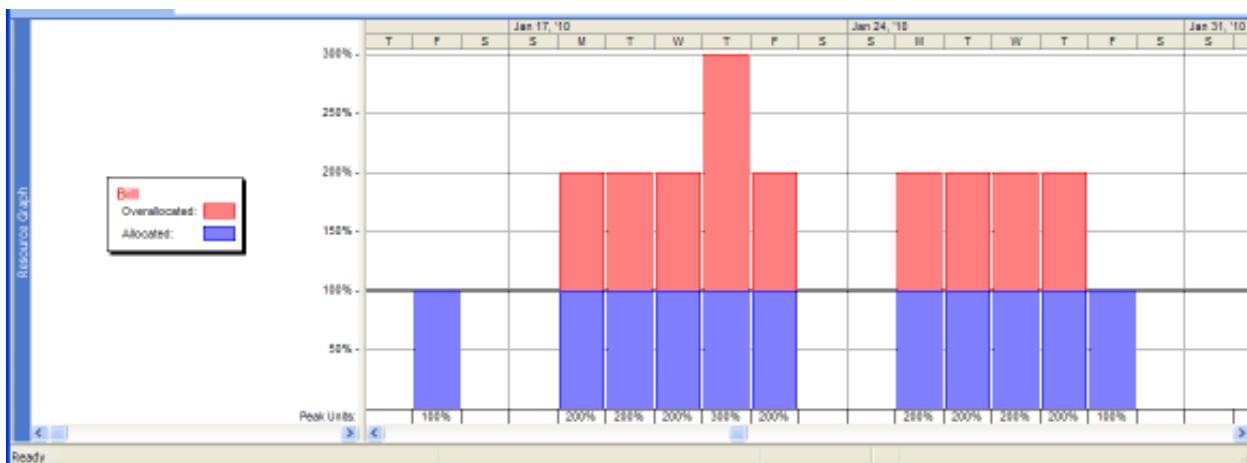
Exam Tip: CCPM accounts for limited resources, adds duration buffers, and focuses on managing the time buffer and resources. With CPM, the focus is on managing float. *With CCPM, the focus is on managing the buffers.* You may see CCPM as a possible answer to several exam questions.

Resource Leveling

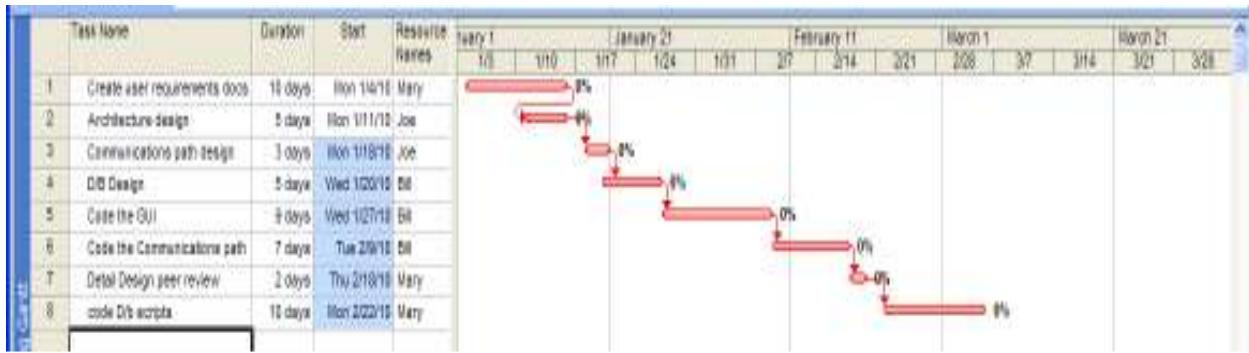
Resource leveling is a network analysis technique that is applied to a schedule after it has been analyzed by the Critical Path Method (CPM). It is particularly useful for illuminating resource over or under allocation at any point in the project schedule. In most organizations, however, resource over-allocation is the issue. Over-utilizing individuals with needed skill sets – e.g. assigning a resource to two or more tasks simultaneously within the same period - can lead to team burn-out, higher defect rates and other problems. Resource leveling an MS Gantt chart, where resources are being utilized at 125-150% of their standard work day, can push out the critical path far past the original schedule end date. See example below:



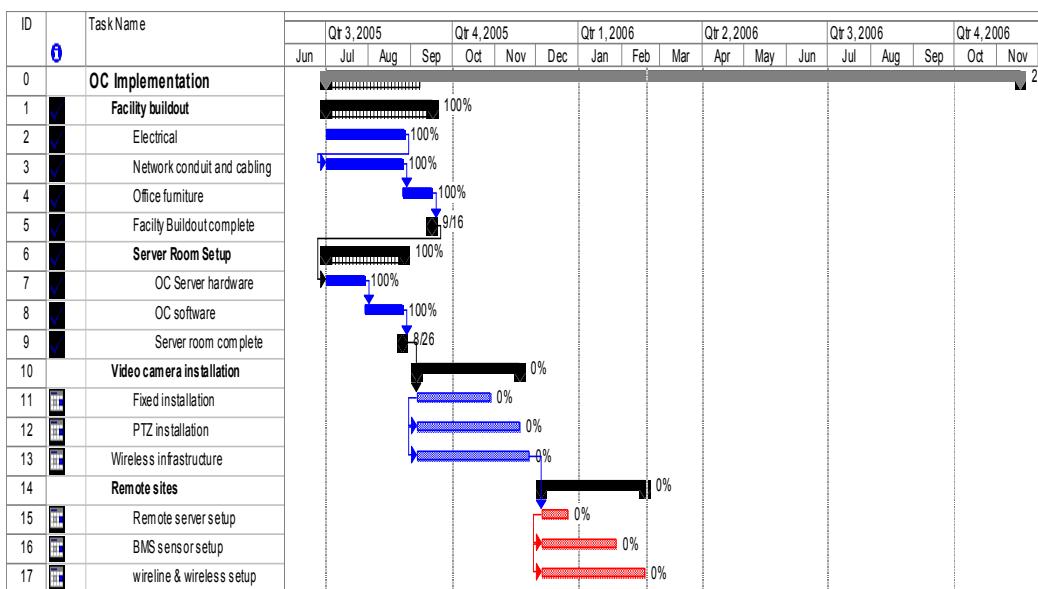
Notice that Joe and Bill show substantial overlap of activities. When displaying a graph of resource utilization, notice the following over-allocation levels for Bill. At one point it shows that Bill is working 24 hours in a 24 hour period!



While the original project timeline shows that the project work will complete in 6 weeks, this is a highly unrealistic estimate. When the timeline is resource leveled, notice the new end-date now sits at 9 weeks and provides for a consistent 40-hour/week allocation level for each resource. Also notice that the first two activities were not resource leveled because each activity is now being performed by a different person:



Bar Charts



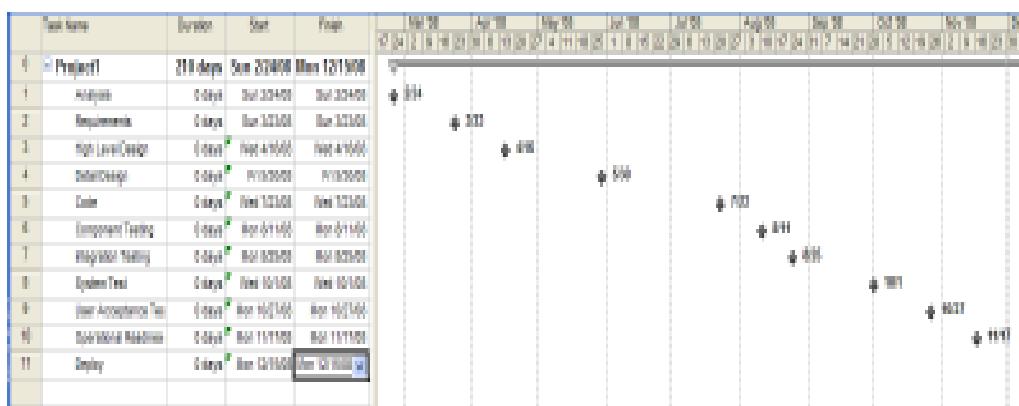
For the examination, know that the bar chart is useful for progress reporting and with some of the more sophisticated bar chart tools (e.g. MS Project), it can allow you to plot multiple critical paths and perform what-if scenarios. The chart shown above was created from MS Project; it is not a standard bar chart, but is referred to as a *network diagram* by PMI. Standard bar charts will appear as simply the bars with no logical connections of any kind between bars.

As project management planning tools, they are generally inadequate and they are ***not*** project management plans. The original bar chart created by Henry Gantt was developed around 1910 and was allegedly used for the first time as a scheduling tool during the construction of the Panama Canal.

Exam Tip: Higher-level summary activities that occur between milestones in a bar chart are frequently called **hammock** activities¹⁹.

¹⁹ PMBOK® Guide, 4th edition, p. 157

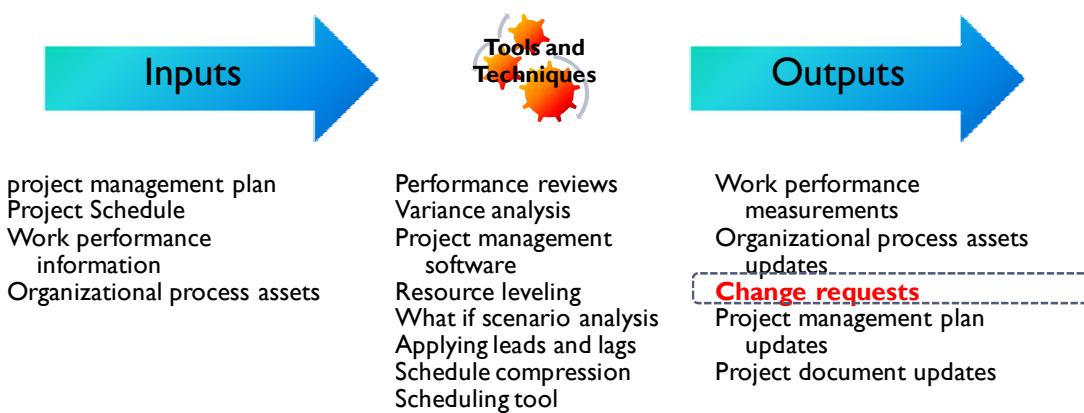
Milestone Charts



The milestone chart is similar to the bar chart, but it only shows major deliverables and major events in your project. From this perspective, it is a useful tool for producing executive summaries. The example shown above is a typical milestone chart representation.

Exam Tip: milestones have no duration, and are simply an indicator that something has been completed or that a specific goal has been reached

Control Schedule



Control Schedule is contained within the Monitoring and Controlling process group. From the point of view of the exam, it is assumed that you as the project manager have been implementing sufficient process to monitor and control the schedule on your project. Unless an exam question states otherwise, you have been doing your job, you have been measuring the project against the schedule baseline, and you have been making corrections where necessary to keep the project on track and on time.

Notice that the tools and techniques of controlling the schedule include things like variance analysis, resource leveling, performing what-if scenario analysis, and schedule compression. If you are truly performing the process of progressive elaboration, you'll be learning more about the project as the

project progresses. However, the plan is one thing, reality is something else. Take a tip from a 19th-century Prussian field marshal Helmuth von Moltke, who succinctly stated: "No plan survives contact with the enemy. Planning is everything, the plan is nothing".

Controlling the schedule involves planning and *replanning*, measuring the result, making adjustments, adjusting metrics, adjusting progress and status reports, using a disciplined change control process, and applying your project management 'dental pick' to control unnecessary changes. Keep all these things in mind when you think of controlling the schedule.

PDM Exercises

Draw the network diagrams or perform calculations based on the information provided below. All durations are in weeks.

Exercise #1:

Activity	Predecessor	Duration
Start		-
A	Start	2
B	A	3
C	A	5
D	B	7
E	B,C	12
F	D,E	4
G	D,F	6
End	E,G	-

Answer the following questions:

1. What is the critical path?
2. Where is the float or slack, if any?
3. The customer needs the schedule brought in seven weeks sooner. You discuss options with the customer and decide to reduce activity 'E' by seven weeks. How does this affect critical path?
4. Starting with the original schedule, activity 'B' experiences a major discovery and as a result changes to seven weeks. How does this impact critical path, if at all?

Exercise #2:

Activity	Optimistic	Most Likely	Pessimistic	Predecessor
A	3	5	13	None
B	4	6	11	A
C	2	4	6	A
D	8	12	22	B
E	7	12	20	C
F	6	10	17	D, E
G	3	6	18	F
End				G

1. Compute the critical path

2. Risk on activity E sharply increases 21 weeks due to a major discovery. Which part of the PERT estimate does this impact and what is the impact on the critical path?

Exercise #3:

Activity	Predecessor	Duration
Start		-
A	Start	4
B	A	3
C	A	9
D	A	5
E	B,C	6
F	C,D	5
G	E,F	10
H	F,G	7
I	G	9
End	H,I	

Questions:

1. What is the critical path?
2. What is the near-critical path?
3. If the customer wanted to reduce the schedule by 4 weeks, what would be the resulting float?
4. What would happen if activities 'H' and 'I' change to a finish-to-finish relationship and the predecessor relationship between activity 'I' and 'G' is eliminated?

Exercise #4:

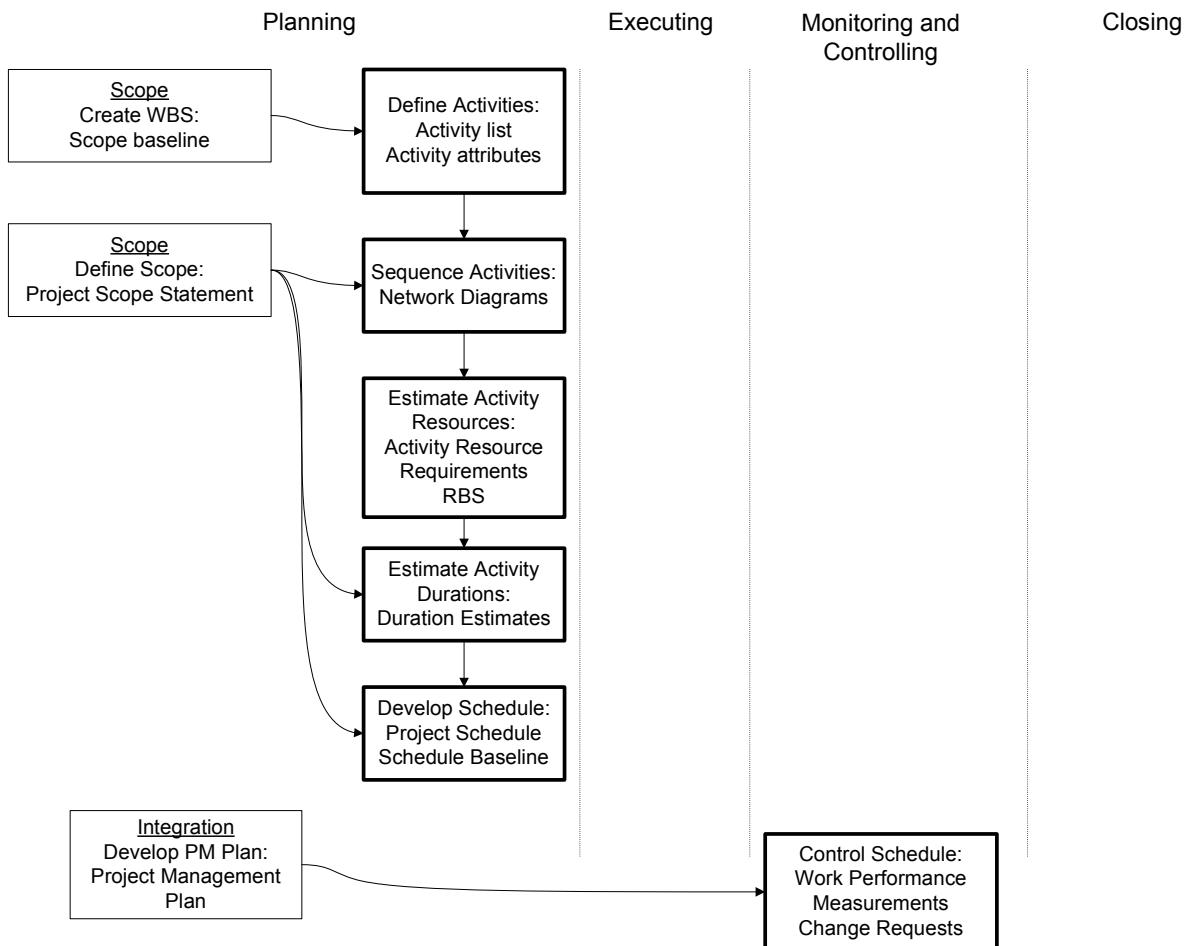
Activity	Duration
Start- A	4
A-B	3
A-C	11
C-D	5
B-E	6
C-E	Dummy
E-F	13
D-G	7
G-End	9
F-End	9

Questions:

1. What is the critical path?
2. What is the near-critical path?
3. If the customer wanted to reduce G-End by 2 weeks, what would the critical path be?
4. What would be the simplest way to reduce the schedule by 4 weeks?
(Answers for PDM exercises in Chapter 14).

Project Time Management: Key Process Interactions

The key inputs from the other Knowledge Areas to Project Time Management processes are shown below. *Know these process interactions for the exam.*



In Summary...

Project time management, covers the following:

- Network diagrams: how to draw AON diagrams
- The CPM, PERT, Monte Carlo simulations, and critical chain to create time estimates
- Calculate leads, lags, slack, float, and critical path
- Crashing and fast tracking a project timeline

Chapter Six Memory Check

1. The four possible precedence relationships in an AON network diagram are: _____ - _____, _____ - _____, _____ - _____, and _____ - _____
2. The diagramming method that allows for conditional looping is called _____
3. The three types of network dependencies are known as: _____, _____, and _____
4. The completion of a key deliverable or a phase in the project is called a _____
5. Starting a successor activity before the predecessor is complete is called a _____, while a delay in starting a successor activity is defined as a _____
6. The five processes in the Planning process group for Time Management are: _____
_____, _____, _____, _____, _____, and _____
7. Another name for the three point estimate is called _____
8. The most accurate and time consuming of the estimates is called _____ - estimating
9. The sigma percentages are 1 Sigma = _____ %, 2 Sigma = _____ % and 3 Sigma _____ %
10. The time an activity can be delayed without delaying the project end date is called _____
11. The earliest you can begin an activity is called the _____, while the latest time in the network schedule that an activity can begin without impacting the late finish (LF) is called the _____
12. Conformance to target values is defined as _____, while the precision of the measurement is expressed as _____
13. The _____ in a network diagram is the longest path through the network that produces the shortest possible completion time for the project
14. The time a project can be delayed without delaying the start of a successor project is called _____
15. The two primary schedule compression techniques are called _____ and _____
16. The _____ analysis is used to build statistical models and perform what-if analysis
17. Stabilizing the number of resources working in each time period to prevent resource over-allocation is known as _____
18. _____ project management accounts for limited resources, adds duration buffers, focuses on managing the time buffer and resources
19. _____ describes the time an activity can be delayed before delaying the early start (ES) of a successor activity
20. Higher-level summary activities that occur between milestones in a bar chart are frequently called _____
21. In addition to various updates, a key output of the Control Schedule process is _____
22. An activity that has no duration is called a _____
23. Computing the _____ pass allows us to ascertain the critical path in the network diagram, while computing the _____ pass is used to determine areas of float or slack in the network diagram

Chapter 6 Test

1. The blueprints for the new construction projects have been completed and construction is ready to begin. While the organization was thinking about erecting a modular structure, they decided on a more traditional approach. The foundation will be poured and cured before the framing begins. This is an example of:
 - a. Discretionary dependency
 - b. Mandatory dependency
 - c. External dependency
 - d. Internal dependency
2. You have determined your project will optimistically take 24 weeks to complete, with a most likely completion date of 36 weeks and a pessimistic completion date of 72 weeks. Based on this three point estimate what is the likely completion timeline for the project?
 - a. 38.4 weeks
 - b. 39.6 weeks
 - c. 40 weeks
 - d. 42.4 weeks
3. A finish to finish relationship is defined as which of the following?
 - a. Both activities have to finish at the same time
 - b. The predecessor has to finish before the successor can finish
 - c. Both activities are on the critical path
 - d. The predecessor has a defined lead while the successor has a defined lag
4. Rolling wave planning is a form of:
 - a. Progressive elaboration
 - b. Critical chain Project management
 - c. Critical Path method
 - d. Precedence diagramming
5. Management from the customer side wants to bring in a project one month earlier than they had originally planned. Based on the current project timeline, product testing will have to be cut short. You have reviewed several options with the customer; they have decided that crashing the schedule would be the best approach to bringing in the project earlier. As a result of customer's decision, what is your *biggest* concern using this approach?
 - a. Additional expense
 - b. Availability of additional resources to perform testing in a shorter time frame
 - c. Customer buy-in
 - d. Developing an adequate reward system to address the overtime that will be needed to bring in this project one month early
6. The project optimistic estimate is 10 weeks and the pessimistic estimate is 40 weeks. What is the standard deviation of the estimate?
 - a. 4
 - b. 5
 - c. 6.7
 - d. 7.5

7. What is the *most correct* definition of the critical path in a network diagram?
- The shortest path through the network
 - The longest path through the network
 - The longest path through the network that contains zero or negative float
 - The shortest path through the network that cannot be compressed
8. While executing the project it becomes obvious that you're not going to hit your end date. The project may be delayed by at least two months. This may impact the start date of another project that was due to start right after yours completed. What type of float *best* describes this situation?
- Total float
 - Project float
 - Free float
 - Slack float
9. You have been discussing several estimating options with the project team. Some of the team members think that this particular project is similar to something that they worked on last year. However, the technical team has been quick to point out that there are some unknowns on this project that make parts of the project significantly different from last year's project. As the team starts performing a detailed analysis of the previous project, they uncover a great deal of historical information that would apply to the current project. In this situation the *best* estimating tool would be:
- Analogous estimate
 - Parametric estimate
 - Bottom-up estimate
 - One-time estimate
10. You have reached a point in your project where a major deliverable has been completed and submitted to the customer for approval. In a project timeline, this is *typically* called:
- Validated deliverable
 - Milestone
 - Work performance information
 - Phase completion
11. You and the project team are planning the work of the project. In addition to all of the planning activities that you're engaged in, part of the team has been reviewing the customer requirements, and has started to outline a work breakdown structure as well as create elements of the WBS dictionary, breaking down the work packages into smaller increments. The *most accurate* way of describing this is that you are creating:
- A milestone list
 - A deliverable list
 - An activity list
 - A scope elaboration
12. The biggest disadvantage of the parametric estimate is?
- It is just like an analogous estimate
 - It does not take cross-functional dependencies into consideration
 - There really is no disadvantage
 - The solution may not scale

13. You have been discussing a key deliverable with your customer. The discussion has centered on the accuracy and precision of the deliverable. Customer has indicated that due to the nature of the deliverable, a high level of precision is not really required. They have indicated to you that a precision of slightly less than 70% is adequate and acceptable. In terms of the Sigma reading, this number *approximately* translates to?
- 1 Sigma
 - 2 Sigma
 - 3 sigma
 - 6 Sigma
14. The technical team has asked for multiple estimates on a specific product component's delivery time. They fed the results of their measurements into a three-point analysis which identified the optimistic as 4 weeks, the most likely estimate of 7 weeks, and a pessimistic estimate of 14 weeks. The variance equals:
- 1 and 2/3 weeks
 - 1.29 weeks
 - 2.77 weeks
 - 7.66 weeks
15. Two of your junior project managers are having an intense discussion about building a network diagram for their current project. It appears that while there is a clearly defined critical path, there are also three near critical paths and two other parallel paths with significantly more 'wiggle room' in the schedule. On these remaining two parallel paths, one of the activities has a required delay. The first project manager thinks this is a problem while the second project manager is arguing not to worry about it. Each thinks that the other doesn't really understand the issue. What is the *real* issue here?
- They are really arguing the difference between the critical path (CPM) and the critical chain (CCPM) methods
 - One of the project managers doesn't understand the issue
 - They are confusing float and lag
 - The argument is meaningless
16. The project team is progressing well with all planning activities. They have sat down with the customer for a JAD session to review some alternatives for proceeding with the project. The customer wants to model some of the potential paths forward to see which one of these paths offers the best solution. This type of analysis is *best* described as:
- Critical Path analysis
 - Monte Carlo analysis
 - Multi-objective algorithm analysis
 - QFD analysis
17. Management has requested that you look for ways to compress the schedule on your project. It seems that the end date will be 2 months too late for the business to obtain a marketing advantage for that year. You and the project team have looked at various schedule compression techniques, and have decided that fast tracking will be your best approach. What is an advantage *and* a disadvantage of fast tracking?
- Some activities can be run in parallel but costs increase
 - Some activities can be run in parallel but risk increases
 - Some activities can be executed as overtime but costs increase
 - Some activities can use the same resources but team burnout is an issue

Activity	Predecessor	Duration
Start	-	-
A	-	5
B	A	4
C	A	6
D	B,C	11
E	C	10
F	D,E	5
G	E	7
End	F,G	-

Create the Network Diagram using the grid above. All times in weeks. Use for the next three questions.

18. What is the critical path of the network described above?
- a. A-B-D-F-end
 - b. A-C-D-F-end
 - c. A-C-E-F-end
 - d. A-C-E-G-end
19. The customer has asked that you reduce activity D by 2 weeks. What impact does this have on the schedule?
- a. None. It is not on the critical path
 - b. It will reduce the schedule like two weeks
 - c. It will only work if you also reduce activity B by two weeks
 - d. It will only work if you also reduce activity F by two weeks
20. The customer has demanded that you reduce the schedule by three weeks. What does this mean in terms of the Project schedule?
- a. You have decided that fast tracking is the best option to pull in the schedule by three weeks
 - b. You have decided that crashing the schedule is the best option to pull in the schedule by three weeks
 - c. Your project has negative float
 - d. You cannot deliver the project three weeks earlier without impacting project quality
21. You have just been assigned a new project within your organization. After performing an initial analysis, it has become obvious that you will not have enough resources to complete the project by the requested due date. You bring your analysis back to the sponsor and to senior management, who respond with, "just do the best you can". In looking at various scheduling techniques, which of the following would be the *best* scheduling approach to handle this situation?
- a. Critical Path method
 - b. Precedence diagramming method
 - c. Resource leveling heuristics
 - d. Critical chain method
22. A new design for an ocean-going oil tanker has prompted your organization to produce the first of a new generation of oil tanker. The project involves a complex project network diagram with a number of parallel paths. As the project progresses, the single critical path becomes 3 critical paths. As the project manager, what is your *largest* concern right now?
- a. Managing Communications
 - b. Managing dependencies between the parallel path activities
 - c. Managing multiple stakeholders
 - d. Change Management

23. What is a key output from the Control Schedule process?
- a. Work Performance Information
 - b. Change Requests
 - c. Updates to Enterprise Environmental Factors
 - d. Risk Register updates
24. The project schedule has finally been completed for the project. In reviewing the resource estimates, you notice that several key resources have been assigned multiple activities on several parallel network paths. You have also noticed that the resources for the different time phases vary greatly, sometimes as much as 300%. What scheduling technique would be the best to use at this point?
- a. Critical chain
 - b. Critical path
 - c. Monte Carlo
 - d. Resource leveling
25. What is the primary difference between critical path (CPM) and critical chain (CCPM) schedule approaches?
- a. There is fundamentally no difference
 - b. CPM focuses on managing float while CCPM focuses on managing buffers
 - c. CCPM focuses on extensive multi-tasking while CPM focuses on resource leveling
 - d. CPM uses heuristics while CCPM uses mathematical modeling

Chapter 6 Test - Answers

1. B - This is a clear example of a mandatory dependency; The foundation must set before you can start erecting the walls of the structure.
2. C – $(24 + 4*36 + 72) / 6$ yields $240/6 = 40$
3. B - This is the definition of a finish to finish relationship: I must complete activity 'a' before I complete Activity 'b'
4. A – Rolling wave planning uses progressive elaboration to identify details of a project that can be executed in the near term while keeping options open on elements that are further down the project timeline
5. B – Since the customer has decided that crashing is an option, answer 'A' has already been taken into consideration as well as answer 'C'. Answer 'D' is a complete unknown at this point. Of the four answers, the biggest concern is whether the testing resources are actually available to do the job
6. B – By straight calculation: $(40-10)/6$ or $30/6 = 5$
7. C – By definition the, critical path is the longest path through the network that contains no float or slack. After the CP is created, there are schedule compression techniques that can be applied, but each of these techniques carries risk. (Fast track or crash).
8. B – Project float is the delay a project can incur without delaying a succeeding project. Total float addresses delaying the project and date. Free float addresses the early start of a successor activity. Slack float is a made-up term
9. C – The bottom-up estimate is based on verifiable historical data - in other words you're dealing with things that you've done before. The analogous estimate compares projects at a high level without getting into detail. The parametric estimate is designed to estimate repetitive activities and forecast a result based on the estimate from the initial activity. A 1-time estimate is a total 'shoot-from-the-hip' estimate.
10. B – Read this question carefully - it asks about the project timeline. While the result might constitute a validated deliverable (answer 'A'), in terms of the timeline, this deliverable is a milestone.
11. C – The key phrase in the question is 'breaking down work packages into smaller increments' which is the definition of creating activities. Milestones and deliverables are higher levels above the work package. Scope elaboration is a red herring
12. D – By definition, the biggest disadvantage of the parametric estimate in the answer set is that the solution may not scale. Answers 'A' and 'C' are simply incorrect, and answer 'B' applies to a WBS
13. A – By definition, one Sigma translates into 68.26%, slightly less than 70%
14. C – Variance is the square of the standard deviation. Standard deviation equals $(14-4)/6 = 1.67$. Therefore standard deviation squared equals 2.77
15. C – This can be resolved by process of elimination. Answer 'A' is incorrect; there is no discussion of differences between CPM and CCPM. Answers 'B' and 'D' completely missed the point. The argument is about this: you've got two parallel paths that are not on the critical path. One of the activities has a 'required' delay - read that 'lag' - that has one of the project managers concerned. The other is saying not to worry about it due to the fact that you're not dealing with the critical path activity - read that 'float'. So it appears there is some misunderstanding about the difference between float and lag and how that plays into the project schedule.
16. B – The technique that uses modeling is the Monte Carlo analysis. Answer 'C' is a constrained optimization method. Answers 'A' and 'D' are red herrings
17. B – By definition, fast tracking allows you to run some activities in parallel, but the downside is that there is an increase in risk.
18. D – A-C-E-G yields a critical path of 28
19. A – None. Activity 'D' is not on the critical path - shortening it will make no difference.
20. C – Notice the question doesn't ask you what you will do about it – it simply asks you 'what does this mean'? What it means is that your project now has a negative float of three weeks
21. D – By definition, the critical chain method deals with scarce resources
22. B - When a single critical path breaks into multiple critical paths, the biggest issue is managing the dependencies between those parallel activities. Managing communications or multiple stakeholders is

something that you would do regardless of what your project schedule looked like, and a disciplined change management process is the least of your worries right now.

23. B – Change requests is the only correct answer. Work performance information is an input, updates occur to organizational process assets (not enterprise environmental factors) and updates to the risk register occur in the risk process.
24. D – If resources have been assigned simultaneous activities on multiple parallel project paths, then the resource load on the project can vary as much as 300%. Resource leveling is the only appropriate choice here
25. B – By definition, critical path method focuses on managing float while the critical chain project management method focuses on managing buffers. Answer ‘A’ is incorrect, and answers ‘C’ and ‘D’ are red herrings

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Chapter 7 : Project Cost Management

Section Topics:

- ▶ Estimate Costs
- ▶ Determine Budget
- ▶ Control Costs

Section Objectives

On completing this section you will be able to:

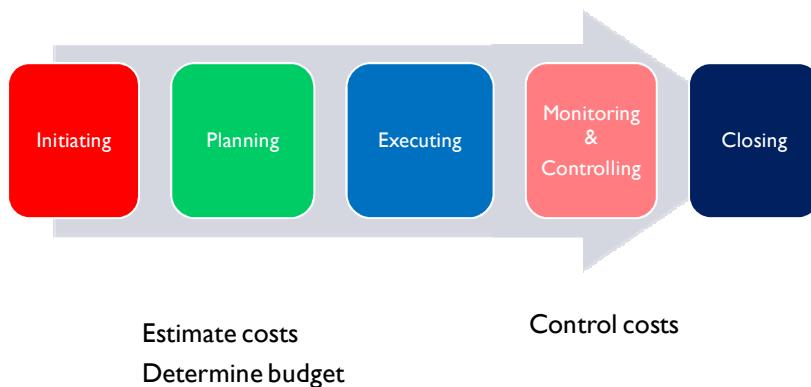
- Place cost management processes into PM process groups
- Define various cost estimating techniques
- Define and compute earned value
- Apply all earned value formulas needed for the exam

Project Cost Management Process Summary

The high level Project Cost Management output elements, by Process Group are:

Initiating	Planning	Executing	Monitoring and Controlling	Closing
	-Activity cost estimates -Basis of estimates		-Budget forecasts -Work performance measurements -CR's	
	-Cost performance baseline -Project funding requirements		Various document updates	

Cost Management



There are a dozen questions or so on the exam relating to earned value. If you have never done this before, don't worry. We will address all the needed computations and formulas relating to cost management for the exam in the pages following. The process of cost management is generally documented in the cost management plan. According to PMI, the cost management plan establishes the following:

- Level of accuracy - activity cost estimates rounded to a prescribed precision
- Unit of measure - standard workweek, blended rates for resources and similar measurements are units of measure for the project
- WBS procedure links - the WBS component for project cost accounting is called the control account (CA)
- Control thresholds - levels of variance that are allowed before action needs to be taken
- Earned value rules of performance
- Reporting formats
- Process descriptions

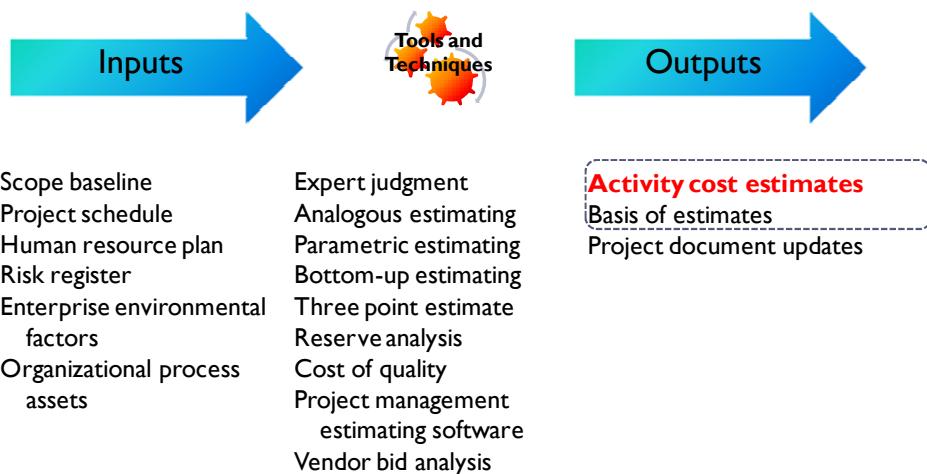
Exam Tip - understand the following concepts for the exam:

- **Life cycle costing** - another way of saying this is the 'total cost of ownership'. It is not only the cost of the car that you must consider, but also what it will cost to maintain the vehicle over its usable lifetime. Delivering the product of a project is no different.
- **Value Engineering (from Define Scope)** - also called value analysis, value management, or value methodology. It began at General Electric Co. during World War II. Due to shortages of skilled labor, raw materials, and component parts, Lawrence Miles of G.E. looked for acceptable substitutes. Frequently, the substitutions often reduced costs, improved the product, or both. What started out as a constraint was turned into a systematic process which he called "value analysis".

NOTE: while the Cost Management Plan is not an input or output in the Cost Management process, the cost management plan is created in the planning process group, which precedes the activities in the cost management knowledge area. The cost management plan usually establishes the following:

- level of accuracy pertaining to cost estimates
- units of measure - for staff hours, weeks, work days
- Control thresholds – variance thresholds for measuring cost performance
- Rule of performance measurement – EVM (earned value management) rules of performance
- Reporting formats and process descriptions

Estimate Costs



Cost estimates are based on the analysis of activities that were created in the WBS and further elaborated in Define Activities (what we are doing) and Estimate Activity Resources (who is doing the work). Therefore, many of the elements that were required for estimating the schedule are also true for estimating cost:

- Obtaining historical information from past projects

- Coming up with your own estimates. If you are taking a project over from another project manager or there are management imposed constraints, your job is to assess the needs of the project and not take someone else's word for it
- Reviewing estimates to ensure they are reasonable and checking for cost padding and risks
- Looking for ways to reduce project costs through the mitigation, reduction, or elimination, of risks
- Basing the estimate on the WBS
- Ensuring that the resources who are actually performing the work (the subject matter experts) are delivering estimates, instead of a stakeholder who is telling you what they *think* the estimate should be
- Implementing a process to create the most accurate estimate possible

The following occur here and in Determine Budget and Control Costs:

- Managing the project to the cost baseline
- Knowing when to implement a change if schedule problems occur
- Periodically forecasting the end costs to come up with your own estimate to complete (ETC)

What costs are estimated on a project? Any work needed to complete the project. A partial list appears below:

- Project manager's time
- Overhead
- Project management activities
- Leased equipment
- Hardware purchases
- Consulting resources
- Risk estimating
- Quality assurance

EXAM Tip:

Notice the three-point estimate has come back as a tool and technique for cost. The formula keeps the same format as PERT in the Time chapter, only 't' changes to 'c':

PERT for Cost

$$\text{Mean} = \frac{C_O + 4 * C_{ML} + C_P}{6}$$

$$\text{Standard Deviation} = \frac{C_P - C_O}{6}$$

$$\text{Variance} = \sigma^2$$

Where:

C – cost

O – optimistic

ML – most likely

P – pessimistic

Cost Types

For the exam, there are a few questions asked about cost types. The four fundamental types are listed below, all with a brief explanation of each:

- **Variable costs** - costs that change with the amount of work being performed such as costs for hourly consultants.
- **Fixed costs** - costs that are constant throughout the project such as equipment leases
- **Direct costs** - costs that are directly attributable to your project. Wages and salaries for team members, software licenses, etc.
- **Indirect costs** - costs that are shared by your project with other projects such as heat, light, building security, and other overhead items.

Cost Estimating Tools

There are three fundamental types of estimating tools that are used to estimate costs on a project:

- **Analogous estimating** (also called a 'top down' estimate) compares a similar past projects to the current project in terms of cost. This is called an estimating 'heuristic' or rule of thumb - it is designed to give you a 'ballpark' estimate without having to use a lot of supporting detail.
- **Bottom-up estimating** is highly detailed and uses the WBS to create the activity estimates for cost. Bottom-up estimating can be very accurate if there is enough historical data on which to base the estimates.
- **Parametric estimating** or modeling as it is sometimes called, is based on the use of a parameter and repetitive units of identical work. If one unit costs 'x' dollars, then a hundred units will cost '100x' dollars.

Analogous Estimating

► *This project is like that project:*



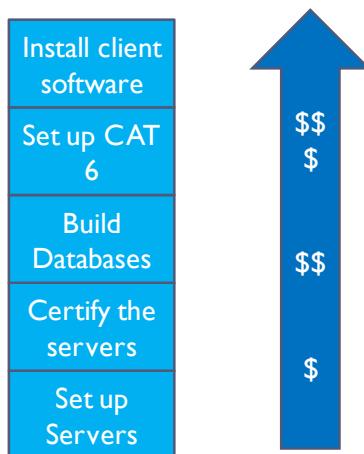
Advantages

- Little time and effort
- Less costly to create
- Activities don't need to be spelled out
- Overall project costs are capped

Disadvantages

- Less accurate than Bottom-up estimating
- Historical information or expert opinion may not be available
- Extremely difficult for project with high uncertainty

Bottom-Up Estimate



The bottom-up estimate is built from historical data. This means that your estimates are based on activities that you have performed before, and that the cost of these activities can be estimated to within a narrow range.

Advantages

- Improved accuracy
- Appropriate detail to monitor and control project
- Provides team buy-in to estimates

Disadvantages

- Longer time and higher cost to create
- Subject to padded estimates by team members
- Only as accurate as the WBS

Parametric Estimating

The parametric estimate is used when an activity can be priced repetitively for a project. For example, the project requires the setup of 1000 servers with the proper hardware and software configuration. How long will it take and how much will it cost? We priced the set up of one server as follows:

- Server set-up time: 4 hours
- Hardware load and configuration: 8 hours
- Load the database and configure all software: 12 hours
- Resource blended rate for the work: \$65/hr
- Therefore 1 server setup costs: $24 \times \$65 = \1560

Using the parametric estimating approach, if one server costs \$1560 to set up, 1000 servers will cost (we predict): $1000 \times \$1560 = \$1,560,000$. The key element for the parametric estimate to work is that the parameters must scale accurately.

Advantages

- Can be more accurate and detailed than analogous
- Can be quicker than bottom-up
- In certain situations, can offer a more accurate projection of project completion and total costs

Disadvantages

- Accuracy varies widely
- Can be more costly to produce
- Historical information may not be available
- Parameters may not be scalable

Estimate Types

Type of Estimate	Range	Process Area
Rough order of magnitude	-50% to +50%	Initiating
Definitive estimate	-10% to +10%	Planning



Brain dump!

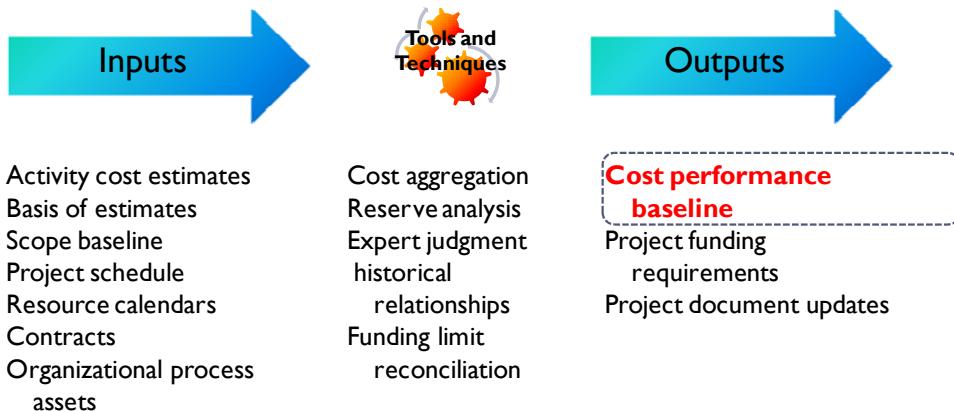
There may be some tricky questions on the exam about different types of estimates, and the questions may be asked obliquely. In other words, you will have to know the type of estimates, what the range of the estimate is and in which process area the estimate is used. You will then have to take this knowledge and apply it to the question at hand. For example:

'You have just completed the project charter for the project and have initiated the kickoff meeting. One of the stakeholders is being very insistent about the need for an accurate budget estimate. They are stating that they will not allow the meeting to adjourn until the team has hammered out an estimate that is within +/- 10% of actual. What is the *most correct* response you can offer to the stakeholder?'

- a. You and the team will use your best efforts to comply with the stakeholders request
- b. It is too early in the project process to deliver an estimate at that level of accuracy
- c. You state that the best you can do at this point is an estimate that is -10% to plus 25%
- d. Since this request is unrealistic, you tell the stakeholder their request will be entered in the risk log and immediately reported to senior management

(Answer: b)

Determine Budget



Determining your budget requires a combination of all your activity cost estimates, scope baseline, project schedule, the resource calendars, contract information with external vendors and something called a 'basis of estimates'. Basis of estimates is an output of the Estimate Costs process. A basis of estimate is a detailed analysis on how the cost estimate was derived. The supporting detail can include:

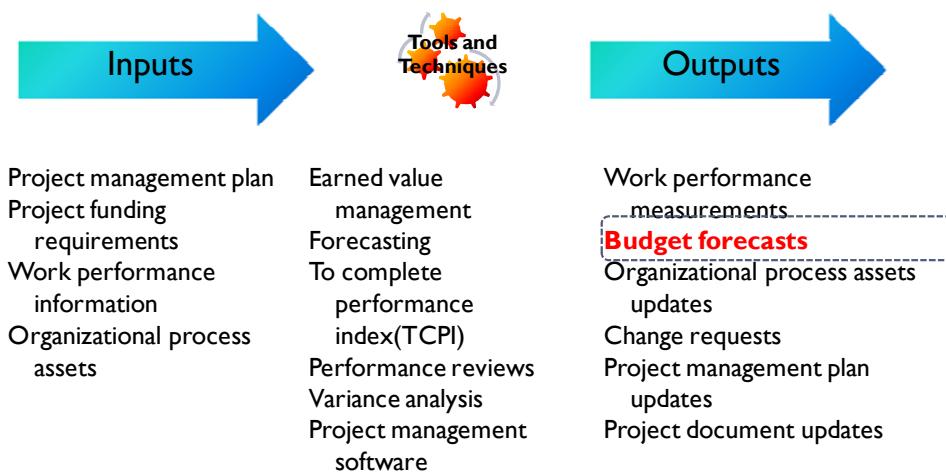
- How the basis of estimate was developed
- Assumptions
- Constraints
- Possible range of estimates (e.g. \$25,000 +/- 15%)
- Confidence level of the final estimate (a confidence factor represented as a percentage)

Understanding basis of estimates is a key component in deriving earned value calculations. Two key tools in the determine budget process are **reserve analysis** and **funding limit reconciliation**.

- **Reserve analysis** - addresses management reserve and contingency reserve in a project. Contingency reserve addresses the known risks in a project while management reserve addresses the 'unknown unknowns'. To be covered in detail in the Risk Chapter.
- **Funding limit reconciliation** - addresses the variance between funding limit and the planned expenditures for the project. This will occasionally require the rescheduling of work to level out the rate of expenditure.

Exam Tip: the contingency reserve and management reserve amounts are not included in earned value calculations²⁰

Control Costs



Notice that the tools and techniques of cost control involve implementation of earned value calculations, delivering a forecast, calculating the TCPI (To Complete Performance Index) and variance analysis. In addition, you want to be consulting your cost management plan, as well as following strict change management processes on your project.

Exam Tip: know the difference between a Cost Baseline and a Cost (Total) Budget.

- Cost Baseline - the cost of all activities, work packages, project estimates and *contingency reserves*
- Cost (Total) Budget - includes the cost baseline with the addition of *management reserve*

²⁰ PMBOK® Guide, 4th Edition ,Section 7.2.2.2

Earned Value Definitions

Acronym	Name	Definition
PV	Planned Value	Planned cost of work to be done at this point in time
EV	Earned Value	Value of work actually accomplished
AC	Actual Cost	Cost of work
BAC	Budget at Completion	Total planned value for the entire project
EAC	Estimate at Completion	What do we think the project will actually cost
ETC	Estimate to Complete	From this point, how much more will it cost to complete the project
VAC	Variance at Completion	How much over/under budget do we expect to be at project end
TCPI	To Complete Performance Index	What cost performance goals must be met to stay within the BAC



Brain Dump!

You may see reference to some of the old acronyms for PV, EV and AC. They are respectively:

- PV - used to be called BCWS (budgeted cost of the work scheduled)
- EV - used to be called BCWP (budgeted cost of the work performed)
- AC - used to be called ACWP (actual cost of the work performed)

You may see reference to the old acronyms, but you will not have to memorize them.

Exam Tip:

PV (planned value) is a schedule reference. It refers to how much money you were planning to spend on a project at some point in the project schedule.

BAC (budget at completion) refers to how much you planned to spend for the entire project. This is an output of the planning phase.

Earned Value Formulas



Brain Dump!

Exam Tip:

Notice that cost and schedule variance are always represented in terms of dollars(!) Notice also that:

- When computing a cost or schedule variance, earned value (EV) is always the first number. If a variance is negative, you're either over budget or behind schedule. If a variance is positive, you are either under budget or ahead of schedule.
- When computing a cost or schedule performance index, EV is always in the numerator. Performance indices that are less than 1 indicate that you are either over budget or behind schedule. Performance indices that are greater than 1 indicate that you are under budget and ahead of schedule.

Name	Formula
Cost variance	$CV = EV - AC$
Schedule variance	$SV = EV - PV$
Cost performance index	$CPI = \frac{EV}{AC}$
Schedule performance index	$SPI = \frac{EV}{PV}$
Cumulative cost performance index	$CPI^C = \frac{EV^C}{AC^C}$

Analyze the following variances and indices. What do they tell you about the project?

$CV = -\$123$ (you are \$123 over budget)

$SV = + \$255$ (you are ahead of schedule – you have earned \$255 more in value than you had planned to spend)

$CPI = 1.25$ (you are achieving \$1.25 in value for every dollar you spent)

$SPI = .89$ (you are at 89% of where you expected to be on the schedule)

$TCPI = .95$ (you have \$0.95 of work remaining for every dollar in the budget)

Name	Formula
Estimate at completion (1)	$EAC = AC + \text{New ETC}$
Estimate at completion (2)	$EAC = AC + BAC - EV$
Estimate at completion (3)	$EAC = \frac{BAC}{CPI}$
Estimate at completion (4)	$EAC = AC + \frac{BAC - EV}{CPI_C \times SPI_C}$
To Complete performance Index	$\frac{BAC - EV}{BAC - AC} \text{ or } \frac{\text{Work remaining}}{\text{Funds remaining}}$
Estimate to Completion	$ETC = EAC - AC$
Variance at completion	$VAC = BAC - EAC$



Brain Dump!

The Estimate At Completion(EAC) is a budget forecast of the actual dollars ultimately needed for the project. It can be less than, but is very frequently more than, the original budget (BAC). There are four possible formulas that can be used to compute EAC, depending on the conditions listed below:

Key:

- 1 – Use if a new estimate was required (the original was flawed)
- 2 – Use if spending will continue at the budgeted rate: no BAC variance
- 3 – Use if current variances are typical of the future (current CPI will continue)
- 4 – Use if sub-standard cost and schedule performance will continue, impacting the ETC²¹

Exam Tip:

The simplest way to memorize these formulas is simply to write them out by hand every day, three times a day for one week. After that, write them down once a day from memory every day prior to the exam. You will have no difficulty rattling off these formulas for your brain dump prior to the start of the examination.

TCPI – what it means and how it works

Essentially it means: work remaining in \$/ budget remaining:

- If TCPI is < 1, work remaining is less than the funds needed to accomplish the work.
- If TCPI is > 1, work remaining is more than the funds needed to accomplish the work.

Here is what PMI says about the TCPI calculation:

"The to-complete performance index (TCPI) is calculated for projection of cost performance that must be achieved on the remaining work to meet a specified management goal, such as the BAC or EAC. If it becomes obvious that the BAC is no longer viable, project manager develops a forecasted estimate at completion. Once approved, the EAC effectively supersedes the BAC as the cost performance goal." ²²

- The equation for the TCPI based on the BAC: $(BAC-EV)/(BAC-AC)$
- The equation for the TCPI based on the EAC: $(BAC-EV)/(EAC-AC)$

The TCPI is a specialized form of estimate to completion (ETC)

BAC Example:

If the budget at completion (BAC) is \$50,000, with earned value (EV) at \$20,000 and actual cost (AC) at \$30,000, the formula becomes:

$$\frac{\$50,000 - \$20,000}{\$50,000 - \$30,000} = \frac{\$30,000}{\$20,000} = 1.5$$

²¹ PMBOK® Guide, 4th edition, pp 184-185

²² PMBOK® Guide, 4th edition, p. 185

In other words, the team will have to work at an efficiency of \$1.50 for every dollar spent to bring the project in on budget from this point forward. (At best, very difficult).

EAC Example:

It is determined that the original BAC is not achievable, and we compute the EAC based on the idea that sub-standard cost and schedule performance will continue (EAC type #4). For this example, PV=\$25,000. We compute the new EAC based on the following scenario:

$$CPI = EV/AC = \$20,000 / \$30,000 = 0.67 \quad SPI = EV/PV = \$20,000 / \$25,000 = 0.8$$

$$\text{Thus EAC} = \$30,000 + [(\$50,000 - \$20,000) / (0.67 \times 0.8)] = \$85,970$$

With TCPI = (BAC-EV)/ (EAC-AC) we have:

$$\frac{\$50,000 - \$20,000}{\$85,970 - \$30,000} = \frac{\$30,000}{\$55,970} = 0.536$$

In this case, our new EAC is \$35,970 higher than the original BAC. This means the team will have to work at an efficiency of at least \$0.536 for every dollar spent to bring the project in on budget from this point forward.

Earned Value Accrual – Progress Reporting

Most organizations have their own convention for when they accrue value on an activity for a project. Many times, project managers using commercially available bar chart software tools, will chase after developers and other team members for 'percentage complete' statistics on each activity in the bar chart.

This is a complete waste of time.

Your team members and subject matter experts know what they have to do, and know what the deadline is for the activities they are working on. If you've been managing your project correctly, they will also inform you if they are running into any difficulties so that you can proactively deal with the problem and address it *prior to* the delivery date.

As a result, you can use one of the accrual methods listed above: the 50/50 rule, the 20/80 rule, or the 0/100 rule:

- The 50/50 rule. You earn 50% of the value on the activity upfront and collect the final 50% of the earned value when the activity is completed
- The 20/80 rule. You earn 20% of the value on the activity upfront and collect the final 80% of the earned value when the activity is completed
- The 0/100 rule. Typically used when the deliverables can be completed in a short timeframe - the activity does not earn any value until it is 100% complete

Performance Reviews and Variance Analysis

Performance reviews are used to compare actuals to the plan. As such, they compare cost performance and schedule performance to their respective baselines and use variance analysis, trend analysis and earned value to compare actual performance to the plan.

The variance analysis is a key tool used to track any cost or schedule actual and compare it to the baseline.

Earned Value Practice Exercises

Exercise #1:

You are managing a small construction project. The vendor was hired to install an intricate parquet floor in nine sections. Each section is supposed to take one week to complete at a cost of \$750/section. Assume spending continues at the current rate.

At this point in time, you are 4 weeks into the project and you have the following information:

- Expenditures to date: \$3250
- Sections completed: 4.5

Fill in the following grid with your answers:

Value	Formula/Calculation	Answer	What it Means
PV			
EV			
AC			
BAC			
CV			
SV			
CPI			
SPI			
EAC			
ETC			
VAC			
TCPI			

Exercise #2:

Your current project is running with the following indicators:

- CPI = 1.07
- SPI = 1.1
- AC = \$22,500

You are 4 weeks into a 12 week project, and some of the financial data is missing (the previous project manager left the project unexpectedly). Spending will continue at the budgeted rate – no BAC variance.

Given the information above, compute:

- EV
- PV
- BAC
- EAC
- ETC
- VAC
- TCPI for BAC

Exercise # 3:

You have run a PERT analysis on the major components in your project and have generated the following data:

Deliverable	Optimistic	Most likely	Pessimistic	PERT	Std. Deviation
Component 1	\$5000	\$10000	\$15000		
Component 2	\$3000	\$7000	\$14000		
Component 3	\$20000	\$35000	\$80000		
Component 4	\$15000	\$30000	\$63000		
Totals:					

Assume that components are developed sequentially.

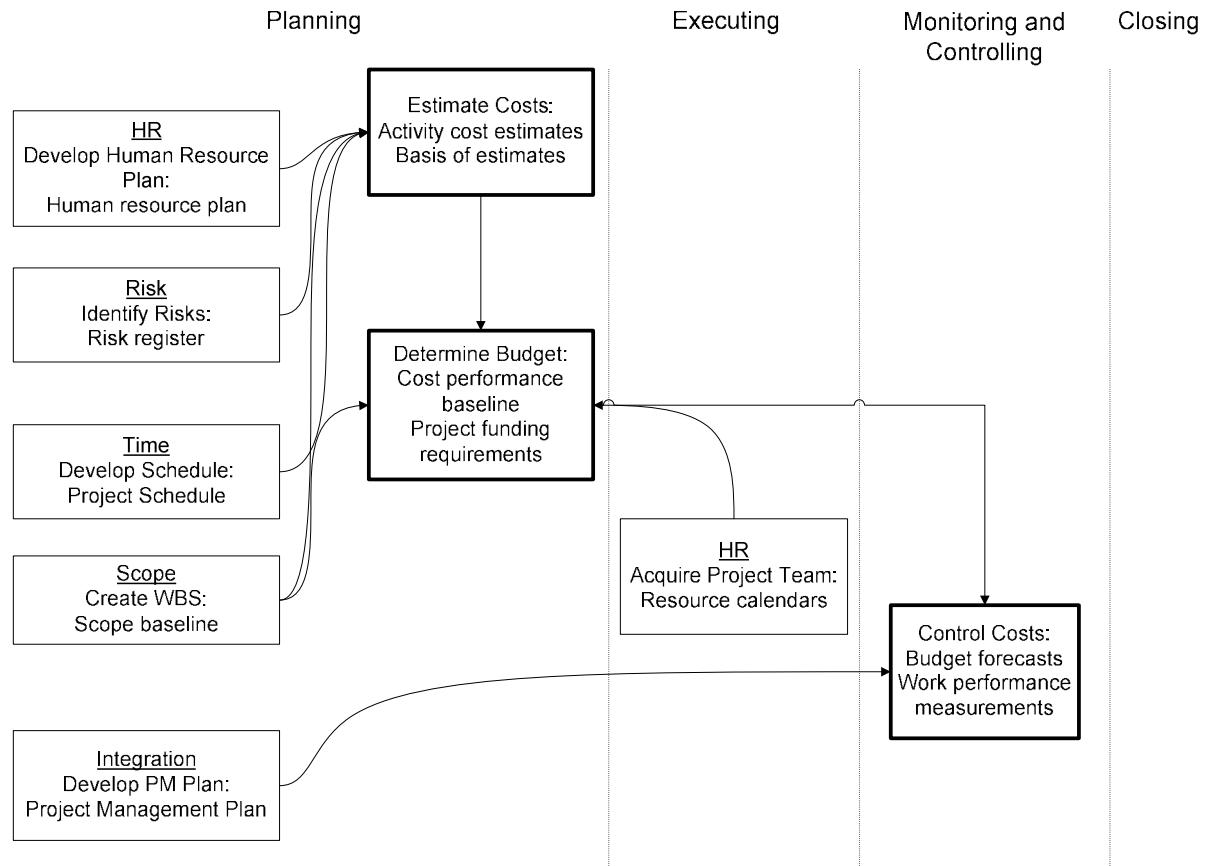
Questions:

1. What is the PERT estimate for the project – rounded to the nearest dollar?
2. Which component estimate is least precise?
3. What is the budget range to a 95% confidence factor?

Answers for EV exercises in Chapter 14.

Project Cost Management: Key Process Interactions

The key inputs from the other Knowledge Areas to Project Cost Management processes are shown below. *Know these process interactions for the exam.*



Summary...

This section covered cost management:

- The advantages and disadvantages of analogous estimating, bottom-up estimating, and parametric modeling
- Applying earned value formulas, including CV, SV, CPI, SPI, ETC, EAC, and VAC
- Different methods that can be used to calculate progress made on a task

Chapter Seven Memory Check

1. The estimate that takes little time to create, but is not very accurate, is known as an _____ estimate
2. The rough order of magnitude estimate ranges from ___% to ___%
3. The key output of the Estimate Costs process is _____
4. A _____ is a detailed analysis on how the cost estimate was derived
5. The tool that addresses the variance between the funding limit and the planned expenditures for the project is called the _____
6. The two types of monetary reserves on a project are identified as _____ reserve and _____ reserve
7. The main output of the Control Costs process is _____
8. The cost baseline includes the _____ whereas the cost (total) budget includes the _____ and the _____
9. What the work of the project is supposed to have cost by a specific point in the schedule is called the _____, whereas the total amount that the work should cost for the entire project is called the _____
10. The formula for CPI = ___ / ___
11. The formula for SPI = ___ / ___
12. A new budget forecast is created to address variances in the project and replaces the BAC. This new forecast is called the _____
13. The amount of money that remains to be spent on a project that is 1/3 complete is called the _____
14. The formula for TCPI = ___ - ___ / ___ - ___
15. The formula for variance at completion (VAC) = ___ - ___

Chapter 7 Test

1. Cost variance is computed by:
 - a. Subtracting planned value from actual cost
 - b. Subtracting actual cost from earned value
 - c. Subtracting budget at completion from earned value
 - d. Subtracting BAC from ETC
2. You have just completed your project activity, work package, and contingency reserve estimates. What have you created as a result of completing these estimates?
 - a. Bottom-up estimate
 - b. Cost budget
 - c. Cost baseline
 - d. Definitive estimate
3. Several vendors have proposed solutions for your current project. Your organization has made it a requirement that the lowest price solution will be the one that is selected to deliver the project. The vendor was selected and the project was completed successfully and handed off to the maintenance organization for ongoing product support. A year into the product's release, it has become apparent that the maintenance costs are much higher than what the organization had anticipated. What did the project manager *probably forget* to do?
 - a. Validate the vendor's credentials
 - b. Perform adequate quality testing
 - c. Earned value cost forecast
 - d. Life cycle costing
4. What typifies an analogous estimate?
 - a. More expensive than other estimate types
 - b. Relies on extensive historical data
 - c. Essentially a top-down approach
 - d. May not scale effectively
5. Which of the following is *not* needed to generate a schedule performance index (SPI)?
 - a. Earned value
 - b. Actual cost
 - c. Planned value
 - d. Basis of estimate
6. Earned value = 650, planned value = 550, actual cost = 700. What is the schedule variance at this point in time?
 - a. + 100
 - b. - 50
 - c. - 100
 - d. - 150
7. What is estimate at completion (EAC)?
 - a. The amount of money that was budgeted for the project
 - b. The original budget plus the contingency reserves
 - c. A budget forecast that takes project variances into account
 - d. The budget at completion (BAC) times the TCPI

8. You are in the planning phase of the project and are using various tools to estimate project costs. Which of the following is *not* a tool or output of the estimate costs process?
- Details of the costs of all activities on the project
 - Prioritized risks and contingency dollar amounts contained in the risk register
 - Direct and indirect costs charged to the project
 - Analysis of the vendor bids on the project
9. You have just initiated a new project in your organization. At the initial meeting with the stakeholders, several of them expressed concerns about the size of the budget. As the project manager, you coach the stakeholders by telling them that the project is being undertaken as a progressive elaboration. As a result, the initial budget estimate covers a wide range of +/-50% because not a lot is known about the project yet. This type of estimate is known as:
- Budget estimate
 - Rough order of magnitude estimate
 - Definitive estimate
 - Predictive uncertainty estimate
10. You have been keeping careful tabs on a 1 year project via weekly earned value calculations. A key factor is that an early product release will give your organization a decisive competitive advantage in the marketplace. However, at the last stakeholder meeting, one of the stakeholders questioned how well the project was really going. They are worried that the project is over budget and that if it continues in this way, the project will face a serious budget shortfall by the end of the project, jeopardizing its completion. At six months through the project, the SPI = 1.2, and the CPI = .95 and variances are expected to continue at this rate. What is the *best* response you can offer that would address this stakeholder's concerns?
- The team will implement immediate corrective action to bring the budget back in line
 - With CPI of .95, this puts us well within the range of a definitive estimate of +/- 10%
 - The team will discuss potential scope reduction that can bring the cost back in line
 - At the current SPI, we will finish the project better than 10 weeks early. With an early finish; cost increase is small, but competitive position is greatly improved, increasing profitability
11. Cost estimates are based on all the following *except*?
- The scope baseline
 - Procurement contract award
 - Human resource plan
 - Risk register
12. Project cost management is primarily concerned with _____?
- Cost of human resources
 - Basis of estimates
 - Assessing total cost of ownership
 - Establish the cost performance baseline
13. Management reserve is part of?
- The scope baseline
 - The Cost budget
 - The Cost baseline
 - Contingency reserve
14. Value engineering is used when the project team wants to?
- Deliver the highest value to the customer with each deliverable
 - Evaluate multiple project solutions that will deliver the highest value to the customer

- c. Calculate the cost of doing the work versus the value that is delivered
 - d. Reduce project costs without sacrificing scope
15. You've set aside a certain amount of your project funds to cover key, identified risks. What specifically did you use to determine how much should go into this fund?
- a. Bottom-up estimate
 - b. Reserve analysis
 - c. Variance analysis
 - d. Upside-risk estimate
16. The estimate of the work accomplished is defined as:
- a. Actual cost
 - b. Estimate at completion
 - c. Earned value
 - d. Budget at completion
17. Two of your junior project managers in the PMO are having a disagreement about the meaning of earned value. The first project manager is arguing that earned value is the dollarized amount of the work actually completed; the second project manager is arguing that the earned value actually represents the amount of money that the work is supposed to cost *within a given timeframe*, and when that work is completed, you have *earned* that much value. While you are listening to the argument unfold, a stakeholder on their project approaches them and tells both project managers that the original basis of estimate was less accurate than a rough order of magnitude. How does this information *mostly likely* impact earned value calculations?
- a. It makes no difference. They are still tracking work completed and there are dollars associated with the completed work
 - b. Variances have little meaning when the basis of estimate is flawed or covers too wide a range. Earned value calculations may misrepresent the occurrence of actual variances
 - c. The only impact may occur when calculating estimate at completion or estimate to completion. Variances may occur up to 25%
 - d. You must start at the end of the project and work backwards to derive the correct earned value calculations due to the ranginess of the basis of estimate
18. You are three months into a six month project. Assume the budget burn rate is constant. The budget at completion (BAC) is \$120,000. AC = \$65,000. The SPI = 1.2. What is the CPI of this project? (Round to 2 decimal places)
- a. 1.32
 - b. 1.25
 - c. 1.11
 - d. It cannot be determined from the information given
19. All of the following are incorrect regarding the computation of EAC *except*?
- a. EAC calculations always include the AC or the BAC, but usually both
 - b. EV is always included
 - c. SPI is always included
 - d. ETC is never used in an EAC calculation
20. The project team has done outstanding work on a current project. While the stakeholders are satisfied with the product of the project, they have been consistently whining about the cost and have asked you, the project manager, to review options that would help reduce costs on the project. Given that this scope has been reduced to the most essential must-have items, where are your best options for reducing costs?
- a. Fixed and variable costs

- b. Direct and indirect costs
 - c. Direct and variable costs
 - d. Fixed and indirect costs
21. Several stakeholders on the project have been questioning the effectiveness of some of the technical team. While the work is proceeding according to plan, some of the stakeholders are not satisfied with the work delivered to date, even though it meets requirements specifications. You have held several meetings with the stakeholders to try to get to the root cause of the problem. With some of the technical team present at these meetings, it becomes obvious that some of the stakeholders have had great difficulty in describing what they want. As a result, some of the delivered product doesn't meet stakeholder expectations. Currently your CPI is 1.3 and the SPI is .89. What is your *largest* concern right now?
- a. Clarifying the requirements collection process
 - b. The schedule
 - c. Managing stakeholder expectations
 - d. An increasing probability that some technical team members may leave the project due to high levels of frustration with stakeholders
22. You are one year into a three year multimillion dollar project. The project CPI =.91 and the project SPI is 1.15. The Project is only earning \$.91 for every dollar spent, while it is 15% ahead of schedule. As a result, the project manager has assembled the project team to review options for correcting the budget overage. Which of the following would *best* address the budget overage issue?
- a. One of the project team members recommends a fast tracking option, thus lowering the costs
 - b. Since most of the complex technical work has been completed, it was suggested that the most experienced resources could be swapped out for less experienced resources, thus lowering the cost
 - c. The business analyst recommended a negotiation with the stakeholders to reduce scope, thus lowering project costs
 - d. The CFO's representative recommended firing all the consultants. Since 30% of our development budget is being burned by contractors, this would remove a huge financial burden, thus lowering costs
23. CPI is 1.2, SPI is 1.1. Four months later CPI is .91 and SPI is .86. The *most likely* reason for this change is:
- a. The project manager has not been keeping track of variances on the project to implement corrections
 - b. As work packages were being executed, discovery on critical path activities caused estimates to change drastically on several of the work packages
 - c. The WBS was inaccurate
 - d. Several key stakeholders insisted on a last-minute scope change
24. Which performance index describes the cost projection of the remaining work that must be achieved to meet the goals of the project?
- a. TCPI
 - b. EAC
 - c. ETC
 - d. CPI
25. In terms of progress reporting, when do project activities earn value?
- a. As soon as the activity begins
 - b. Only after the activity has completed
 - c. According to the earned value accrual rules set up by the project manager
 - d. Determined by the Configuration Control Board in your organization

Chapter 7 Test - Answers

1. B – CV = EV-AC
2. C – The cost baseline includes the contingency reserve. Cost budget additionally includes management reserve. Bottom-up estimate focuses on activities and a definitive estimate is a range
3. D – Life cycle costing includes the total cost + maintenance and support cost for the lifetime of the product
4. C – This is by definition, a top-down approach
5. B – Actual cost is part of the CPI calculation
6. A – SV = EV-PV or in this case, +100
7. C – EAC is a forecast
8. B – Risks and risk contingency amounts are not contained in the output of the estimate costs process
9. B – +/- 50% is the definition of a rough order of magnitude. A budget estimate is -10% to plus 25%. A definitive estimate is +/- 10%, and a predictive uncertainty estimate is a made-up term.
10. D – This requires some critical thinking. Answer 'A' is premature. With a CPI of .95 it is somewhat of a knee-jerk reaction to start implementing corrective action when the problem may self-correct. Answer 'B' is technically correct, but at this point sounds somewhat dismissive of the customer's concern. Answer 'C' might be an option if there are no other potential methods for reducing costs, however that determination has not yet been made. Answer 'D' is the most reassuring - you are telling the customer that his one-year project will complete 10 weeks early, satisfying the need for a better competitive position.
11. B – Procurement contract award is an output of the conduct procurements process
12. A – It is the cost of the resources needed to complete project activities. Per the *PMBOK® Guide* 4th edition, p 167.
13. B – Cost budget includes management as well as contingency reserve. The cost baseline includes only the contingency reserve. Answers 'A' and 'D' are simple misdirection
14. D – Value engineering is a technique that is used to look for ways of reducing costs without sacrificing features or scope
15. B – The reserve analysis is explicitly used for determining risk contingency reserve amounts. *PMBOK® Guide*, 4th edition, p. 173
16. C – Earned value is also defined as the estimate of the work accomplished. Actual cost is what you've spent to date. Estimate at completion is the new budget forecast based on project variances. Budget at completion was the original budget estimate
17. B – If the basis of estimate is a fiction, then your variances are also a fiction. Earned value or calculations work only when there is a solid bottom-up estimate or historical data on which to base the estimate. The estimator needs to know what the work is supposed to cost in order to compute accurate earned value
18. C – This is a two-part calculation. You must first derive earned value from the SPI formula; SPI = EV/PV. At this point you know SPI (1.2) and PV (\$60,000). Thus solving for EV you get: EV = 1.2 * \$60,000 = \$72,000. You can now compute CPI = EV/AC or \$72,000/\$65,000 = 1.11
19. A – EAC calculations use AC three out of four times and BAC three out of four times. All the other answers are incorrect. *PMBOK® Guide*, 4th edition, pp 184-185
20. C – The costs that you can best control are costs that directly impact your project (direct costs), and variable costs (contract resources that work hourly). You have less control over fixed and indirect costs.
21. B – The first part of the question is a red herring. With an SPI of .89 your biggest concern is the schedule
22. B – Swapping out expensive resources for less expensive resources would most directly impact your budget and is the simplest thing to do, especially if there is no technical impact on the project. Fast tracking may not reduce your costs, but they reduce schedule. Reducing scope is a last resort when nothing else may work. Suddenly firing all the consultants may sink your project.
23. B – Significant changes in earned value, such as the one described, usually point to some kind of discovery on the project, especially since the product was sailing along smoothly until it appeared to hit a bump. Answer 'A' is highly unlikely as is answer 'C'. Changing scope at the last minute would also force a change request which may cause a re-baseline of the project. This would not necessarily change its CPI or SPI

24. A – This is a definition of the To Complete Performance Index (TCPI)
25. C – Usually when reporting performance, activities get credit based on rules set up by the project manager at the beginning of the project, which can be: 50-50, 80-20, or 0-100

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Chapter 8 : Project Quality Management

Topics covered:

- ▶ Quality Planning
- ▶ Perform Quality Assurance
- ▶ Perform Quality Control

Section Objectives

This section will enable you to:

- ▶ Place the quality management processes into the PM process groups
- ▶ Define quality as defined by PMI
- ▶ Understand the key quality theories and identify quality proponents
- ▶ Implement techniques used in cost-benefit analysis
- ▶ Understand quality control techniques

Project Quality Management Process Summary

The high level Project Quality Management output elements, by Process Group are:

Initiating	Planning	Executing	Monitoring and Controlling	Closing
	<ul style="list-style-type: none">-Quality management plan-Quality metrics-Quality checklists-Process improvement plan	<ul style="list-style-type: none">-CR's-Various document updates	<ul style="list-style-type: none">-Validated changes-Validated deliverables-QC measurements-CR's- Various document updates	

Quality Overview

Quality is a 'hot button' for PMI:

- PMI stresses prevention over correction as the preferred quality approach
- Continuous improvement is a recurring quality theme
- Focus on the concept that everyone in the organization is responsible for organizational quality in the project, product or service

There are a number of varying definitions for what constitutes quality in a product or service. Below are some definitions of quality, starting with PMI's definition:

- "The degree to which a set of inherent characteristics fulfills *requirements*."²³
- The characteristics of an entity that bear on its ability to satisfy stated and implied needs²⁴
- Fitness for use²⁵
- "Quality in a product or service is not what the supplier puts in. It is what the customer gets out and is willing to pay for. A product is not quality because it is hard to make and costs a lot of money, as manufacturers typically believe. This is incompetence. Customers pay only for what is of use to them and gives them value. Nothing else constitutes quality."²⁶

For the exam, the definition of quality by PMI (shown above) is the only definition of quality that you need to memorize.

Notice that in the sections we have reviewed up to this point, there are a number of activities that one can perform as part of the Monitoring and Control process group:

²³ PMBOK® Guide, 4th edition p. 445

²⁴ ISO 8402, 1994

²⁵ Joseph Juran

²⁶ Peter S. Drucker, *Innovation and Entrepreneurship*, HarperCollins, 1985

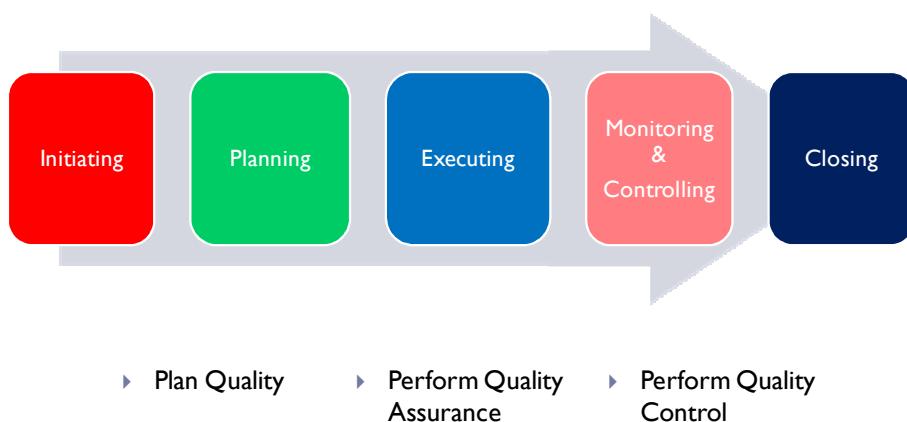
- Corrective Action
- Repair/Rework
- Preventive Action

With this chapter, we will focus on why PMI promotes preventive action above the other methods listed above.

PMBOK® Guide, 4th edition ISO Certification

The entire PMI credential system, which includes the *PMBOK® Guide, 4th edition*, is ISO-certified.²⁷ What that means in terms of ISO process is that the PMI framework is a process that enables practitioners to manage projects with a high level of control. When a process is in ‘control’ as defined by ISO, the process is both predictable and repeatable. Therefore the *PMBOK® Guide, 4th edition* defines a series of processes to control projects that give the project practitioner a high degree of predictability and repeatability in the process.

Project Quality Management



The process of Project Quality Management includes the organization’s quality policies, methods, and procedures designed to meet the objectives of the project and to satisfy the customer’s needs.

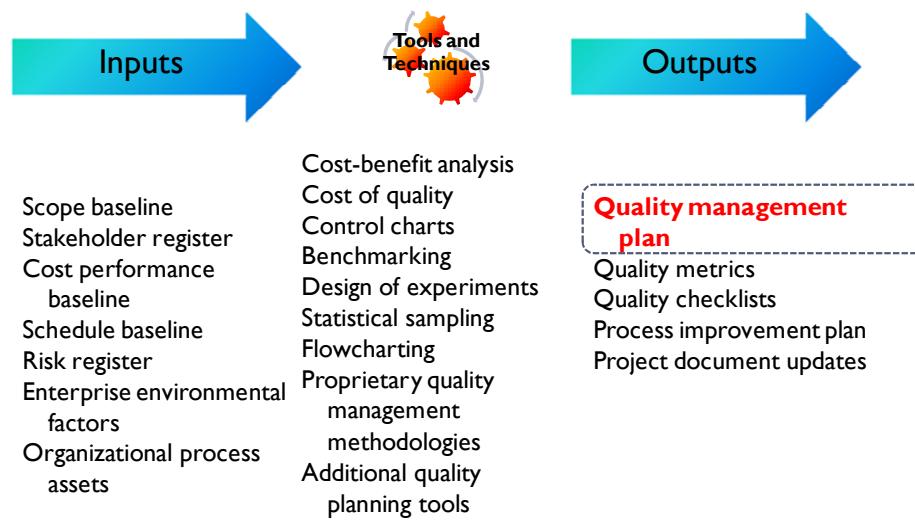
Failure to meet the quality requirements of a project can have negative consequences for all stakeholders involved in the project. In worst case scenarios, failure to meet the quality requirements of a project may render the end product unusable.

²⁷ Per PMI press Release dated 10-8-2007: “The International Organization for Standardization (ISO) in Geneva, Switzerland, has bestowed the ISO 17024 accreditation upon PMI’s credential system for the PMP.”

The project manager's job in performing project quality management includes some of the following elements:

- Performing continuous improvement activities
- Implementing a plan to continuously improve quality
- Determining specific quality metrics that apply to the project
- Verifying quality prior to the completion of a work package or a deliverable
- Help to facilitate quality audits of the project

Plan Quality



Plan quality addresses the processes needed to identify all quality requirements and standards for the project and the project's product. It also documents how the project will demonstrate compliance with those standards.

Notice the extensive list of tools and techniques used in the Plan Quality process. We will be addressing all of the appropriate tools on the upcoming pages for the purpose of the exam.

Quality Planning Tools

- Cost-benefit analysis
- Benchmarking
- Control Charts
- Statistical Sampling
- Design of experiments
- Cost of quality (COQ)
- Additional Quality Planning Tools
- Proprietary quality management methodologies*
- Flowcharting*

Quality tools listed above will be described in greater detail on the upcoming pages. The first six items represent specific tools and concepts that are mentioned in the *PMBOK® Guide*, 4th edition. The seventh item - additional quality planning tools - is a catchall that PMI uses. For the exam, you may see certain elements covered under this heading that you've never seen before. We will also attempt to identify a number of these additional tools, you may see mentioned in a question on the exam.

*Proprietary quality management methodologies will be addressed in the Quality Management Concepts section and Flowcharting will be addressed in the Perform Quality Control section.

Cost-Benefit Analysis

With the cost-benefit analysis, project manager weighs the cost of implementing the quality requirements against the benefit it will deliver for the project. While there is always some cost to implementing quality, as we will see on the upcoming pages, costs of failing to implement quality are significantly higher.

The ultimate benefit that has to be considered is this: what is the customer willing to pay for in terms of quality? If the product or process does not meet the customer's expectation of quality, will they pay for it? Stated in these terms, it may make a difference between whether or not you stay in business, based on whether you're meeting the customers quality needs.

What are the benefits of meeting quality requirements in your project?

- Decreased Rework
- Decreased Costs
- Increased Productivity
- Increased stakeholder satisfaction

Benchmarking

Benchmarking activities compares project practices used in the past to those that are being used in the present. Thus, one can identify best practices, guidelines for improvements, and a method for measuring performance. Benchmarks can be obtained through industry publications or commercially available databases containing benchmark standards.

For example, in the construction industry, the RS Means Company offers a commercial database known as "CostWorks", which contains construction cost benchmarks. This database contains 23,500 activities that can be performed at a construction site, and has these activities priced by geographic location (depending on where the construction is being performed), as well as by the skill of the crew (low, medium, high).

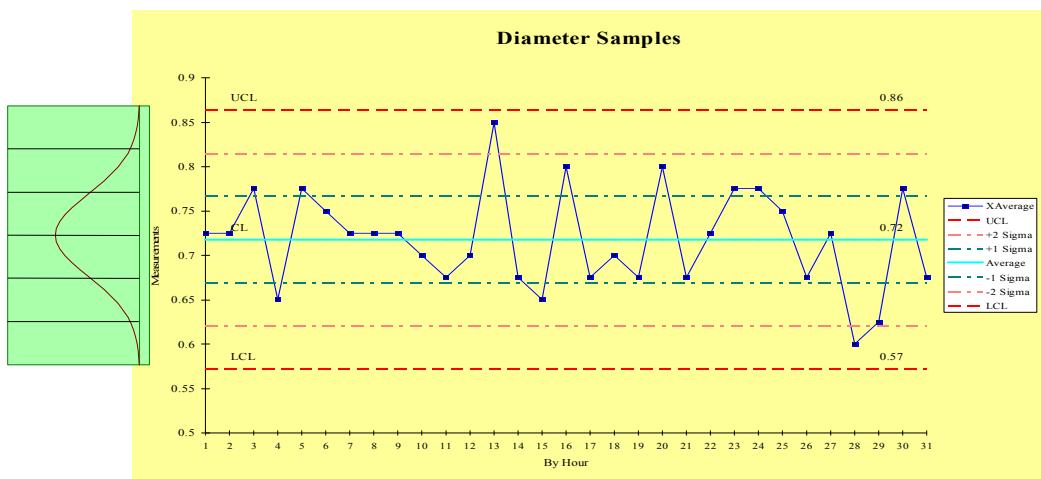
Control Charts and Statistical Sampling

There are two elements that are important for the exam regarding control charts:

- **Control limits** are calculated by the process itself to determine if the process is capable and in a stable state
- **Specification limits** are determined by the customer and the PM. The spec limits essentially establish the requirements needed from the product or process.

Understand that a process can be in statistical control, but may not meet the customer's requirements.

SPC (Statistical Process Control) Chart Example



Control Charts are used:

- To determine if a process is stable and is exhibiting predictable performance
- To identify upper and lower **control limits** (UCL/LCL) which are calculated by the process
- To identify upper and lower **specification limits** which are established by the customer and the PM

Statistical Sampling:

- Identifies a particular part of the overall population for study
- Sampling techniques can be stratified, random, population and others

Here is an example of an SPC (Statistical Process Control) data chart in which measurements have been collected on shaft diameters for a motor drive. Notice the bell curve to the left of the chart. While the Bell curve shows the probability distribution of all the data, the SPC chart shows the individual measurements that went into creating that bell curve.

Design of Experiments (DOE)

Design of experiments was first developed by Sir Ronald Fisher for an agricultural experiment in the early 1920s. The typical scientific method process is to change one factor in time when performing an experiment. This approach is very time-consuming, as Thomas Edison found out when he attempted to create a functioning light bulb.

With DOE, multiple factors can be experimented on simultaneously. This approach has two distinct advantages:

- Fewer total experiments need to be run, resulting in lower cost
- Interactions between factors can be tracked for potential synergies

The process is done today using sophisticated statistical software tools such as Minitab®, Crystal Ball®, @Risk® and others. This is a nontrivial process that requires training.

Exam Tip:

Use DOE during the Plan Quality process to determine testing approaches and their impact on cost of quality. Use it to optimize the product or the process to drive high levels of customer satisfaction.

Cost of Quality

Prevention – the lowest cost of quality:

- Quality planning
- Quality training
- Reliability engineering
- Poka Yoke (Shingo)
- Zero Quality Control (ZQC) (Shingo)
- Data analysis
- Test engineering (FMEA)
- Voice of the customer (VOC)

Appraisal:

- Inspection
- Gage R & R (Repeatability and Reproducibility)
- Surveys
- Calibration /Test equipment
- Calibration

Philip J. Crosby was the vice president of quality under the legendary CEO, Harold Geneen. His belief was that a company that establishes a quality program will experience savings that will more than pay off the cost of the quality program – thus the title of his 1979 book, *Quality Is Free*:

“Each year your cost of sales rise faster than your prices. That means you have to eliminate or reduce costs to make a profit. The best single way to do that is by defect prevention.”²⁸

Notice the lowest cost of quality comes through prevention activities, and that these activities occur in the quality planning phase of a project. Two of the ideas came from the Toyota engineering genius, Shigeo Shingo.

Shigeo Shingo, developed the concepts of Poka Yoke (mistake proofing), and Zero Quality Control (100% source inspection).

FMEA (Failure Modes and Effects Analysis) was developed by the United States Army in 1949, and is described by PMI as a non-proprietary approach to quality management.

The voice of the customer (VOC) is a concept that originated in Japan, and focuses on capturing what the customer is asking for from the process. The VOC process excels at not only capturing the stated needs, but the *implied* needs as well.

► **Highest** quality costs >>>>

► **Internal:**

- Scrap
- Rework
- Service-after-Service
- Excessive inspections
- High liability or insurance costs

► **External:**

- Excessive warranty costs
- Lost reputation, sales and customers
- Low team morale
- Decreased efficiency
- Cost to regain customers, sales, and reputation
- Negative press – increased competitive pressure

The highest costs of quality, or should we say of *poor* quality, are described in the *PMBOK® Guide*, 4th edition as “non-conformance” issues which include internal and external costs. Phil Crosby brought the real cost of quality into focus when he stated that “The cost of quality is the expense of doing things wrong. It is the scrap, rework, service after service, warranty, inspection, tests, and similar activities made necessary by non-conformance problems.”²⁹

Studies have been done on what it costs a software organization when defects are discovered in a unit testing situation versus when those defects are discovered after they have been delivered to the customer. Studies suggest that the cost of delivering defects to the customer are anywhere from 1000 to 5000 times higher than catching them in a unit test.

Notice that some of the external costs of quality such as lost reputation, lost sales, and therefore, lost customers, can lead to the demise of the business.

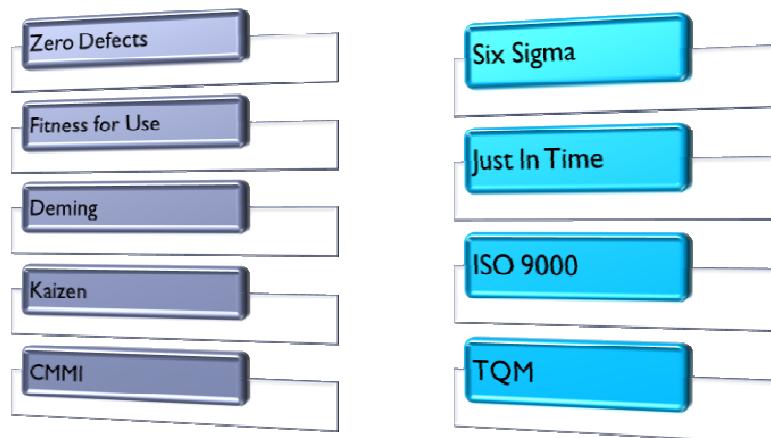
²⁸Philip J. Crosby, *Quality is Free*, 1979

²⁹Philip J. Crosby, *Quality is Free*, 1979

Additional Quality Planning Tools

- The **Loss Function** was developed by Genichi Taguchi as a quality tool. It establishes a financial measure of the user's dissatisfaction with a product's performance, as it deviates from a target value. Thus, both average performance and variation are critical measures of quality.
- **Matrix Diagrams** such as the House of Quality (HOQ) which is utilized in the QFD (Quality Function Deployment) process was developed in the late 1960s by Tokyo professors Mizuno and Akao. First utilized in the late 1960s at Mitsubishi's Kobe shipyards, the process enabled the company that built oceangoing oil tankers to reduce their production time from six months to four months, thus increasing their yearly productivity by 50%.
- The **Kano Model** was developed by Japanese social anthropologist Noriaki Kano in the 1980s. It is a theory of product development and customer satisfaction by focusing on product attributes that are perceived to be important to customers. This supports product specification and discussion through better development team understanding accomplished by focusing on differentiating the features of the product: what satisfies the customer versus what delights the customer versus what dissatisfies the customer.
- **Marginal analysis** is done from the point of view of the performing organization, and weighs the benefits or revenues from improving quality versus the costs to achieve quality.
- The **force field analysis** (FFA) - a tool used to weigh the pros and cons of a specific course of action. It is also used to evaluate current business situations and obstacles to goal attainment. The FFA views proactive and opposing forces working for or against the idea or proposed plan, and is used as a decision making or a tactical tool.
- **Nominal Group Technique** is a form of brainstorming utilizing a voting process to rank ideas in order of importance. See Chapter 5 – Group Creativity Techniques.

Quality Management Concepts



You may see a reference to any of the above-mentioned quality concepts on the exam. We will elaborate these concepts in some detail on the pages that follow.

What is important to understand is that the quality management concepts listed above have been around for 30 years or longer. These techniques represent a historical compendium of quality ideas and concepts that have been successful in the marketplace. While a number of the concepts are based on theories, those theories have been validated by practitioners many thousands of times across a broad range of businesses and business environments.

Zero Defects

Zero Defects was a concept offered in Crosby's book 'Quality Is Free'. The idea is not simply to exhort the team to try to be careful so as to not make any mistakes, but to identify what methods and processes can be implemented to systematically remove defects from the process. Once the processes have been developed to prevent defects, they become institutionalized as part of the project process.

Fitness for Use

Does the product or service meet the customer's need – i.e. is it fit for use by the customer?

Exam Tip: Understand the distinction between 'grade' and 'quality'. A product can be low grade but high quality as long as it meets your quality criteria:

- Is a Uniball Gel Pen™ equal in quality to a Montblanc™? (What are your quality criteria?)
- What about in terms of grade? (The Montblanc™ may have better form, fit and finish)

Fitness for use as a quality principle embraces five dimensions that need to be monitored and addressed as needed by the project:

- First is the quality grade of the design. Are you building a Lexus or a Corolla?
- Second is the degree of quality conformance. How closely does the product or service match the tolerance requirements needed by the purchaser?
- Third concerns the reliability and/or maintainability of the product or service
- The fourth dimension concerns the safety of the product reflected in the potential risk or injuries associated with using the product or service
- The fifth concerns how the product or service will actually be used in the field by the customer. Operating a Harley-Davidson motorcycle in Miami, Florida may be very different than running it in Fairbanks, Alaska.

This principle was outlined by quality pioneer Dr. Joseph Juran in his book *Quality by Design*.

W. Edwards Deming

W. Edwards Deming was an American quality pioneer that developed the “14 Points for Management” and “Seven Deadly Diseases” of management.

Deming developed the 14 Points as the "...basis for transformation of American industry... Adoption and action on the 14 points are a signal that the management intend to stay in business and aim to protect investors and jobs".³⁰

Since, as Deming asserted, management was responsible for creating the work environment, management is also responsible for 85% or more of the cost of quality issues that occur in the environment.

One of Dr. Deming's most significant contributions was his development of what he called his ‘System of Profound Knowledge’. The system consists of four parts:

1. Appreciation for system
2. Knowledge about variation
3. Theory of knowledge
4. Psychology

A **system** is a series of interdependent components that work together to accomplish the aim of the system. If there is no aim, then there is no system. The idea for any component of the system is to contribute its best to the system. With many businesses, unfortunately, management has the independent units of organizations compete against each other for resources, budget, etc. this sub optimizes the system and ultimately, leads to a degradation of overall system capability.

The key concepts Edwards Deming tried to get across to management was that it was critical for management to understand **variation** in a process, and who was responsible for addressing the variation in the process. He defined the two types of variation as **Special Cause variation and Common Cause variation**:

- **Special Cause variation** occurs when a process exceeds its control limits. This type of error can be addressed by the operator of the system, for example, if a piece of equipment goes out of adjustment or out of calibration
- **Common Cause variation** is the natural variation or randomness in the process. Common Cause deviation is measured by standard deviation and is a measure of precision. Improving the precision and tightening the standard deviation is beyond the control of an operator of the system and can only be addressed by management

It was Dr. Deming's view that management in any form is prediction, therefore having a **theory of knowledge** helps us to understand that. Any kind of rational prediction is built on theory and requires systematic revision when impacted by reality. This is how knowledge is built: on a combination of predictions, observation, and adjustment of the prediction based on what has been observed. It is a fundamental empirical process.

³⁰ *Out of the Crisis*, W. Edwards Deming, 1986, MIT Press, p.23

Finally, knowledge of human **psychology** is necessary so that we understand people. Dr. Deming observed that a manager of people must be aware of differences in how people learn, the speed at which they learn, and what motivates them, as well as how to use these differences for optimization of everyone's abilities.

Kaizen

The concept of kaizen is to implement consistent and incremental improvement. In Japan: kai means 'to alter', zen means 'to improve or make better'. This concept was understood in the United States as far back as 1926 by Henry Ford who stated:

"If we reach a stage in production which seems remarkable as compared to what has gone before, then that is just a stage of production and nothing more. We know from the changes that have already been brought about that far greater changes are to come, and that therefore we are not performing a single operation as well as it ought to be performed".³¹

Modern implementations of kaizen focus on activities that reduce costs, reduce cycle times, drive higher customer satisfaction, and improve quality overall to help the business grow and sustain relationships with its customers.

Using the P-D-C-A (Plan-Do-Check-Act) cycle as an empirical process; repeated, incremental improvements can be realized that benefits the business and, most importantly, the customer.

Six Sigma

For the exam understand that Six Sigma defect levels are equal to 3.4 defects out of 1 million opportunities. This translates to a defect free percentage of 99.99966% or in short 99.999%.

This is designed to bring about 'rocket shot', 180° turn-around improvement in a process that is causing significant loss to the organization.

Six Sigma uses a five step process (DMAIC), which is a variant on plan-do-check-act, to implement the turn-around:

- Define – define the one biggest problem or issue causing loss to the business
- Measure – measure the current state of the process. This can be a painful reality check
- Analyze – analyze options to address the problem
- Improve – implement the solution identified in the analysis phase
- Control – Monitor and control the result using statistical tools to measure the result of the change and monitor forward progress.

³¹ *Today and Tomorrow*, Henry Ford, Doubleday, 1926, p. 48

One of the newer implementations of Six Sigma is DFSS (Design for Six Sigma), which has the objective of determining the needs of customers and the business and driving those needs into the product solution. DFSS is relevant to the complex system/product synthesis phase, especially in the context of unprecedented system development. It is process *generation* in contrast with process *improvement* and, as such, uses the DMADV (Define, Measure, Analyze, Design, Verify) or the IDOV (Identify, Design, Optimize, Validate) approach.

Quality Philosophies

The **Just in Time** approach to production eliminates the unnecessary and expensive buildup of inventory in a manufacturing or service process. The idea of 'just in time' promotes the concept 'single piece flow', a key lean concept and one of the 14 points in the Toyota Production System. The Just in Time manufacturing concept was founded due to the contribution of Dr. Shingo Shigeo and Mr. Taichii Ohno of Toyota Motor Co. from 1949 to 1975.

Exam Tip: Just in time processes typically carry no inventory.

In view of his contributions, Utah State University founded the Shingo prize for excellence in manufacturing in 1988. This prize promotes world-class manufacturing and recognizes companies that achieve superior customer satisfaction and business results. The Shingo Prize has been compared as the manufacturing equivalent of the Nobel Prize (<http://www.shingoprize.org>).

The International Organization for Standardization (ISO) was reorganized in its current form at the end of the Second World War in 1946. ISO is a voluntary organization that promotes international standards for manufacturing. Organizations that are ISO certified know that their products will work in other countries where the same ISO standard has been implemented, thus removing barriers to trade.

TQM according to ISO 8402:1994, is defined as follows:

"TQM is a management approach for an organization, centered on quality, based on the participation of all its members and aiming at long-term success through customer satisfaction, and benefits to all members of the organization and to society." According to William Golomski (American quality scholar and consultant, 1924-2002) TQM was first mentioned by Koji Kobayashi at NEC (Nippon Electrical Company) in his acceptance speech for the Deming Prize in 1974.

CMMI

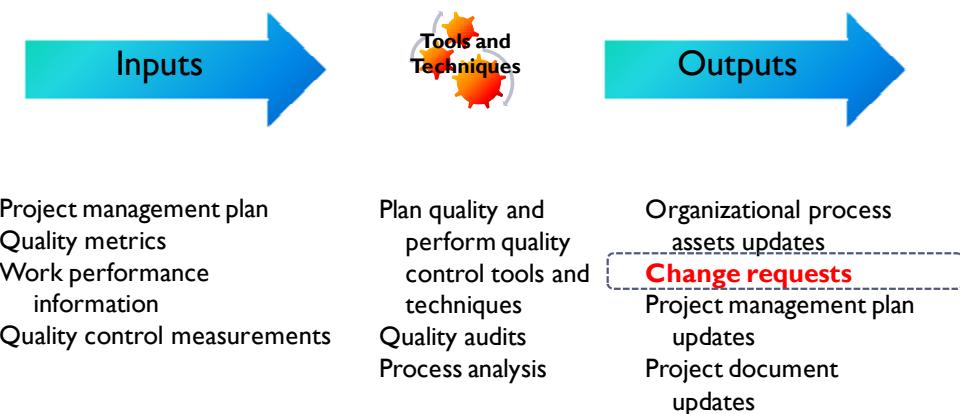
Level		
5	Optimizing	Continuous process improvement
4	Quantitatively managed	Quantitative management
3	Defined	Process standardization company wide
2	Managed	Fundamental project management
1	Initial	Fire Drill - adrenaline based management

The Capability Maturity Model Integration (CMMI) is the second major incarnation of the capability maturity model. The original CMM was ‘sunset’ in 2004 by the Software Engineering Institute and was replaced by the more robust CMMI by 2006.

The CMMI is fundamentally a process designed to help organizations improve overall software quality, which includes software design, development and deployment. The assessment levels for the CMMI are shown above. The stairstep model that was originally used in CMM was described by Phil Crosby in his book *Quality Is Free*.

The Software Engineering Institute (SEI) conducts audits of organizations that desire to be assessed at levels 2 and above in the CMMI model. Notice the use of the word ‘assessed’ - the SEI does not *certify* any organization for a specific assessment level. The assessment is conducted by a lead assessor and a team supporting the assessor. The assessment is good for two years, at which point the organization needs to be reassessed in order to maintain its assessment level.³²

Perform Quality Assurance



³² <http://www.sei.cmu.edu/cmmi/index.cfm>, Software Engineering Institute, Carnegie Mellon

Perform quality assurance is the process of ensuring that the quality standards set down by the organization are being followed for the project. This includes the performance of quality audits as well as process analysis (the third step in the Six Sigma process).

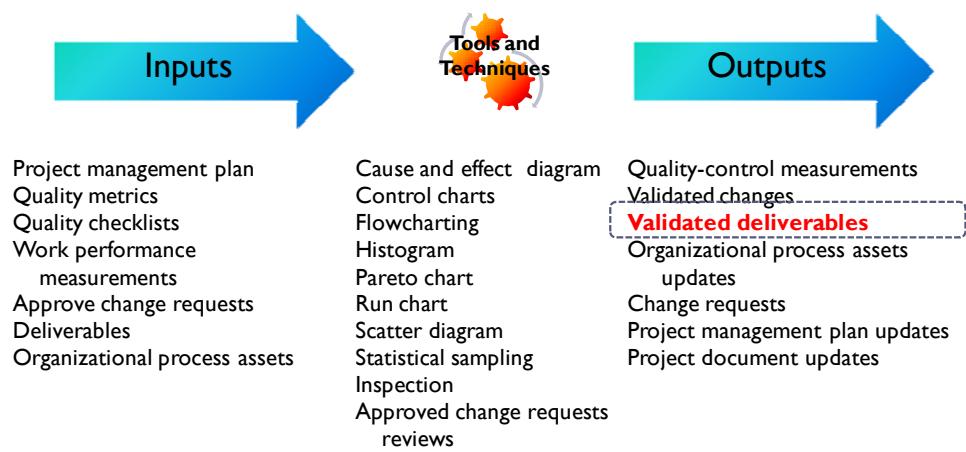
Since Perform Quality Assurance occurs in the Executing process group, we focus on requested changes, continuous process improvement, and following organizational standards and practices. Perform Quality Assurance utilizes the data that was collected in the Perform Quality Control process to assess whether the project is adhering to the appropriate quality standards.

Quality Audit

Quality audits can occur with or without warning. The idea of performing an audit is to establish the following:

- Is the project team following the policies, standards, and procedures as outlined by the organization?
- Are any changes by way of corrective or preventive actions necessary to bring any part of the project back into quality compliance?
- Are there any improvements, lessons learned or new processes that contribute to best practices within the organization and that can be institutionalized as ongoing processes?
- Identify best practices, gaps or shortcomings
- Share good practices introduced, organizationally or industry-wide
- Offer assistance to help improve productivity and highlight contributions in lessons learned repository

Perform Quality Control



Perform quality control gives a project manager the opportunity to apply measuring and statistical tools to measure the effectiveness of the project team, the deliverables, and the overall level of customer satisfaction on the project. Also note the key output: Validated Deliverables. This means that the deliverable has been validated against the customer's specifications.

Included in the tools and techniques you see above are Kaoru Ishikawa's seven basic quality tools. Ishikawa stated that with the mastery of these seven tools, anyone with no more than an eighth grade education in mathematics will be able to correct 95% of the problems they face on the job.

These tools are:

1. cause-and-effect diagram
2. control charts
3. flowcharts
4. histogram
5. Pareto chart
6. run chart
7. scatter diagram

We will review these tools in some detail on the pages that follow.

Additional Statistical Terms

The normal distribution is the most common of the statistical distributions. In the world of statistics all distributions will approach the normal distribution, otherwise known as the bell curve, as the size of the sample approaches the entire population. In other words, given a large enough sample, everything becomes a normal distribution.

Probability is a term that is expressed as a percentage, and describes the likelihood of a specific event occurring. Another term you might see used in the exam is the concept of **Conditional Probability**. Conditional probability deals with causation; it is a cloudy day and there is a probability that it will rain. What is the probability that it is going to rain given that you have just heard thunder?

Statistical independence is the opposite of conditional probability. It states that the probability of one event occurring does not affect the probability of another event occurring. Flipping a coin, there is a 50-50 probability that I will either get heads or tails. If I flip the coin for a second time, the chance of getting heads or tails remains 50-50. The first coin flip has no impact on the probability of the outcome of the second coin flip.

Mutual exclusivity means that two events cannot occur in a single trial. If we throw a six sided dice, it cannot come up simultaneously on six and on five. If you flip a light switch on the wall, the light is either on or it is off. It cannot be in both states simultaneously.

Variable and Attribute Sampling

There are two types of data that will be referenced on the exam:

- Variable data – also called ‘continuous’ data
- Attribute data – also called ‘discrete’ data

The characteristics of the two data types appear below:

Discrete

Data:

- Attribute
- Yes/No
- Pass/Fail

Continuous

Data:

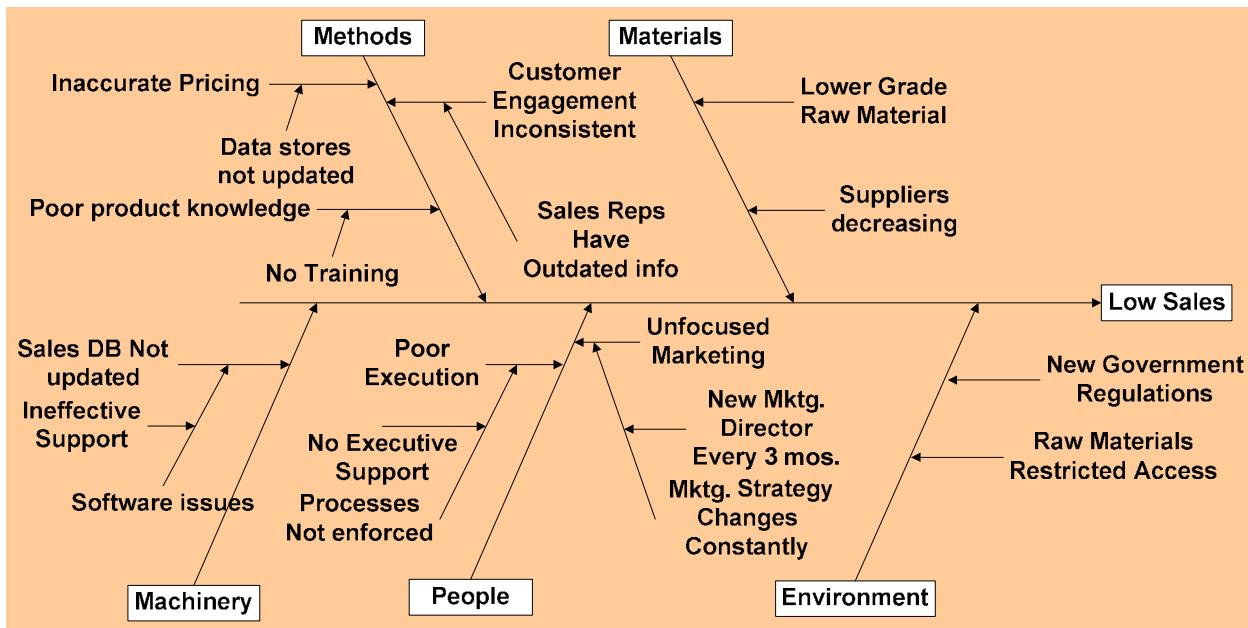
- Variable
- Test Score
- Height/Weight

One of the key points you need to understand about variable data (continuous data) and attribute data (discrete data), is that *you cannot perform math on attribute (discrete) data.*

Discrete data represents an attribute, for example, the number on a football jersey or the number of a bus route. In this case, the attribute data is simply a label that helps to identify the football player or the bus route. If you have two bus routes, #252 and #121, performing a mathematical operation on these two numbers yields a meaningless result.

Continuous data on the other hand, enables us to perform mathematical functions on the data. The data can be added, averaged or have other operations performed on it. For example, I want to compute the average height of males in a specific population. The measurements that we take, accurate to an eighth of an inch, can be computed and averaged.

Ishikawa Diagram



The Ishikawa diagram was developed by Kaoru Ishikawa, a Japanese quality guru and winner of the Deming Prize for individual performance in 1952. The Ishikawa diagram, also known as the cause and effect or 'Fishbone' diagram, is a tool that is used to perform root cause analysis in the graphic format.

The main effect pictured in the diagram is shown at the head end of the diagram. In this case, a specific product is experiencing low sales; that is the 'effect'. The spines on the remaining part of the diagram indicate high level causes (the major spines), and contributory causes (the smaller spines).

The idea is to drill down into the causes by continuing to ask 'why?' until you surface a potential cause.

The basic major spines of an Ishikawa diagram consist of the 5M's:

- Methods
- Materials
- Machinery
- Manpower (People)
- Mother Nature (Environment)

Other major spines can be added depending on need; 'money', for example.

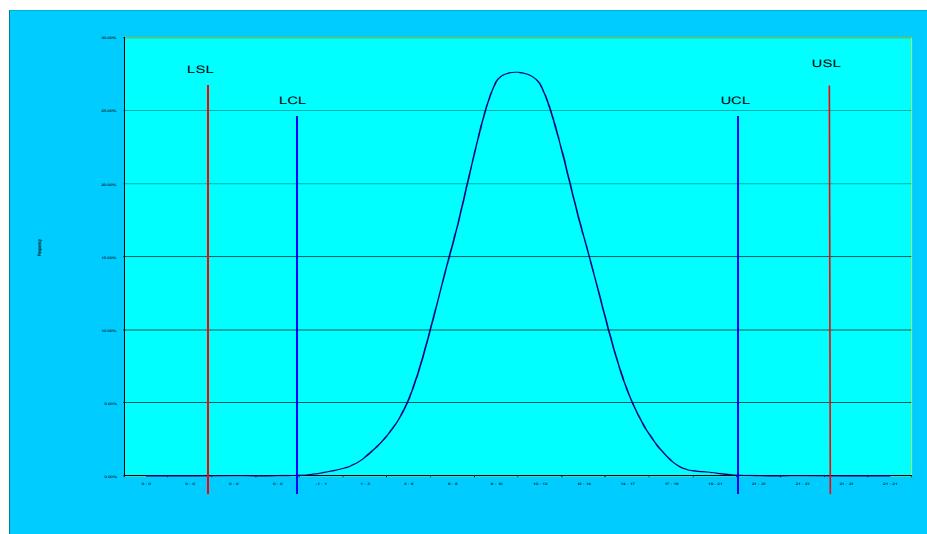
In Japan, the process of questioning what caused the effect is called the '5 whys' process. When you identify a cause ask, 'why did that happen?'. Asking why at least five times will either get you to the root cause of the problem or identify a point where you need further information to understand the cause.

Statistical Process Control

The state of the statistical process control involves two types of limits:

- **Process Control Limits** - these are usually identified by the UCL (upper control limits), and the LCL (lower control limits). Process control limits are never selected by the project manager or by the stakeholders. They are always computed by the process itself and tell the practitioner whether the process is in a state of statistical control and whether the process is capable.
- **Process Specification Limits** - these limits, the USL (upper specification limits) and LSL (lower specification limits) are defined by the customer, or the customer with the help of the project manager. The specification limits indicate what levels of variance the customer can withstand before the process is deemed to be out of specification and in a state of error.

A process can be within statistical control (within the UCL and LCL) and yet be out of customer specification (outside of the USL or LSL). What this means is that the process is experiencing common cause variation (random) that cannot be corrected by an operator of the system. This is a situation that requires the help of management.



If the customer specification limits (USL and LSL) are outside the control limits your process can drift out of control but still be within customer specification!

Stability Analysis/Zone Test

The stability analysis, or zone test, is used with the statistical process chart on data that may be within the boundaries of the upper control limits and the lower control limits of the chart. What this means is that data may be within the UCL and the LCL and yet still indicate an out-of-control situation.

Typical zone tests include the following:

- The Rule of Seven - seven consecutive data points on either side of the mean may indicate an out-of-control situation
- The Rule of Six - six consecutive data points or more, trending in an upward or downward direction, may indicate an out-of-control situation
- The Rule of Ten - essentially 10 data points represented as a saw-tooth pattern alternating above and below the mean.

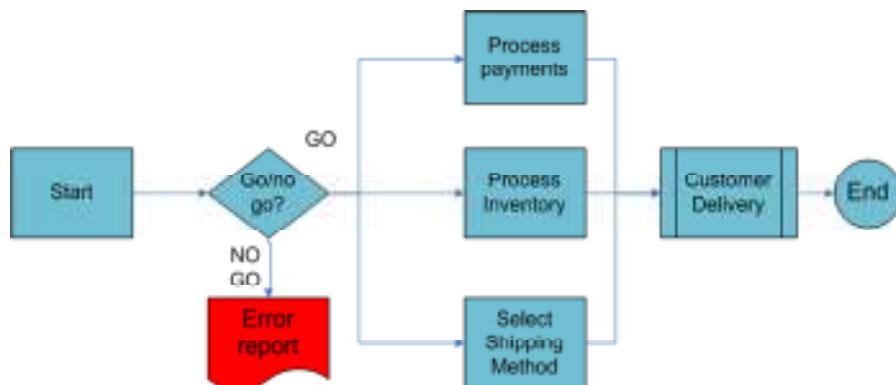
The concept that binds these rules together is simply this: in a statistical process chart where the data supposed to be random within the control limits, one has no way of predicting where the data points will land at any given time. With the rules above, we are seeing a pattern where we are expecting randomness. This pattern is what Dr. Joseph Juran referred to as the 'signal in the noise'.

Flowchart

There are numerous tools, software and otherwise, that enable the drawing of flowcharts. Flowcharts help to identify process flow, logic or a method for performing a specific activity or group of activities. Flowcharts can be used to show dependencies between activities or simply show a series of steps from start to finish.

Exam Tip:

From the perspective of Quality Control, flow charts can be used to identify failing process steps and identify process improvement opportunities



Pareto Chart

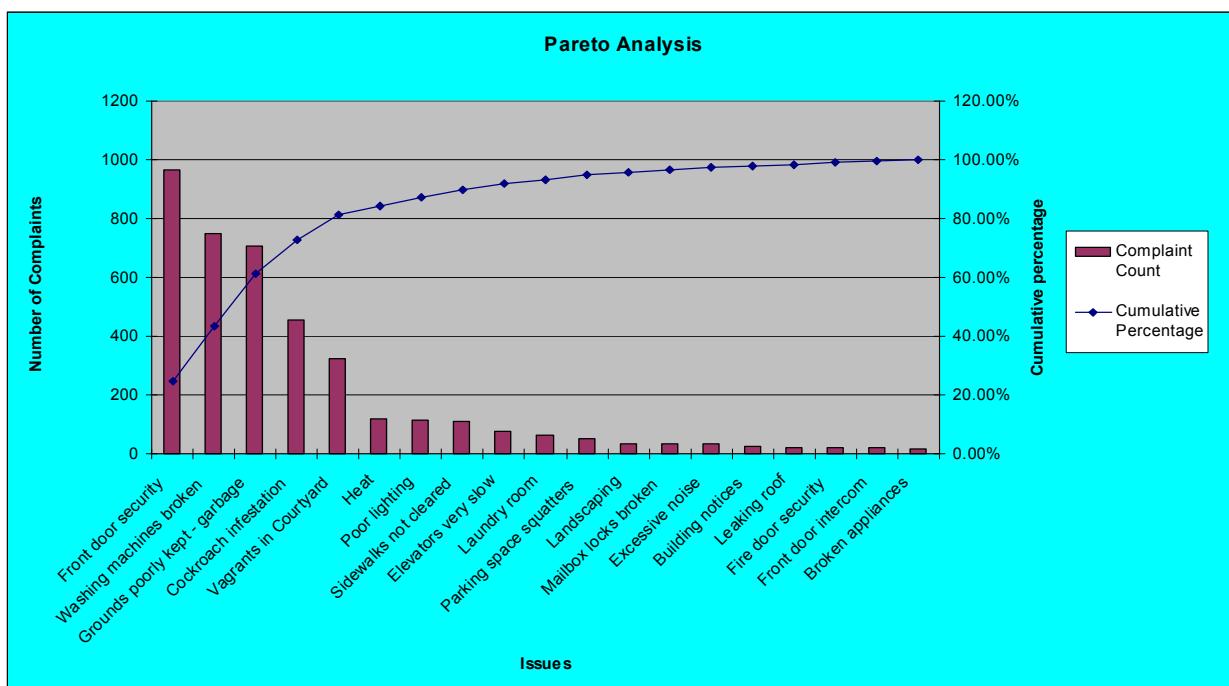
The Pareto chart was based on the work done by Italian economist at Wilfredo Pareto in the late 19th century who discovered that 80% of the wealth in Italy was held by 20% of the population. Dr. Joseph Juran took Pareto's idea and applied it to general business process to see if this 80/20 rule would apply in a business environment. His discoveries included:

- 20% of the business produces 80% of the waste and rework
- 20% of your customers produce 80% of your revenues
- 80% of your customer complaints come from 20% of your customers

The Pareto chart is a key tool in Kaizen – it will identify which incremental improvements will produce the largest results for the least amount of effort.

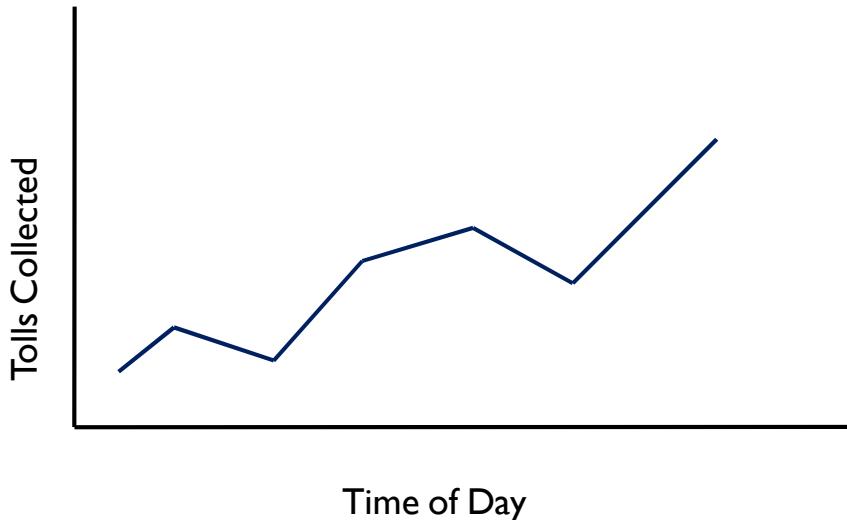
For the exam, the Pareto chart is a prioritization tool used to identify critical issues, and identify your largest problems.

The Pareto chart is also a specialized type of histogram.



Run Chart

A run chart is similar to an SPC chart, except that the control and specification limits are not shown. Here, you are simply looking for a run of the data to see what it looks like over a given period of time. An example appears below. Notice there are no statistical control or specification limits in this chart:



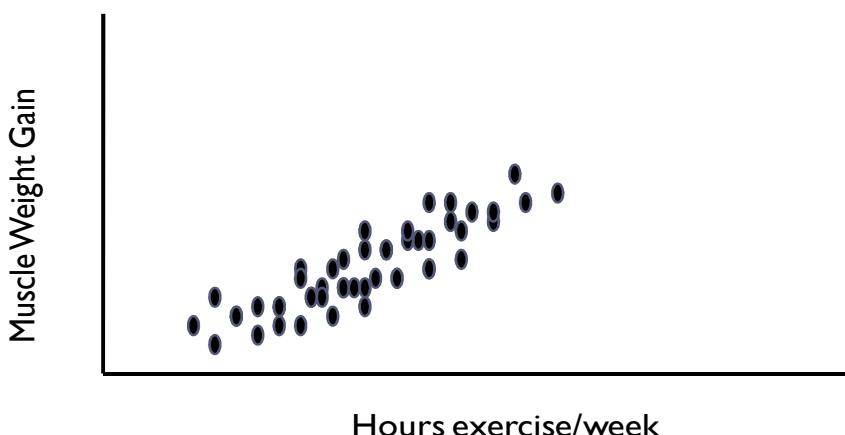
Scatter Diagram

The scatter diagram is used in trending and regression analysis. It plots data in an x-axis (in this case, hours of exercise per week) and compares it to data in y-axis (gain in muscle weight). For this example, the scatter diagram answers the following question:

Does a change in X correspond to a change in Y?

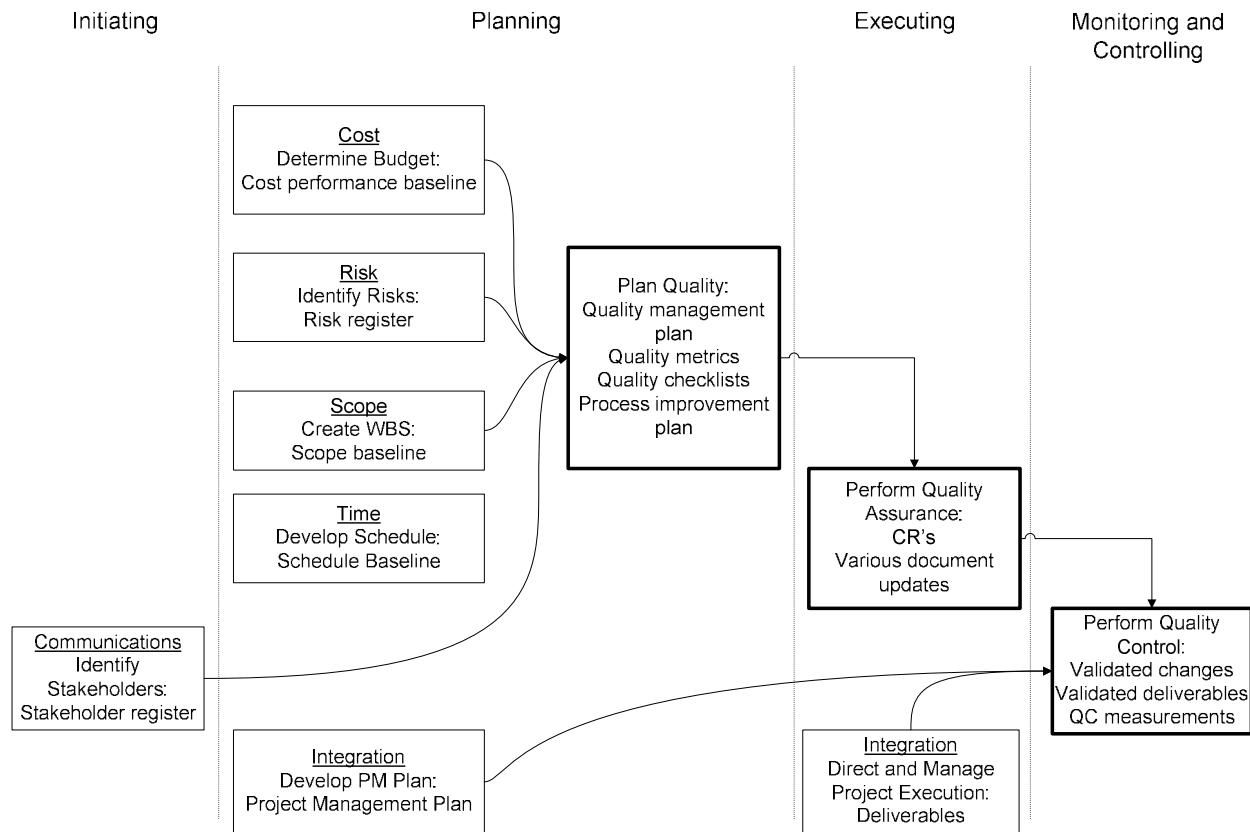
- When there is a positive correlation - an increase in X corresponds to an increase in Y, we are trending in a positive direction.
- When there is a negative correlation - an increase in X corresponds to a *decrease* in Y, we are trending in a negative direction.
- When there is a neutral correlation - an increase in X leads to neither an increase nor a decrease in Y, we are showing no correlation or no impact between the measurements

For the scatter diagram to be effective or useful, the compared elements must be causally related in some way. It is very easy to develop a series of false-positive or false-negative measurements when comparing unrelated sets of data. Comparing US traffic deaths to an increase in global warming may show a positive correlation in the scatter diagram, but in reality are completely unrelated elements.



Project Quality Management: Key Process Interactions

The key inputs from the other Knowledge Areas to Project Quality Management processes are shown below. *Know these process interactions for the exam.*



In Summary...

This section discussed quality management, including:

- Gold plating, and why it is not acceptable
- Quality theories, including Zero Defects, Fitness for Use, Deming, Kaizen, Six Sigma, CMM, and CMMI
- Fishbone diagrams and how they are used
- Standard deviation and definition of One Sigma, Two Sigma, Three Sigma, and Six Sigma
- How to read and use control charts, Pareto diagrams, run charts, and scatter diagrams

Chapter Eight Memory Check

1. The limits that are calculated on a statistical process control chart are the _____ limits, whereas the limits that are set by the customer are called the _____ limits
2. A comparison of project activities against a known standard is called _____
3. Weighing the cost of implementing quality against the benefit it will deliver for the project is called a _____ - _____
4. The tool that is used to test multiple factors simultaneously is called _____
5. _____ is the lowest cost of quality, while _____ is the highest cost of quality
6. The tipping point where benefits or revenues received from improving quality equals the cost to achieve that quality is called a _____
7. A process that establishes a financial measure of the user dissatisfaction with a product's performance, as it deviates from a target value, is described in Taguchi's _____
8. 'Fitness for use' was a concept pioneered by _____
9. The five levels of the CMMI are in order; _____, _____, _____, _____, _____
10. The amount of inventory carried in a _____ process is typically zero.
11. Six Sigma represents an accuracy of _____ %
12. Continuous, incremental improvement in a product or process is called _____ in Japan
13. Deming observed that at least _____ % of the cost of quality (or poor quality) is management's responsibility
14. _____ states that the probability of one event occurring does not affect the probability of another event occurring
15. The key output of the Plan Quality process is the _____
16. A product that is not particularly attractive but meets your quality criteria for fitness for use can be described as _____, but high quality
17. The key output of Perform Quality Assurance is _____
18. Data that you can perform mathematical computations is called _____ or _____, whereas data that describes a label or a pass/fail scenario is described as _____ or _____ data
19. The quality pioneer that promoted the idea of zero defects was _____
20. Kaoru Ishikawa created a diagram used to ferret out root causes of problems that was called the _____ diagram
21. The _____ is used to determine if the data in an SPC chart is out of control, even though the data points are within the control limits of the chart
22. The _____ chart is used to identify critical issues in descending order of frequency
23. To determine if a change in 'X' corresponds to a change in 'Y', the chart that best displays this correlation is the _____
24. _____ means that two events cannot occur in a single trial
25. The key output of Perform Quality Control is _____

Chapter 8 Test

1. You are in the process of developing the quality management plan for your project. You have asked the technical team for some quality metrics that would be useful to document for the quality management plan. They've identified several other projects that are similar to this one, and seemed to think that the quality metrics established in these projects would also be applicable to the current project. This technique is called:
 - a. Quality audit
 - b. Process analysis
 - c. Benchmarking
 - d. Statistical sampling
2. The project team has collected a series of issues and ranked them by frequency. This data will be a key input into your process improvement plan. What specific tool or technique is used to chart in this data?
 - a. Ishikawa diagram
 - b. Pareto chart
 - c. Scatter diagram
 - d. Statistical sampling
3. The project stakeholders are somewhat concerned about the costs of delivering a quality product. While they want to make sure that the customer receives a high quality product they want to ascertain that the benefit of making certain quality improvements will actually translate into something the customer will buy. The process of comparing the quality expense to potential return on investment is called:
 - a. Quality ROI
 - b. Process analysis
 - c. Monte Carlo analysis
 - d. Marginal analysis
4. Part way through the project, one of the stakeholders approached you with a vexing problem. There was an issue with one of the components delivered in the project, however whenever the technical team tried to solve the problem, it kept coming back... As the project manager, you instructed the stakeholder that what was needed here was some form of root cause analysis. What is the best of the quality control tools to use in this situation?
 - a. Ishikawa diagram
 - b. statistical sampling
 - c. Pareto chart
 - d. scatter diagram
5. A statistical process chart requires upper and lower control limits to help establish whether the process is performing as designed. What are the standard UCL/LCL limits in an SPC chart?
 - a. +/- 2 sigma
 - b. +/- 3 Sigma
 - c. +/- 6 sigma
 - d. +/- 1 sigma
6. Who is responsible for project quality?
 - a. senior management
 - b. the project manager
 - c. the sponsor
 - d. the project team

7. You are facilitating your project kickoff meeting and several of the stakeholders have gotten into a discussion regarding specific quality attributes that the product should possess. One of the stakeholders has referenced an article from the Gartner Group about best practices. Another stakeholder is focusing on specific quality processes maintained within their organization. As the project manager you are attempting to reconcile the differences that the stakeholders are raising. What is the *real* issue?
- Quality practices should be determined and administered by the QA organization, *not* the stakeholders
 - Product quality attributes are specific to the product - the stakeholders are focusing on the wrong elements
 - Quality attributes are controlled by senior management and executed during quality control
 - Quality attributes are documented in ISO specifications depending on the industry
8. The project management life cycle consists of initiating, planning, executing, monitoring and controlling and closing. What cycle is the basis for quality improvement?
- Analyze, Review, Execute, Control
 - Plan, Do, Check, Act
 - Prepare, Execute, Analyze, Act
 - Initiate, Design, Observe, Verify
9. The usability of a product or a service by the customer was something that was described by Dr. Joseph Juran as:
- Usability quotient
 - Quality trilogy
 - Customer use satisfaction index
 - Fitness for use
10. All of the following elements are external impacts of poor quality except:
- Cost to regain lost business
 - Decreased efficiency
 - Negative press
 - Rework
11. One of the purposes of a statistical process chart is to measure the variances in a process and to help determine whether those variances are random variations in the process or 'attributable' causes. What does the standard deviation in the chart measure?
- Accuracy
 - Precision
 - Variance
 - Process Capability
12. +/-3 sigma constitutes what percentage of the entire population measured in an SPC chart?
- 99.73%
 - 95.45%
 - 96.85%
 - 99.98%
13. The cost of quality conformance is _____?
- Loss of money due to scrap
 - Money spent on rework
 - Money spent on excessive warranty claims
 - Money spent to avoid failures

14. Your organization was focused on producing good quality for the customer. After a recent merger, however, the new management team is questioning the processes you were using to produce this level of quality. The new CFO claimed that many of these processes were extraneous and were costing the company too much money. As a senior program manager, you set up a meeting with the CFO to discuss his concerns. What is the *most effective argument* you could make for maintaining good quality within the organization?
- a. Good quality is good for the corporate image, retains customers and maintains productivity
 - b. Good quality increases productivity, reduces cost, and decreases risk
 - c. Good quality will ensure the CFO makes her bonus this year
 - d. Good quality will improve positive press for the organization, reduce time-to-market, and increase profitability
15. Quality policies and standards are established in :
- a. Plan quality
 - b. Perform quality control
 - c. Perform quality assurance
 - d. Monitoring and controlling process group
16. You have just reviewed the most recent audit from the quality assurance organization which has identified an out-of-control process. You call the members of the technical team in for an emergency meeting to address the situation, as this is a critical process in your development effort. Analyzing an out of control situation for remediation occurs in which process and results in the creation of?
- a. Perform quality assurance and project management plan updates
 - b. Perform quality control and change requests
 - c. Perform quality assurance and change requests
 - d. Perform quality control and validated changes
17. Your project stakeholders have come to you with an issue: they're attempting to tune a process in one of the recent deliverables from the technical team. They're trying to analyze whether a change in the sensitivity of the logging process will result in greater accuracy from the performance logs. The *best chart* to use that would illuminate a cause-and-effect relationship would be?
- a. Pareto chart
 - b. SPC chart
 - c. Scatter diagram
 - d. Ishikawa diagram
18. Zero defects is a concept promoted by:
- a. W Edwards Deming
 - b. Joseph Juran
 - c. Philip B Crosby
 - d. Kaoru Ishikawa
19. You are working with the marketing organization to help develop a new advertising campaign using a direct mail model. There are literally hundreds of combinations of elements that can be used in each direct mail piece. Testing the most effective approach that will produce the highest response rate will take months to complete and potentially cost many hundreds of thousands of dollars. What method would help reduce the time, dollars, and the actual number of tests that would be required to ascertain the best direct mail combination of elements?
- a. Six Sigma
 - b. Design of Experiments
 - c. Deming's 14 points
 - d. The Juran Trilogy

20. Your technical team has just identified a process that requires some corrective action. Corrective action is closest to:
- Continuous process improvement
 - Defect analysis
 - Rework
 - Constraint analysis
21. You have been reviewing the output on a statistical process chart. While all the data in the chart is contained within the upper and lower control limits of the chart, a potential issue has been identified: it appears that there were eight consecutive points on the chart that occurred between the mean and +1 sigma. In terms of statistical process control this specifically violates:
- The rule of 7
 - The Taguchi loss function
 - The zone test
 - The 't' test
22. During quality planning, flowcharting can help the team _____?
- Anticipate quality problems
 - Fix quality issues
 - Create sampling methods
 - Outline a root cause
23. After several JAD sessions with the customer, the technical team has expressed some concerns. A number of the team members felt that they were not really getting a clear picture of the customer's actual requirements. They felt that actually visiting the customer's facility to see how the customer gets the job done would be great benefit in determining what you, the project manager, have frequently called 'the voice of the customer'. Capturing the voice of the customer is a key tool in which of the following processes?
- Quality audits
 - Statistical sampling
 - QFD
 - ISO 5408
24. The project sponsor and the technical team are sitting down to determine which features would best serve the customer in the upcoming project. The sponsor has indicated that they want to go beyond just simple customer satisfaction; they want to '**wow**' the customer. Which of the following processes would *best* demonstrate this distinction?
- The Kano Model
 - Pareto analysis
 - Monte Carlo analysis
 - Fitness for use analysis
25. You're working in a lean manufacturing environment in which the watchword is 'just in time' (JIT). This is the end of a 36 month process that took your organization from a top-heavy, costly and time-consuming process to a process that reduced cycle time by 85% and costs by 78%. A process that is JIT typically carries what % inventory?
- 5%
 - 0%
 - 10%
 - 2.5%

Chapter 8 Test - Answers

1. C – The process that is described in the question is known as benchmarking
2. B – Pareto charts are set up to rank issues in a frequency of occurrence order from the highest frequency to the lowest frequency
3. D – This defines a marginal analysis: where the benefits from improving quality equal the costs to achieve that quality. In this case, if the costs to make improvements does not translate into something the customer will pay for, then it may not be beneficial to make the improvement
4. A – The Ishikawa diagram is designed to surface core issues through a root cause analysis process
5. B – The SPC chart sets upper and lower control limits at +/- 3 sigma
6. B – The project manager is responsible for project quality. Senior management is responsible for overall organizational quality. The sponsor is usually the recipient of a quality product and the project team members are responsible for the quality of their specific element of the project work
7. B – Product quality attributes are as individual as the product being created and the customer for whom the product is being created
8. B – Plan, do, check, act. All the other ‘cycles’ are made up. *PMBOK® Guide*, 4th edition, p. 191
9. D – Juran defined the usability of product in the customer’s hands as fitness for use
10. D – Rework is an internal cost of quality. *PMBOK® Guide*, 4th edition, p. 195
11. B – Standard deviation is a measure of product or process precision i.e. how closely the product conforms to target values
12. A – Per definition 99.73%
13. D – Money spent during the project to avoid failures. *PMBOK® Guide*, 4th edition, p. 195
14. B – Good quality increases productivity (less cycle time), reduces cost (fewer defects) and decreases risk that the product will be returned by the customer). Answer ‘C’, though important to the CFO, has nothing to do with the customer. Answers ‘A’ and ‘D’ while they may be true are not the core reasons for maintaining good quality
15. A – Quality policies and standards are established in the Plan Quality process. *PMBOK® Guide*, 4th edition, pp. 192-194
16. B – Analysis of an out-of-control situation occurs in Perform Quality Control and usually results in a change request to implement a corrective action. *PMBOK® Guide*, 4th edition p 206
17. C – Does a change in ‘x’ have an impact on ‘y’? What describes this relationship is a scatter diagram
18. C – Philip Crosby described this in his book, “Quality Is Free”
19. B – Design of experiments is, by definition, the tool to use in this instance
20. C – Corrective action is closest to rework by definition. *PMBOK® Guide*, 4th edition, p. 438: “Action taken to bring a defective or nonconforming component into compliance...”
21. A – This explicitly defines the rule of 7: seven or more consecutive data points that are above or below the mean and within 1 standard deviation of the mean
22. A – Anticipate quality problems. *PMBOK® Guide*, 4th edition, p. 198
23. C – Capturing the voice of the customer is a key process in QFD
24. A – The Kano model explicitly captures dissatisfiers, satisfiers and delighters in a product or process
25. B – A just in time process typically carries 0 inventory

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Chapter 9 : Project Human Resource Management

Topics:

- ▶ Overview of Project Human Resource Management
- ▶ Human Resource Planning
- ▶ Acquiring Project Team
- ▶ Developing Project Team
- ▶ Managing Project Team

Section Objectives

With this section, you will be able to:

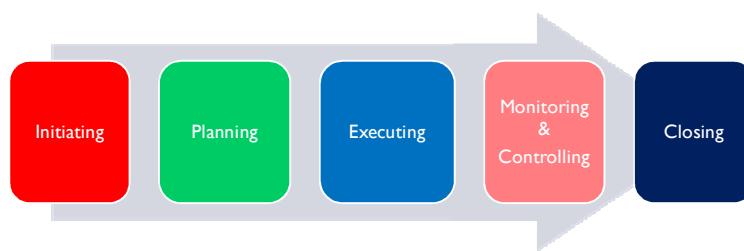
- ▶ Describe how to create and use a staffing plan
- ▶ Design a responsibility matrix
- ▶ List the four stages of the Tuckman team development
- ▶ Describe various motivational theories
- ▶ Describe leadership styles and the most appropriate to use
- ▶ Sequentially list the seven main sources of project conflicts

Project Human Resource Management Process Summary

The high level Project Human Resource Management output elements, by Process Group are:

Initiating	Planning	Executing	Monitoring and Controlling	Closing
	Human resource plan	Project staff assignments Resource calendars		
		Team performance assessments		
		CR's Various document updates		

Project Human Resource Management



- ▶ Develop human resource plan
- ▶ Acquire Project team
- ▶ Develop Project Team
- ▶ Manage Project Team

Project human resource management describes the processes that enable the project manager to organize and lead the project team. A subset of the project team is the project management team, which is responsible for leadership activities in each of the five major process groups.

Part of the role of the project manager in managing the project team is to influence the team when human resource factors may impact the project, and to ensure professional and ethical behavior at all times when conducting project activities.

Human Resource Roles

The key responsibilities of each group are listed below:

The Project Sponsor

- Protects the project from external influences
- Provides funding
- Approves the charter and PM Plan
- Sets priorities between projects
- Identifies Project Manager and authority level
- Approves or rejects changes
- Formally accepts deliverables or product of project

The Stakeholders

- May have PM plan signoff responsibilities
- Verify scope and deliverables
- May be part of the change control process for approvals/rejections
- Provide requirements

The Line (functional) Manager

- Provides project resources and SME's (in a matrixed organization)
- Participates in initial planning
- Manages project activities that fall to their area
- May address team member performance with the project manager

The Project Manager

- May contribute to writing the project charter
- Is responsible for all aspects of the project:
 - Project management planning
 - Communications to stakeholders
 - Change management planning
 - Creating all needed management plans (scope, time, budget, quality, communications, HR, risk and procurement)
 - Using metrics to measure project progress and implement changes or corrections when needed
 - Proactively addressing potential problems
 - Possesses the authority to accomplish the work of the project
 - Resolves variances to the project management plan with the team
 - Regularly and proactively addressing project risks with the team
- Ultimately responsible for project success or failure

The Portfolio Manager – Senior Management

- Responsible for executive level governance of the portfolio
- Ensures the project meets the strategic goals of the organization
- Engages senior executives for project support
- Responsible for driving the highest ROI for the project

The Program Manager – Senior Management

- Offers guidance to project managers on individual projects

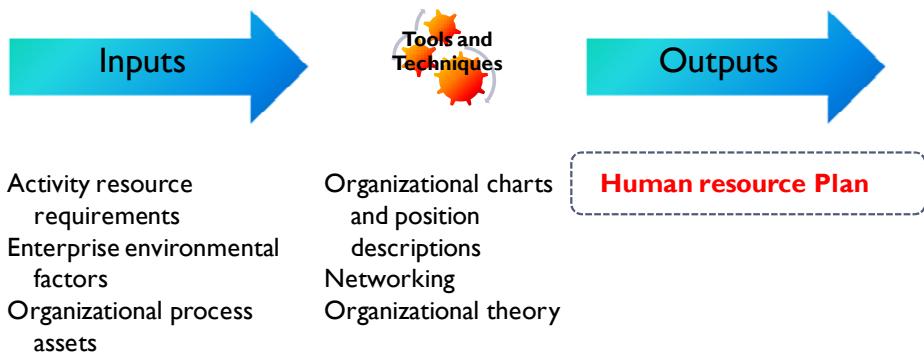
- Functions in an oversight capacity to ensure each project contributes to the overall benefit of the program

The Project Team

- Translates user requirements into technical specifications needed to deliver the product of the project
- Defines work packages and activities in the WBS
- Identifies dependencies between work packages and/or activities
- Provides time and cost estimates for the project manager
- Resolves internal disputes
- Complies with internal corporate standards, methods, procedures, quality requirements
- Can recommend process improvements, corrective actions or implement defect repairs

The above listing is only a partial listing of the responsibilities each group. Readers would do well to study this list, as questions regarding any of the roles and responsibilities in this section may appear on the exam.

Develop Human Resource Plan



Developing the human resource plan includes the major headings listed below, along with a brief description of what is expected for each.

1. **Roles and Responsibilities** - can be assigned to a person or group. These individuals or groups can be within or outside the performing organization. The roles described for the project may not have a direct analog to a position within the organization. Thus it is the project manager's job to identify resources that can take on the responsibilities of the particular role needed for the project. These roles can be documented in a responsibility assignment matrix (RAM) in the form of a RACI chart (responsible, accountable, consult, inform)
2. **Org Charts** - an organizational breakdown chart (OBC) is critical for identifying management hierarchies in the project and identifying potential escalation paths should there be issues that the project manager has not been empowered to resolve. In a matrix organization this becomes a critical factor, as it may identify functional managers from whom the project manager secures resources for the project. The org chart also works hand-in-hand with a roles and responsibilities chart, in that it will identify an unambiguous owner for each work package in the project

3. **Staffing Management Plan** - this plan describes how human resource requirements will be met for the project. The plan can be formal or informal, detailed or general, depending on the project needs. The staffing management plan is continually updated during the project and usually includes the following elements:
 - Staff Acquisition - identifies when specific resources roll on or off the project and the skill levels required of those resources
 - Resource Calendars - identifies when staff acquisition activities should begin as well as staff availability and hours available from a particular resource
 - Staff release plan - defines when resources are released from the project so that those resources are no longer charged to the project
 - Training - may be required if the performing organization is dealing with a new or untried technology. It is also beneficial in that it will help team members attain certifications that support their ability to meet project requirements. In PMI's view, training is not used as a 'perk'.
 - Recognition and Rewards - the idea of a recognition and reward system is that it tends to promote desired behavior on the project.
 - Compliance - this involves compliance with government regulations or union contracts in addition to established human resource policies
 - Safety - these include methods and procedures that are designed to protect team members from the potential safety hazards. These elements are not only included in a staffing management plan, but can also be included in the risk register

HR Enterprise Environmental Factors & Organizational Process Assets

When developing the human resource plan, the project manager needs to understand what enterprise environmental factors and organizational process assets can affect the outcome of the project.

Enterprise Environmental Factors - these elements need to be addressed thoroughly, especially when it comes to organizational and political issues. Remember the definition of a stakeholder? It is anyone that can be positively or *negatively* impacted by your project. If there is a negative impact on a stakeholder, that stakeholder may have a completely different agenda and may work *against* successful completion of the project. The project manager's job is to uncover any alternative agendas and work with stakeholders to ensure their needs are met.

Organizational Process Assets – the elements that will assist the project manager are standardized matrices such as standardized roles and responsibilities as well as any documented and repeatable processes. Usually an organization will have established templates and tools (e.g. progress reports, executive dashboards, change request forms, etc) that are subsumed inside the organization's PMIS. Historical data from previous projects and organizational structures that have been successful on previous projects can serve as guidance for the project manager.

Roles and Responsibilities

The roles and responsibilities grid is a critical tool for the project manager. It can identify activities, documents, and other deliverables along with the person accountable for those activities, documents or

deliverables. In other words, it provides a ‘single wringable neck’ and identifies to the project manager who owns the deliverable and is responsible for its completion.

The grid can be in a form as shown below, customized for the project, or there can be a standardized format based on what is required by way of methods and procedures for your project.

	Person A	Person B	Person C	Person D
Activity A	A		C	R
Activity B		C	A	
Activity C	R	A	I	C
Activity D		C	R	C
Activity E	I	R	A	

Key:

- Responsible
- Accountable
- Consult
- Informed

Staffing Management Plan

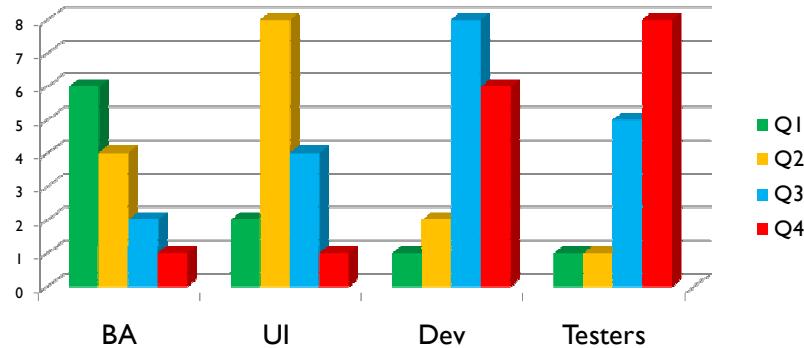
For a small project requiring few resources and a quick turnaround, the staffing management plan may simply be a single page that lists who's going to work on the project. For large, complex projects requiring large teams numbering into hundreds of people, staffing management plan is required to track the following:

- All needed resources for the project
- When the resources for the project are needed, available, and their anticipated duration on the project
- Any gaps such as needed skill sets or levels of expertise required for the project
- When resources roll off the project
- Any potential training needs

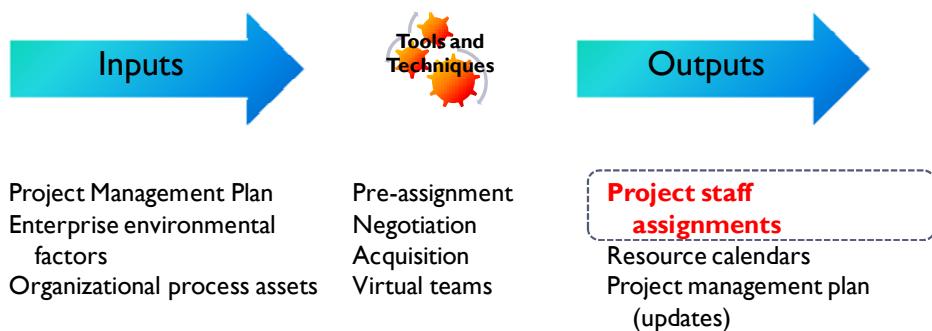
The Staffing Management Plan contains:

- The Resource Histogram: Shows what resources will be needed and at what times in the project
- Staffing Release Plan: Establishes method and timing for releasing resources

The Resource histogram is used to visually chart where resources are needed on the project and the hours needed from each resource on a daily/weekly/monthly basis. An example of a resource histogram appears below.



Acquire Project Team



Exam tip: This means >> ‘acquire the final project team’.

The following actions are included:

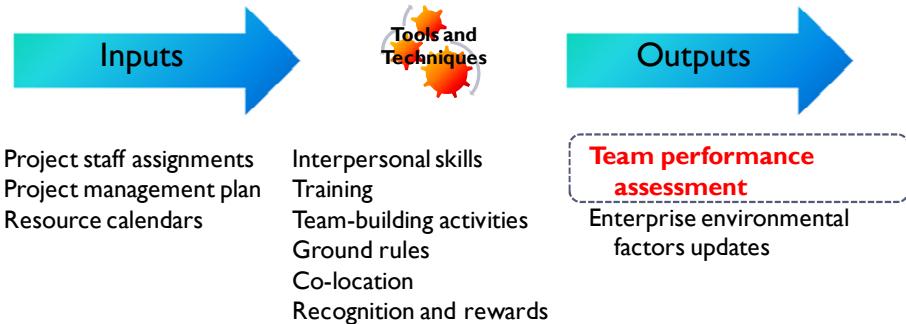
- Know the pre-assigned resources
- Negotiate for the best resources available
- Hire new resources if it is an option
- Bring on contractors/consultants when needed
- Understand the impact of using virtual teams (i.e. non co-located or off-shore)

You may see a question on the exam that relates to a concept called the 'halo effect'. The halo effect is essentially a cognitive bias – for example: because of an individual’s ability to perform well as a tactical planner, the individual’s manager ascribes strategic planning expertise to the same individual. In short, because you are good at one thing, you will be good at everything we ask you to do.

In a psychology study published in 1920, Edward L. Thorndike asked commanding officers to rate their soldiers; Thorndike found high cross-correlation between all positive and all negative traits. People seem not to think of other individuals in mixed terms; instead we seem to see each person as roughly good or roughly bad across all categories of measurement.³³

³³ http://en.wikipedia.org/wiki/Halo_effect

Develop Project Team



The Develop Project Team process is fundamentally about enhancing and improving the overall team environment to increase project performance. Therefore, it is the project manager's job to acquire the necessary skills that will help build, maintain, motivate, lead, and inspire project teams to achieve high performance and meet project objectives.

For the exam, project managers do the following:

- Provide the team with challenges and opportunities
- Offer feedback and support
- Engage in collaborative problem-solving and decision-making
- Utilize effective and open communications between team members and stakeholders
- Manage conflicts in a constructive manner
- Facilitate an environment of teamwork and cooperation

Exam Tip:

Team performance assessments evaluate the entire team for the project as a whole. It is the primary output of the Develop Project Team process.

Project performance appraisals are an evaluation of an individual's performance on the project, and is a tool and technique of the Manage Project Team process

Project Manager Authority

The types of project manager authority are based on authority levels from general management practice. A brief description of these authority types follows:

- **Legitimate** - this authority is then assigned to you by senior management and is outlined in the project charter
- **Reward** - the project manager can issue rewards for exceptional job performance or perks. For example, 'comp time' is usually considered a perk for employees that have expended extra time on the job to meet a deadline.

- **Penalty** - this indicates the power of the project manager to coerce an employee into specific behavior through the threat of penalty, loss of status, or other negative. Writing up an employee for insubordination to force a certain kind of behavior is considered penalty power.
- **Expert** - expert power means that you are an expert in your area. People on the team defer to you or seek solutions from you because of your expertise. Expert power is always earned and never assigned.
- **Referent** – referent power addresses the charisma, personality, and leadership qualities of the project manager. Such a PM can exert a strong influence on a team due to their strong 'likability' factor.
- **Representative** - in this situation the team has decided that you would be the best person to serve the needs and interests of the team and have, in a sense, 'elected' you as their representative.

Expert and reward are the best forms of power according to PMI. The worst is penalty power.

The Tuckman Model

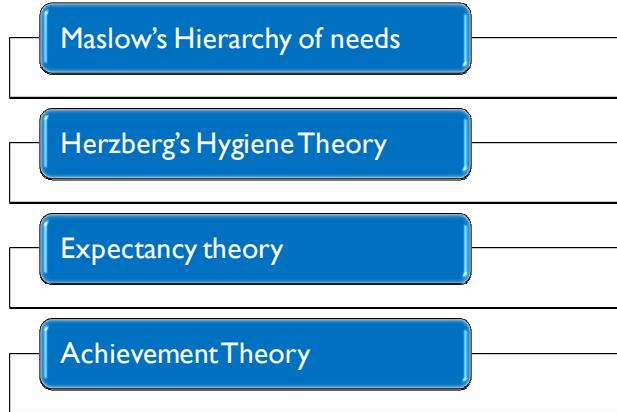
The **Forming – Storming – Norming – Performing** model of group development was first proposed by Bruce Tuckman in 1965, who maintained that these phases are all necessary and inevitable in order for the team to grow, to face up to challenges, to tackle problems, to find solutions, to plan work, and to deliver results. He added a fifth stage – Adjourning – in the 1970's.

Tuckman's model explains that as the team develops maturity and ability, relationships establish, and the leader changes leadership style. Beginning with a directing style, moving through coaching, then participating, finishing delegating and almost detached. At this point the team may produce a successor leader and the previous leader can move on to develop a new team.

The five stages are described as follows:

- **Forming:** High dependence on leader for guidance and direction. Little agreement on team aims other than received from the leader. Individual roles and responsibilities are unclear. Leader must be prepared to answer lots of questions about the team's purpose, objectives and external relationships.
- **Storming:** Team members vie for position as they attempt to establish themselves in relation to other team members and the leader, who might receive challenges from team members
- **Norming:** Agreement and consensus is largely formed among team, who respond well to facilitation by leader. Roles and responsibilities are clear and accepted. Big decisions are made by group agreement. Smaller decisions may be delegated to individuals or small teams within group. Commitment and unity is strong
- **Performing:** The team is more strategically aware; the team knows clearly why it is doing what it is doing. The team has a shared vision and is able to stand on its own feet with no interference or participation from the leader
- **Adjourning:** The break-up of the group, hopefully when the task is completed successfully, its purpose fulfilled

Motivational Theories



You may see reference to any of the four motivational theories shown above on an exam question. You will not see references to any of the above-mentioned theories in the *PMBOK® Guide*, 4th edition, however, it is important that you understand the fundamentals of these theories.

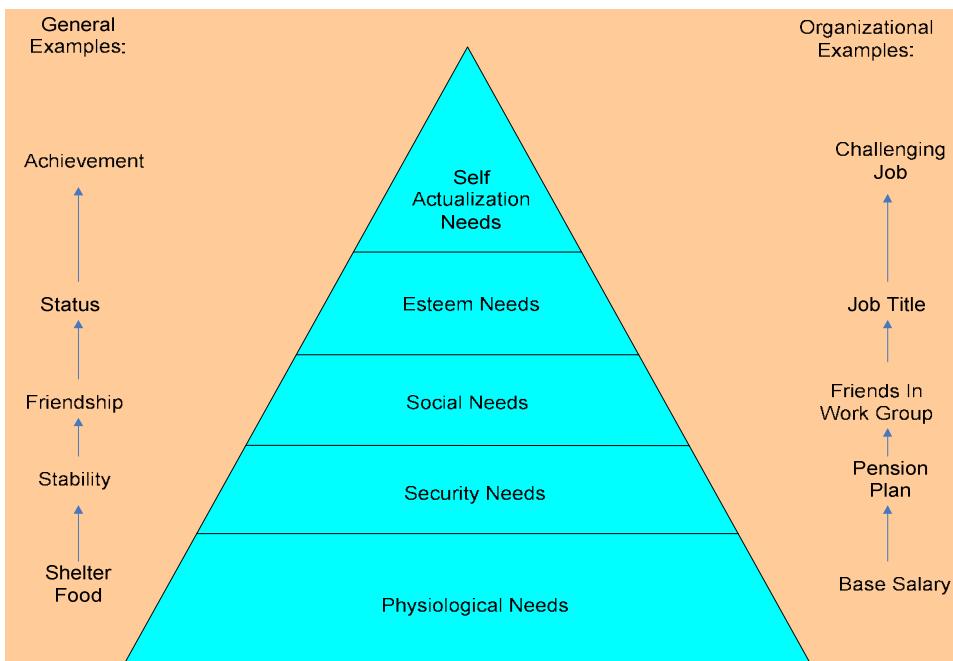
If you have never had any exposure to these theories, see if you can answer the following question, just for fun:

Q: You are a project manager in a matrix organization and are leading a team of people that report to various functional managers. One of these team members seems somewhat distraught; in spite of the fact that you think she's doing a good job on your project, she recently complained to you that her boss (the functional manager) does not seem to take notice of her extra effort on this project. In fact, none of the extra effort that she puts into the job appears to be recognized by her boss at all, and he continues to hammer her for more effort. At this point she is considering looking for another job, as she thinks that nothing she does will make a difference at this company. What motivational theory describes this situation?

- a. Achievement theory
- b. Herzberg's hygiene theory
- c. Maslow's hierarchy of needs
- d. Expectancy theory

(answer: d)

Maslow's Hierarchy of Needs



Psychologist Abraham Maslow first introduced his concept of a hierarchy of needs in his 1943 paper "A Theory of Human Motivation"³⁴ and his subsequent book, *Motivation and Personality*.³⁵ This hierarchy suggests that people are motivated to fulfill basic needs before moving on to other needs.

Maslow's hierarchy of needs represents part of an important shift in psychology. Rather than focusing on abnormal behavior and development (Freud), Maslow's humanistic psychology was focused on the development of healthy individuals.

Herzberg's Hygiene Theory

Frederick Herzberg performed studies to determine which factors in an employee's work environment caused satisfaction or dissatisfaction. The findings were published in his 1959 book *The Motivation to Work*.

The studies included interviews with employees who were asked what pleased and displeased them about their work. Herzberg found that the factors causing job satisfaction (and presumably motivation) were different from those causing job dissatisfaction. He developed the **motivation-hygiene** theory to explain these results. The satisfiers were labeled *motivators* and the dissatisfiers were labeled *hygiene factors*. In this sense, the term "hygiene" means that they are considered maintenance factors that are necessary to avoid dissatisfaction but the presence of these factors does not provide motivation or satisfaction.

³⁴ Maslow, A. H. (1943). A Theory of Human Motivation, *Psychological Review* 50, 370-96.

³⁵ Maslow, A.H. (1943). *Motivation and personality*. New York: Harper.

Herzberg often referred to these hygiene factors as "KITA" factors, (KITA is an acronym for Kick In The A...), which are defined as the process of providing incentives or a threat of punishment to cause someone to do something. Herzberg argues that these provide only short-run success because it is the motivator factors that determine whether there is satisfaction or no satisfaction. These motivators are intrinsic to the job itself, and do not result from 'carrot and stick' incentives.³⁶

Expectancy Theory

While Maslow and Herzberg looked at the relationship between internal needs and the effort to fulfill them, Vroom separates effort (which arises from motivation), performance, and outcomes.

Vroom stated that for a person to be motivated, performance and motivation must be linked. He created three variables (shown above) called Valence, Expectancy and Instrumentality to account for this link.

Expectancy is the belief that increased effort will lead to a specific outcome; i.e. "If I work harder, the boss will reward the extra effort." This is affected by such things as:

1. Having the right resources available (e.g. raw materials, time)
2. Having the right skills to do the job
3. Having the necessary support to get the job done (e.g. supervisor support, or correct information on the job)

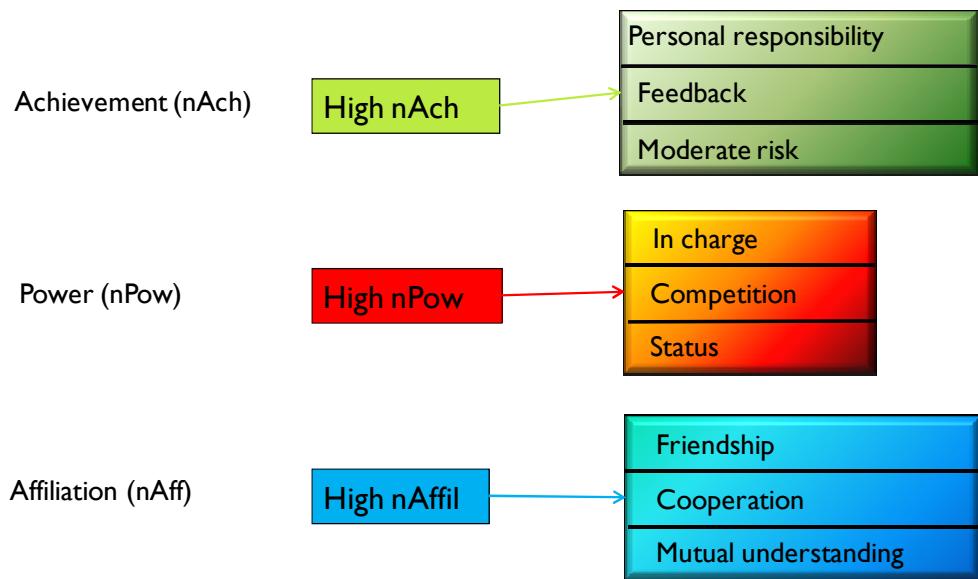
Instrumentality is the belief that if you perform well a valued outcome will be received; i.e. "If I do a good job, there is reward or recognition I can receive."

Valence is the importance the individual places upon the expected outcome. For example, "If I am mainly motivated by money, I might not care about offers of 'comp' time."³⁷

³⁶ Herzberg, F., Mausner, B. & Snyderman, B.B. 1959, *The Motivation to Work*. John Wiley. New York.

³⁷ *Work and Motivation*, Victor Vroom, Jossey-Bass 1994

Achievement Theory



David McClelland is noted for elaborating three areas of motivational need, which he described in his 1961 book, *The Achieving Society*.

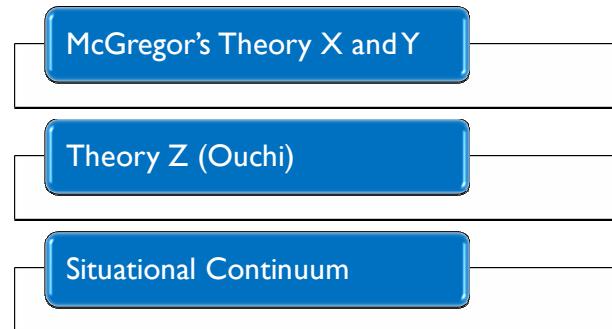
Most people possess and exhibit a combination of all three characteristics.

Some people exhibit a strong bias to a particular motivational need, and this 'needs mix' affects their behavior and managing style.

McClelland suggested that:

- Strong n-affil 'affiliation-motivation' can undermine a manager's objectivity because of their need to be liked, which affects the manager's decision-making capability.
- Strong n-pow 'authority-motivation' will produce a determined work ethic and commitment to the organization, however n-pow people are attracted to the leadership role and may not possess the required flexibility and people-centered skills.
- Strong n-ach people with strong 'achievement-motivation' make the best leaders, however there can be a tendency to demand too much of their staff in the belief that they are all similarly and *highly* achievement-focused and results driven.

Leadership Theories



In addition to the specific theories listed above, there is a listing of various leadership and management styles that may be referenced on exam questions. These elements are included in what you'll find discussed in the three leadership theories outlined on the next pages:

- Analytical - a manager with technical expertise that makes technical decisions for the project
- Autocratic - the PM has power to do whatever they want
- Bureaucratic - as the title implies, this management style focuses on following documented procedures exactly without deviation. This may be necessary on work involving government contracts such as DOD contracts or contracts with state and city government
- Charismatic - motivates the team to high levels of performance because of an energizing leadership style.
- Consultative - seeks input from the team to make decisions on the project
- Driver - issues orders and expects them to be followed. Some view this approach to management as 'micromanagement'.
- Influencing - this approach emphasizes collaborative decision-making and focuses on teamwork and team building.
- Laissez-faire - here the manager functions in a consultative capacity and basically stays out of the way while the team focuses on the work at hand. Sometimes this approach is called a 'self organizing team'.

Theory X and Y

This was created and developed by Douglas McGregor at the MIT Sloan School of Management in the 1960s. It describes two very different attitudes toward workforce motivation. McGregor felt that companies followed either one or the other approach. He also thought that the key to connecting self-actualization with work is determined by the managerial trust of subordinates.

Theory X

In this theory, which many managers practice, management assumes employees are inherently lazy and will avoid work if they can. They inherently dislike work. Because of this, workers need to be closely supervised and comprehensive systems of controls developed. A hierarchical structure is needed with narrow span of control at each and every level. According to this theory, employees will show little ambition without an enticing incentive program and will avoid responsibility whenever they can. According to Michael J. Papa, researcher in organizational communication, if the organizational goals are to be met, theory X managers rely heavily on threat and coercion to gain their employee's compliance.

Theory Y

In this theory, management assumes employees *may be* ambitious and self-motivated and exercise self-control. It is believed that employees enjoy their mental and physical work duties. According to Papa, to them work is as natural as play. They possess the ability for creative problem solving, but their talents are underused in most organizations. Given the proper conditions, theory Y managers believe that employees will learn to seek out and accept responsibility and to exercise self-control and self-direction in accomplishing objectives to which they are committed. A Theory Y manager believes that, given the right conditions, most people will want to do well at work.

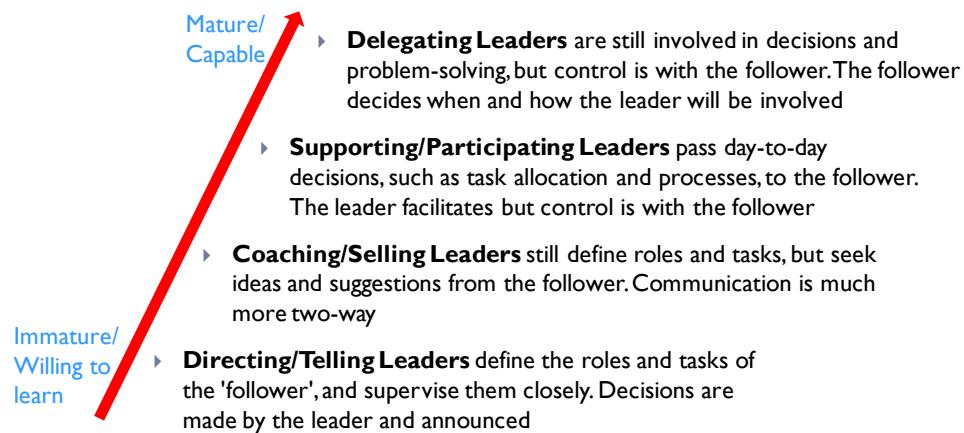
Theory Z

In **THEORY Z**, Ouchi describes the art of Japanese management and shows how it can be adapted to American companies. He takes readers behind the scenes at several U.S. corporations making the Theory Z change and shows step-by-step how the transition works. Ouchi also examines the corporate philosophies that have become blueprints for Theory Z success, and looks at the evolving culture of "Z" people in society.

Theory Z focused on increasing employee loyalty to the company by providing a job for life with a strong focus on the well-being of the employee, both on and off the job.

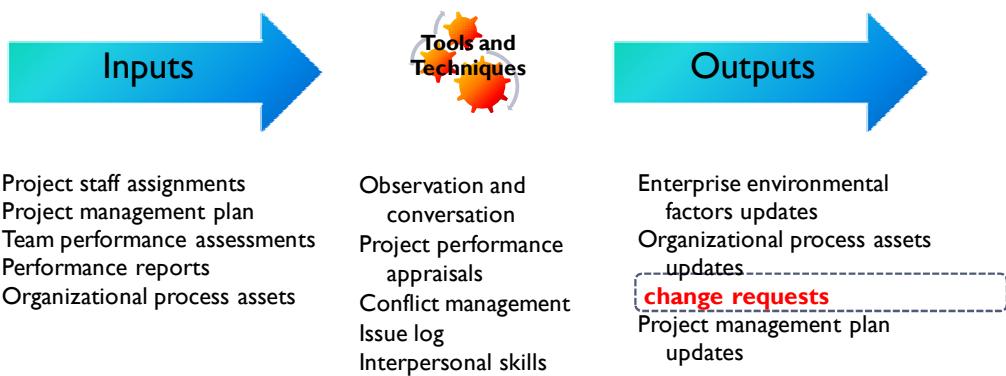
Theory Z management tends to promote stable employment, high productivity, and high employee morale and satisfaction.

Situational Leadership



The situational leadership model was developed by Paul Hersey and Ken Blanchard in the 1960s and is sometimes called the 'situational continuum'. What this means is the manager of a team will apply more influence and direction to managing inexperienced employees. As the team members grow in skill and capability, the manager moves from a directing approach (telling the employee exactly what to do) to a delegating approach (the employee knows the job, does the job, needs very little guidance, and will engage the manager when needed).

Manage Project Team



The Manage Project Team process specifically tracks team member performance on the project, provides feedback to team members, helps to resolve issues, and manages changes to project processes. The key element in managing the project team is the creation of change requests, updating the human resource plan, and updating the enterprise environmental factors and organizational process assets.

Since Manage Project Team occurs in the Executing process group, the project manager needs a battery of skills to create and sustain high performance teams.

The skills include:

- Communication Skills
- Conflict Management Skills
- Negotiation Skills
- Leadership Skills

Exam tip:

Team performance assessment addresses the effectiveness of the team as a whole. *Project Performance Appraisals* address the performance of individuals on the team.

Conflict Management

Old View of Conflict	New View of Conflict
Is inevitable	Is necessary
Is negative	Has benefits
Should be avoided	Allows team to grow
Best resolved by avoidance or upper management intervention	Produces more creative project solutions
	Best resolved by team members and their immediate manager

Performed successfully, addressing conflicts and bringing them to desired resolutions can result in increased productivity and improved working relationships between team members. If conflicts escalate, it is the project manager's job to help facilitate a resolution.

For the exam, understand the following:

- Conflict forces a search for alternative solutions
- Conflict is a team issue
- Conflict resolution focuses on issues, not personalities
- Openness resolves conflict
- Conflict resolution focuses on the present, not the past

Causes of Conflict

There can be many causes of conflict on a project – however the list of seven below is in descending order of frequency.

- **Schedule** - schedule conflict can be due in part to the unavailability of resources when needed, however the real cause of schedule conflict is primarily due to this reason: management's insistence on a defined schedule in the initiating phase of a project when very little is known about the project itself. If the project faces a significant number of unknowns and uncertainties it will be very difficult if not impossible to establish an accurate schedule early in the project.
- **Project Priority** – frequently, management fails to prioritize projects. This in turn leads to stakeholder conflict about project priorities and a battle, or a series of battles ensues, usually centering around funding and resource levels for the current project load.
- **Resources** - resource availability can in itself be a conflict, even if project priority is not a conflict. This is especially true if a number of projects require highly qualified resources that are scarce in the organization. The resource conflict will occur if the organization cannot add headcount either permanently or temporarily with the use of consulting resources.
- **Technical opinions** - this can be an issue when there are highly skilled and experienced resources that have differing ideas on how to approach a technical solution for project. A skilled Project manager will be able to facilitate a solution between battling technical experts.
- **Administrative overhead** - administrative processes can be seen as burdensome or can be seen as out-and-out obstacles to the completion of work on the project. If project team members are complaining about the extraordinary amount of administrative overhead required in completing work, the project manager needs to pay attention to what can be done to streamline those processes so that the administrative processes do not become more work than the *actual* work.
- **Cost** - budgets can sometimes be a source of contention on a project. The inability to purchase/lease key pieces of equipment, software licenses, hire consultants or add headcount due to budget constraints can critically hamper project progress. Here an effective project manager can help a project achieve its budget needs by socializing those needs with senior management.
- **Personality** - let's face it; some people on the project team just don't seem to get along no matter what you do. It's like trying to mix oil and water. An experienced project manager will either attempt to resolve the conflict peaceably through discussions with the feuding parties or will look for areas where they can work on the team where they will not have much contact with each other. In either case, sometimes personality disagreements can result in someone self-organizing off the team due to irreconcilable differences.

Conflict Resolution Methods

The following are considered the fundamental conflict resolution methods:

- Confrontation - facing the issue head on; solving the problem
- Collaborating – Driving consensus by incorporating multiple viewpoints
- Compromise – each side gives up something and everyone is dissatisfied; a ‘lose-lose’ scenario
- Forcing – e.g. ‘my way, or the highway’

- Smoothing – avoids addressing the issue directly and applies a band-aid
- Withdrawing – a complete avoidance of the issue; postponing a decision

According to PMI:

- The best approach is confronting the issue followed by collaborating
- The worst approach is forcing
- Compromise, smoothing and withdrawing can lead to ‘lose-lose’ situations

For the resolution of conflicts, ensure that an issue log is established with an owner and a due date for resolution.

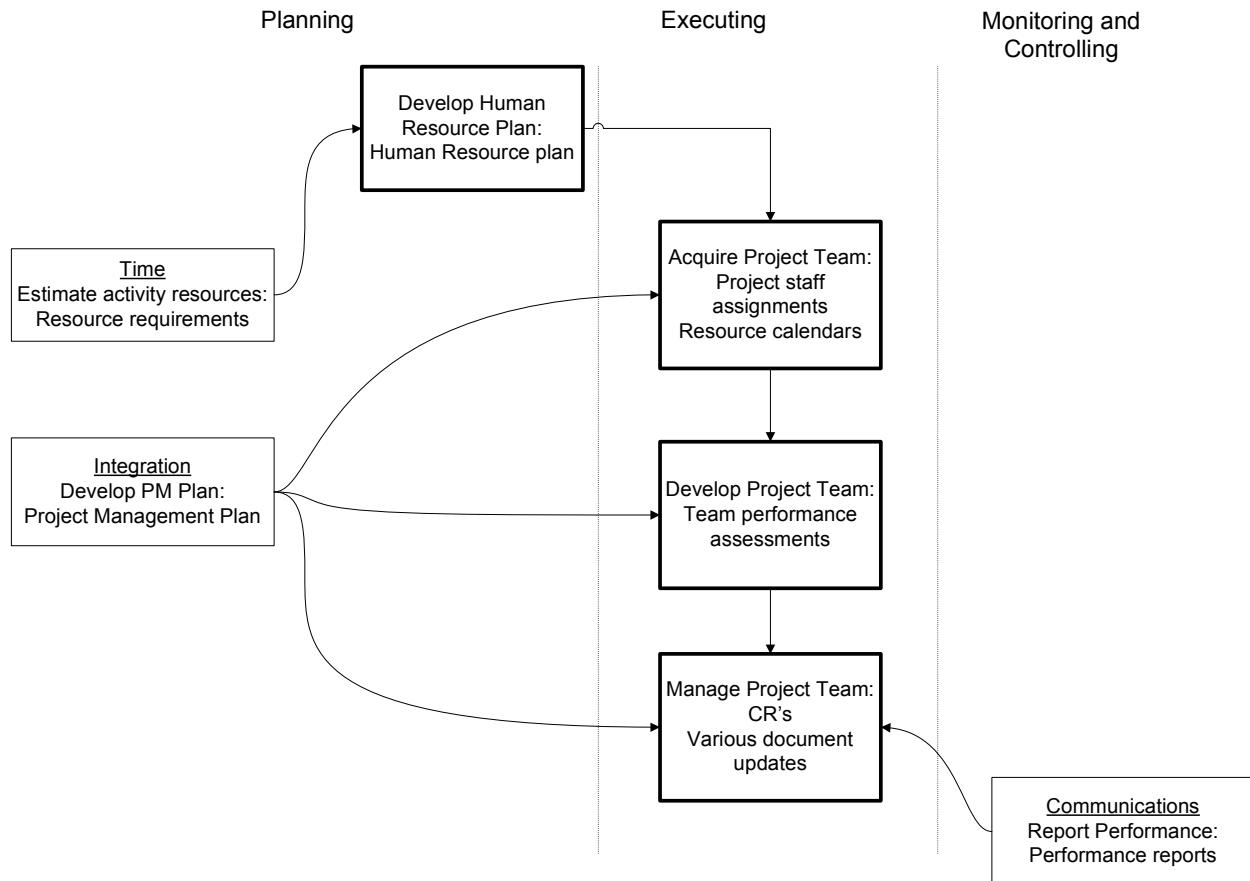
PMI also states that the PM should decide on the most appropriate resolution method.

For the project manager, there is a brief listing of interpersonal skills that not only contribute to conflict resolution scenarios but that help drive to the strengths of the project team members. Key skills are:

- **Leadership** - imparting vision and inspiring the team to achieve high performance
- **Influencing** - particularly important in a matrix environment in which the project manager may have little direct authority over the team members. In this case, the ability to influence stakeholders becomes a key component in project success. Effective skills in this area include:
 - Interactive listening skills
 - Clear articulation of points of view and the ability to be persuasive
 - Seeing all sides of the issue from your stakeholders perspectives
 - Being a trusted resource - not taking sides when addressing stakeholder issues
- **Effective decision-making** - Strong negotiation skills to influence the organization for the success of the project

Project Human Resource Management: Key Process Interactions

The key inputs from the other Knowledge Areas to Project Human Resource Management processes are shown below. *Know these process interactions for the exam.*



In Summary...

This section discussed HR management, including:

- The need for a responsibility matrix
- The HR responsibilities of the PM
- Authority levels of the PM and which are the best
- Benefits of team building
- Concepts driving various motivational theories
- Techniques used to manage and resolve conflict

Chapter Nine Memory Check

1. The processes in the Project Human Resource Management knowledge area occur in the _____ and _____ process groups of the Project Management Life cycle
2. The role that accepts the product of the project and provides financial resources for the project is the _____ whereas the role that sets organizational priorities between projects and the triple constraints is performed by _____
3. The _____ and _____ grid identifies activities, documents, and other deliverables along with the person accountable for those activities
4. Develop Project Team is in the _____ process group and has the key output of _____
5. The two forms of project manager authority that PMI states are the most effective are _____ and _____
6. The four stages of team growth according to the Tuckman Model are, in order, _____, _____, _____, and _____
7. The psychologist who introduced his concept of a hierarchy of needs was _____
8. The management theory that assumes the average person dislikes work, has no ambition, avoids responsibility and is not too intelligent is entitled _____
9. _____ focused on increasing employee loyalty to the company by providing a job for life with a strong focus on the well-being of the employee
10. A key output of the Manage Project Team process is _____
11. PMI considers _____ as the best approach in resolving conflict while it considers _____ the worst approach
12. The leadership model in which the manager of a team applies more direction to managing inexperienced employees, and then moves to a delegating approach as the team members grow in skill and capability is called _____
13. Frederick Herzberg found that the factors causing job satisfaction (and presumably motivation) were different from that causing job dissatisfaction. He called the _____ elements that, if not satisfied, would lead to job dissatisfaction
14. _____ is the belief that increased effort will lead to increased performance; i.e. "If I work harder, the outcome will be better".
15. The top three causes of conflict on a project are: _____, _____, and _____
16. _____ addresses the effectiveness of the team as a whole, while _____ address the performance of individuals on the team
17. The concept that individuals are motivated by the need for power, achievement and affiliation is known as _____, developed by David McClelland
18. The type of power that a PM can exhibit by offering perks or other benefits is called _____ power

Chapter Nine Test

1. The hierarchy of needs is a motivational theory developed by:
 - a. Herzberg
 - b. McGregor
 - c. Maslow
 - d. McClelland
2. Your project is well underway and you have called for the first kickoff meeting with your stakeholders and your project team members. At this meeting, some of the stakeholders expressed bewilderment and wonder why you have been chosen to head the project. One of the stakeholders exclaimed, "You're not even in this division, how is it that you were chosen to head this project?" Anticipating this concern, you prepared copies of the project charter, which you pass out to all the group participants. Since the charter names you as the project manager, the type of authority that this displays is known as:
 - a. Expert
 - b. Referent
 - c. Legitimate
 - d. Representative
3. The PM has been called by two of your project stakeholders to help resolve an issue. He sets up a brief meeting with the two stakeholders to listen to their concerns about a particular aspect of the current project. After hearing their concerns, his comment to both stakeholders is this: "I think you both made some good points here. Jerry, I think if we take part of your solution and combine it with some of Bill's ideas, I think we can bring this to a successful conclusion." What type of conflict resolution technique was being employed by the project manager?
 - a. Smoothing
 - b. Confronting
 - c. Withdrawing
 - d. Collaborating
4. At the last progress meeting, some of the team members thought that they were going above and beyond the call of duty in delivering certain aspects of the project. The project manager agreed and thought that since these key members were carrying some extra responsibility, the project could afford some special rewards such as having dinner brought in after 6 p.m. and comp time for the extra hours expended by these employees. This type of reward is called:
 - a. Fringe benefit
 - b. Perk
 - c. Team building
 - d. Entitlement award
5. A resource histogram shows all of the following except:
 - a. Number resources at any given time
 - b. Specific activities
 - c. Resource utilization
 - d. When resources come on or off the project
6. A line manager in your organization is particularly difficult when dealing with project team members. He is suspicious of their work habits and feels that he must constantly micromanage their activities to ensure that the job gets done. This type of manager is known as:
 - a. Theory X manager
 - b. Theory Y manager
 - c. Expectation theory manager

- d. Achievement theory manager
7. What is a *key* responsibility of the sponsor for a project?
- a. Review requirements
 - b. Creating the project management plan with the PM
 - c. Protecting the project from outside influences
 - d. Gatekeeper for unneeded changes
8. Theory Z is a leadership theory created by:
- a. W Edwards Deming
 - b. Bruce Tuckman
 - c. William Ouchi
 - d. Ken Blanchard
9. The Human resource plan is an output of the Develop Human Resource Plan process. Which of the following will *most likely* be created in support of this activity?
- a. WBS Dictionary
 - b. Stakeholder Register
 - c. Risk Breakdown structure
 - d. Responsibility assignment matrix (RAM)
10. Senior management has received ongoing progress reports on the current project you are managing. It seems that one of the technical team has done an outstanding job of delivering certain aspects of the product in development, and management has taken notice. A Sr. VP has commented to you that they would like to move this resource onto the strategic planning team because of his outstanding job in the development area. In management this is known as:
- a. The Achievement effect
 - b. The Halo effect
 - c. The Expectancy effect
 - d. The Hygiene effect
11. At the last team meeting, several of the team members were tasked with delivering a short presentation to some of the stakeholders on certain product features under development. When the presentation has completed, one of the stakeholders asked a team member, who was responsible for delivering a specific set of features for one of the product components? The team member appeared a bit flustered and asked the PM for assistance with the question. What is *most likely* what the PM forgot to do?
- a. Create a WBS
 - b. Create Resource breakdown structure
 - c. Create a RACI matrix
 - d. Create a staffing management plan
12. The Roles & Responsibility matrix is best described and used for which of the following?
- a. When a resource is available for work
 - b. Defining ownership of project deliverables
 - c. The specific job and deliverables due date
 - d. The job and the reporting relationship to the next higher organizational level
13. The project manager is in the process of developing the human resource plan for the project. What is the *most likely* tool and technique she would use to help create the human resource plan?
- a. Staffing management plan
 - b. Roles and responsibilities
 - c. Resource breakdown structure

- d. Risk assessment matrix
14. What motivational theory proposes that factors which act as dissatisfiers on a job will de-motivate the employee and become an obstacle to achievement?
- Hygiene theory
 - Expectancy theory
 - Theory Z
 - Situational continuum
15. When discussing a recognition and rewards system on your current project, senior management has been reluctant to agree to this aspect of human resource planning. In fact, one senior VP made some decisions regarding the triple constraints on the project that not only created scheduling problems for the team, but also imposed some unrealistic expectations on the team as well. As a result, certain deliverables were missed and VP wants the individuals who were responsible for these missed deliverables to be punished. As the project manager, what is the most appropriate response to the VP's request?
- You will honor the VPs request, offer up the names of individuals who were responsible, and agree on an appropriate punishment.
 - The VP was the one who caused these problems and should own up to his own mistakes.
 - Resources should not be punished for poor planning and unrealistic expectations imposed by senior management
 - You escalate the issue to the president of the company, stating that the missed deliverables were the result of the VP's managerial incompetence.
16. What are the five phases of the Tuckman model in order?
- storming, forming, performing, norming, adjourning
 - forming, storming, norming, performing, adjourning
 - norming, performing, storming, adjourning, forming
 - performing, norming, forming, adjourning, storming
17. A new position in the company has been posted for a new senior manager with a very specific set of skills. One of your team members approaches you and asks about the position in confidence. You set up a meeting with this individual who asks you a series of questions about the position and concludes by saying, "I've seen a lot of positions like this posted but I don't think it will do me any good to apply for the job. It seems that when the company does something like this they already have the person in mind for the job but they simply have to post a job as a matter of corporate policy. I think my chances are slim to none of actually getting this job." What is being described here?
- Expectancy theory
 - Fait accompli
 - Hygiene theory
 - Hierarchy of needs
18. An issue log will contain all of the following *except*:
- A due date
 - An owner
 - A probability
 - A resolution
19. You've got some inexperienced team members in your organization - inexperienced but very bright. In working with them for the last six months you have changed your management approach from one of telling them how to do their jobs to the point where you're coaching these team members when they come to you with questions. A few of them are very close to the point where you could simply delegate

the work and step back, instructing them to call you if they run into difficulty. This describes something called:

- a. Achievement theory
- b. Situational continuum
- c. Delegation authority
- d. Progressive responsibility transfer

20. Someone on the technical team who was working on a production emergency into the wee AM hours made an error that impacted the production system; he was so focused on the emergency that he forgot to run a repayment tape that caused another day of interest to be charged to the brokerage at a cost of \$25000. The group VP was furious and called you with a demand: "Give me the name of the idiot that screwed this up!" As the project manager what would be your *best* response?
- a. You agree to identify the resource – professionals need to own up to their mistakes
 - b. You refuse to identify the resource – the production fix saved the company far more than the cost of the error
 - c. You ask the VP what would be gained by punishing the resource – mistakes are part of the learning process
 - d. You agree but first ask the VP what he plans to do with the resource; this event highlights an unusual and unexpected risk situation that needs to be addressed first
21. Of the major causes of conflict on a project, which of the following generally causes the *greatest* conflict?
- a. Technical opinions
 - b. Schedule constraints
 - c. Design constraints
 - d. Personality differences
22. Which is not a motivational theory?
- a. Expectancy
 - b. Achievement
 - c. Tuckman model
 - d. Hierarchy of needs
23. At the last progress meeting, several stakeholders and team members got into an intense disagreement on how certain components in the current project should be constructed. One stakeholder wanted one of the components constructed using a specific technology (the stakeholder used to be a former IT resource). The technical team strongly disagreed - the technical team lead stated that while the stakeholders could describe *what* they wanted, it was up to the technical team to determine *how* they were going to best deliver it. The argument dragged on. After an hour, the stakeholders and the team members were no further along. Before you could speak, a senior VP who was also at the meeting stepped in and said the following, "This bantering is getting old. Either you figure out how to solve this problem or I will make a decision for you." The type of conflict resolution approach being used here is:
- a. Confronting
 - b. Collaboration
 - c. Forcing
 - d. Compromising
24. You have just been assigned a new project and met the project team for the first time. At this first meeting a number of the team members challenge you and question your ability to effectively lead the team. What is the *best* type of project manager authority you could possess that would help put the team on your side and earn their respect?
- a. Legitimate
 - b. Referent

- c. Reward
 - d. Expert
25. Many organizations claim to do teambuilding activities with their employees. Which of the following would be the *most effective* teambuilding activity for a new team that has just been formed?
- a. Organize a red team/blue team game of capture the flag - after work
 - b. Meeting for drinks after work (you're buying the first round)
 - c. Gather the team in a meeting room for 2 hours to informally discuss the new project. Have the event catered and have some 'fun and games' afterwards (e.g. ring toss and 'pin the tail on the manager', etc...)
 - d. Organize a baseball outing during a standard workday at your local MLB team - arrange to talk with some of the baseball players after the game about how they work as a team

Chapter 9 Test – Answers

1. C – The hierarchy of needs was developed by Abraham Maslow
2. C – The project charter gives you legitimate authority on the project
3. D – This best describes a collaboration between the stakeholders
4. B – This is a perk. Fringe benefits are something all employees receive. Team building is an all-team activity. Entitlement award is made up.
5. B – Resource histograms do not show specific activities
6. A – This is a definition of a theory X manager
7. C – In this answer set, the sponsor's key responsibility is to protect the project from outside influences. The sponsor does not review requirements as a key element, and does not create the PM plan or protect the project from unneeded changes (the PM's job)
8. C – By definition, William Ouchi
9. D – The WBS is created in Scope planning, Stakeholder Register in Communication Initiation and the Risk Breakdown Structure in Risk Planning. The only remaining logical choice is the Responsibility assignment matrix.
10. B – This is how the Halo effect is defined. All the other answers are made up
11. C – The RACI matrix would have cleared up this problem
12. B – The RACI matrix defines deliverables and their ownership. Resource calendars show resource availability, deliverables and due date is defined in detail in the WBS dictionary and answer 'D' defines resource breakdown structure
13. C – A key tool and technique is org charts and position descriptions – a resource breakdown structure fits this description
14. A – The hygiene theory describes the dissatisfiers in detail
15. C – The project team should not be punished for poor planning and unrealistic expectations imposed by senior management. *PMBOK® Guide*, 4th edition, p. 234
16. B – This defines the correct sequence: forming, storming, norming, performing, adjourning. *PMBOK® Guide*, 4th edition, p. 233
17. A – This describes a classic expectancy theory scenario
18. C – Probabilities of occurrence are contained in a risk register.
19. B – This describes the progression of the situational continuum
20. D – All these answers are in some respect, correct. However this best describes a unique risk situation that may not have occurred in the past. Blaming the resource in effect, does no good – this is a process issue not a resource issue
21. B – Schedule constraints are the number 1 cause of project conflict
22. C – The Tuckman model describes team development
23. C – The exec is forcing the situation
24. D – Expert power is considered the best type of PM authority by PMI
25. D – 'A' and 'B' are after work activities – usually a bad time for 'team building' exercises (people have children to care for and prior commitments). Option 'C' is too transparent a management promoted team building effort. The best team building efforts generally involve the team off-site where management can get to know their team members as individuals. Even if you are not a fan of baseball, the idea that you can consult a highly productive professional team about how they handle their own team building activities, can be useful to your organization.

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Chapter 10 : Project Communications Management

Section Topics:

- ▶ Identify Stakeholders
- ▶ Plan Communications
- ▶ Distribute Information
- ▶ Manage Stakeholder Expectations
- ▶ Report Performance

Section Objectives

After completing this section, you will be able to:

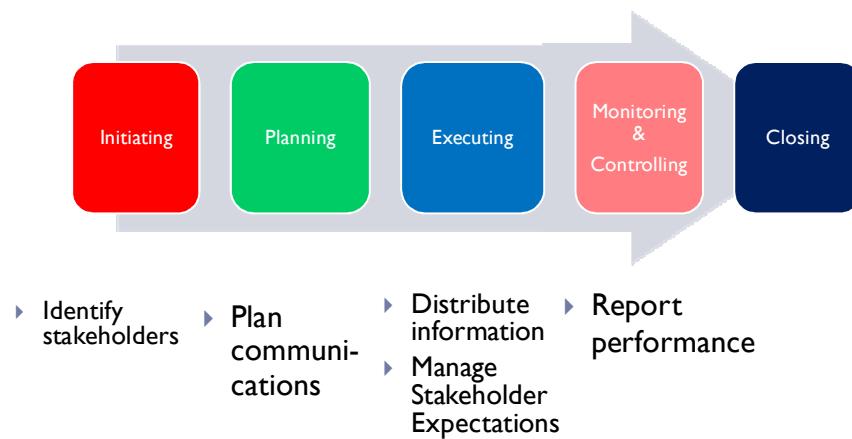
- Explain the importance of project communication
- Describe stakeholders and perform a stakeholder analysis
- Develop the stakeholder register
- List the components of a communications management plan
- Discuss the communications model
- Manage stakeholder expectations
- Determine which form of communication is appropriate
- Discuss the types of performance reviews

Project Communications Management Process Summary

The high level Project Communications Management output elements, by Process Group are:

Initiating	Planning	Executing	Monitoring and Controlling	Closing
-Stakeholder register -Stakeholder management strategy	Communications management plan	-CR's -Various document updates	Performance reports CR's	

Project Communications Management



Project communications management identifies the processes required to assure the collection, generation, distribution, storage, retrieval, and the timely disbursement of project information to all project stakeholders and project team members.

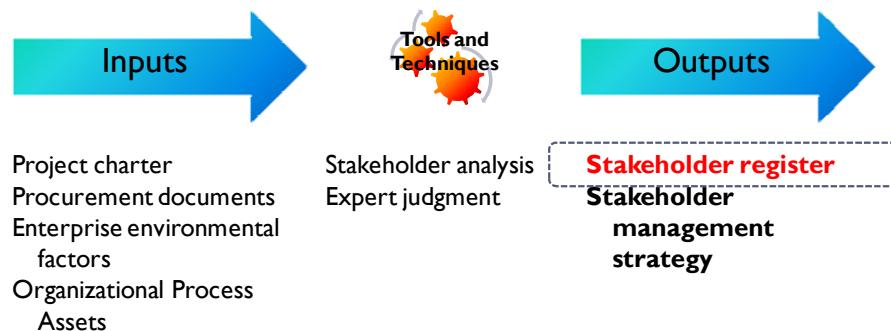
Identify Stakeholders, which occurs in the Initiation phase, identifies all people or organizations that are impacted by the project.

Plan Communications identifies how stakeholder needs will be met, as well as defining an approach to Project communications.

Distribute Information addresses how information will be made available to project stakeholders. Manage Stakeholder Expectations defines the process of working with stakeholders to meet their needs and address issues.

Report Performance addresses the process of collecting and distributing team and project performance information, as well as status reports, measurements, and forecasts.

Identify Stakeholders



Identify Stakeholders is the process of identifying all individuals or organizations that can be positively or negatively impacted by the project, and documenting their influence, impact, interest, and involvement on project success.

This is a key area in the project management process, as many projects fail due to a lack of complete stakeholder identification.

Most projects will have a large number of stakeholders, and it is a project manager's job to identify stakeholders and understand the impact of the project on their specific business areas. In this respect, the project manager's job amounts to a relationship management function.

The key output of this process is to create a stakeholder register which identifies in great detail, everything about the stakeholders on the project.

Stakeholder Analysis



For the exam, stakeholder analysis fundamentally involves three steps:

1. Identify all potential stakeholders and document all relevant information, such as influence level, project interest level, specific skill set and business knowledge, their role on the project, their operational department and their decision-making authority.
2. Identify the impact level the stakeholder has on your project, either positive or negative, and define useful strategies to deal with issues or concerns. Power grids are an effective graphical tool to identify stakeholder influence (see next page).
3. Assess how key stakeholders may respond to specific situations (i.e. determine stakeholder 'hot buttons'), and develop approaches to influence or enhance their support of the project.

EXAM TIP: Know the three "I's" of Stakeholders: Interest, Importance and Influence

For Example, this can all be represented in a Stakeholder Analysis Matrix:

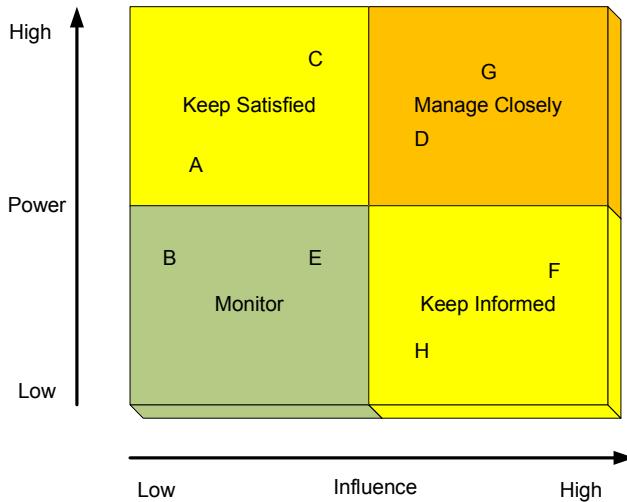
Stakeholder	Stakeholder Interest	Impact Assessment	Support Strategy

Power/Interest Grid

Multiple models are used to classify stakeholder Power/interest/influence:

- Power/interest: Grouping stakeholders based on authority (Power) and interest
- Power/Influence: Grouping stakeholders based on authority and influence (Involvement)
- Influence/Impact: Grouping stakeholders based on influence and project impact (ability to effect change)
- Salience Model: Grouping based on power to influence, urgency (immediate need for attention) and legitimacy (appropriate involvement)

A Power/Interest grid is a useful graphical tool to identify stakeholder influence on a project. A variant called a **power/influence grid** appears below:



This grid identifies two vectors: power and influence. In this case, Power means that the stakeholder can stop your project 'dead in the water' if dissatisfied with the results. Influence, in this case, means that the stakeholder can influence the direction of your project and influence change on the project as well. When Power and Influence are both low, the project manager needs to monitor the situation regularly. When dealing with a stakeholder whose power and influence are both high, the project manager should maintain constant communication with that stakeholder to ensure the project is proceeding to the stakeholder's satisfaction, and that issues are addressed immediately.

Stakeholder Register

Project:				Start Date:						
Name	Position	Location	Role on project	Contact data	Key requirements	Major Expectations	Classification: I - Internal E - External	Impact: S - Supporter N - Neutral	Impact/ Influence Level: 1-10	Comments
Joe	Director	Los Angeles	Software Development Lead	813-555-1234	Resources must be dedicated	Collaboration and adequate testing	I	S	5/7	

An example of a stakeholder register, shown above, includes all information about the stakeholder, including their power, impact, and influence level on the project. The register can also include information about whether they generally support the Project, are neutral about the project, or have issues with the project that need to be addressed. A brief example is shown above, for display purposes only. The list of elements in the register can include, but are not limited to, the following elements:

- Name
- Formal Position

- Location
- Role on Project
- Contact Information
- Preferred communication method
- Key Project Requirements
- Project Expectations
- Stakeholder Classification
- Stakeholder Influence
- Stakeholder Impact
- Senior Management Direct Report
- Significant Issues or Constraints
- Additional Information

Stakeholder Management Strategy

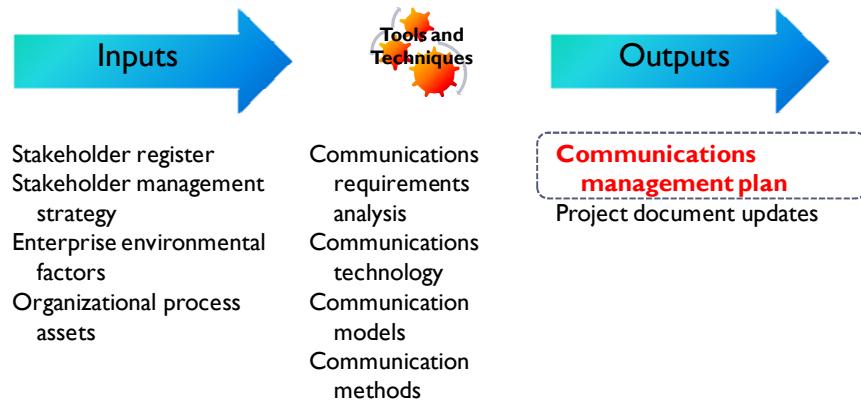
What if you're dealing with stakeholders who view your project as a significant negative, causing them to do extra work, or at worst, impact the livelihood of the people in their department? If you don't have a strategy for dealing with stakeholders who may be less than enthusiastic about the project, your project may experience significant roadblocks or outright resistance from stakeholders.

Therefore it is critical to find out which stakeholders may be negatively impacted by your project from the beginning and identify strategies for removing obstacles for stakeholders and gaining their support.

Quick Quiz: How would you handle the following scenarios and the stakeholders?

- This stakeholder is a business user who is highly knowledgeable and worried about the project impact on her area. She has high interest, but low power on the project. Her team will have to learn new processes in a very short period of time.
- The stakeholder has a sign-off responsibility but has little influence on the direction of the project. There are certain aspects of the project that he doesn't understand.
- The stakeholder has a high interest and a high influence on the project - her team is delivering the software solution, and she has concerns about the aggressive development timeline.
- The stakeholder has a moderate interest in the project, but high influence on the testing phase of the project. He strongly supports the project.
- The stakeholder has little interest in the project, as it only involves them peripherally, but has sign-off responsibility for certain project deliverables.

Plan Communications



The Plan Communications process involves determining the information needs of stakeholders and defining a communications approach to the stakeholders. It addresses the five ‘w’s + ‘h’: *who* needs information, *what* information is needed, *where* is it to be delivered, *when* and with what frequency it is to be delivered, *why* is information important, and finally *how* will it be delivered.

Since distribution methods vary widely depending on the distribution of the project team, it is critical that the communications management plan addresses all these variables, and identifies the means for meeting the communication needs of all the stakeholders.

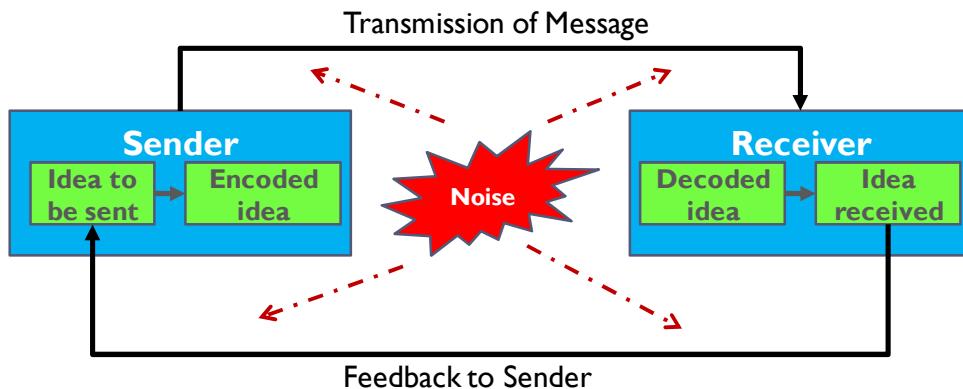
Communications Management Plan

The key output of Plan Communications is the creation of the Communications Management Plan. The primary tools for delivering the communications management plan include the following:

- Communications Requirements Analysis - determines the information needs of the project stakeholders. This can be accomplished by interviewing all stakeholders and determining their specific communications needs for the project.
- Communication Technology - defines the technology needed for the project communications. This can range from face-to-face meetings to video and audio communications platforms designed to facilitate meetings of distributed teams. Also, it addresses whether the technology needed for such communications is available, and whether stakeholders have access to the needed technologies.
- Communication Models - will generally follow the encode-message-medium-decode process. See the following page for the sender-receiver communication model.
- Communication Methods - there are a number of communication methods, however, they can be broadly classified into three following approaches:
 - **Interactive Communication** - this is between two or more parties if there is multidirectional exchange of information. This is the most common and most effective of the communication methods.

- **Push Communication** -this type of communication validates the message were sent, but does not validate that the message was delivered or that it was actually read by the recipient. This type of communication includes reports, e-mails, faxes, voice mail, letters, memos, etc.
- **Pull Communication** - this approach is generally used for large volumes of information, or for a large audience set that can access communications at their discretion. This can include intranet sites, e- learning sites, commercial databases, knowledge repositories, etc.

Communication Sender-Receiver Model



The Mathematical Theory of Communication co-authored by Claude Elwood Shannon and Warren Weaver in 1948, has become the most widely adopted sender-receiver communication model. The Shannon-Weaver model, combined probability theory with something Shannon called ‘information entropy’, which measured the uncertainty in a message. The sender- receiver model consists of:

- An encoded idea - in a form that the receiver can understand
- The message and feedback - the output of encoding
- Medium - the medium is the message is transmitted over
- Noise level - any environmental disruptions that can impact the reception of the message
- The decoded idea - the receiver's interpretation or understanding of the received message

It is the sender's responsibility to make sure that the information is clear and complete and to ensure that the message is correctly understood. It is the receiver's responsibility for ensuring the message was received in its entirety, understood and acknowledged to the sender.

Effective Listening consists of three basic building blocks:

1. **Feedback**
2. **Active Listening**
3. **Paralingual (vocal expression)**

Active Listening

The process of active listening basically involves the four following steps:

1. Look at the person, and suspend other things you are doing.

2. Listen not only to the words, but the feeling content.
3. Be sincerely interested in what the other person is talking about.
4. Restate what the person said.

Effective Communication consists of the following elements:

1. Non-verbal (body language)
2. Paralingual (vocal expression)
3. Feedback

Management expert Peter Drucker noted that when a message is sent up from the lowest levels to senior management, the noise level doubles and the meaning of the message is cut in a half as it passes through each level in the organization's corporate hierarchy.

Communication Hierarchies

Complexity of team communication grows almost exponentially as the team size doubles based on the following formula:

Where N = the number of team members

Therefore:

- Lines of communication for a 5 person team = 10
- Lines of communication for a 10 person team = 45
- Lines of communication for a 40 person team = 780

$$\frac{N(N-1)}{2}$$



Brain Dump!

The formula above is to be memorized for the exam. There are usually some tricky questions regarding the computation of lines of communication on a project. Make sure you read the question carefully, as the answer can turn on a single word. For example:

Q: You are managing a technical team of six highly skilled developers on an XP crash project for senior management. After one week on the project, the lead developer states that two additional resources are needed to complete the project. How many additional lines of communication are created as a result of this addition?

- a. 12
- b. 13
- c. 15
- d. 36

Most people get this question wrong because they either misread the question (it is asking for *additional* lines of communication), or that they forgot someone (did you forget to count yourself as one of the members of the team?). The answer is 'c'.

Meetings: Best Practices

- Publish and distribute agenda with team input before meeting
- Circulate minutes after meeting
- Facilitate meetings
- Assign deliverables to individual with due date
- Set meeting rules
- Meet regularly, or as needed
- Articulate expectations and responsibilities
- Summarize what has been discussed

If you work for an organization which holds meetings to report status, you are wasting your time. Status can very easily be reported via an e-mail, a quick 10 minute phone call, or a posting on the company intranet. Reporting status does not require a meeting. One of the jobs of the project manager is to ensure that people are using their time effectively on the project.

The purpose of getting people together for a meeting is that a decision that needs to be made, or a problem needs to be solved that requires a face-to-face conversation or a live conference call. The idea is to use the time effectively and to make sure that all the right participants are in attendance and have input into the process.

The ground rules set above are a good general guideline to facilitate meetings.

Always distribute the meeting agenda at least 24 hours ahead of the meeting. This gives meeting participants the opportunity to add critical agenda items, or to decide at what point in the meeting they need to participate. If there are issues and risks that need to be addressed, make sure there are deliverables assigned to individuals with the responsibility for completing their assignments, and always make sure they have a due date for completion.

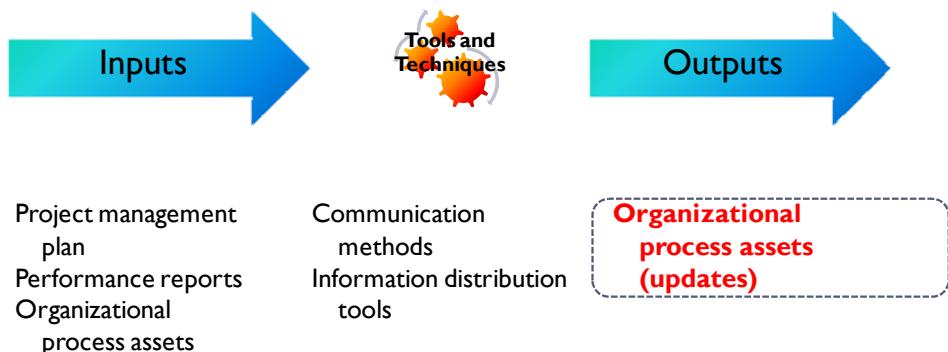
Project Manager Communication

Project Managers spend 90% of their project time on COMMUNICATION activities.

It is one of the primary jobs of the project manager to ensure that all stakeholders are kept informed and updated on project progress, issues, risks, changes, corrective actions, preventive actions and a host of other elements we have discussed up to this point. The way project managers keep all stakeholders and project team members ‘on the same page’ is through proactive communications.

Many project failures are attributable to a lack of thoughtful and thorough communications, which is the responsibility of the project manager.

Distribute Information



The Distribute Information process involves ensuring that all relevant project information is available to project stakeholders as needed. This process is performed throughout the entire project life cycle and as part of all management processes. Since the Distribute Information process occurs in the Executing process group, it focuses on implementing the Communication Management Plan.

Effective information distribution includes some of the following techniques:

- Implementing sender-receiver models
 - Determining choice of media
 - Choice of writing style
 - Meeting management techniques
 - Presentation techniques
 - Facilitation techniques

We have discussed the sender-receiver model and meeting management techniques on previous pages. Some of the other information distribution techniques appear on the following pages.

Communications Barriers/Enhancers

- ▶ **Communication Barriers:**
 - ▶ Distorted Perceptions
 - ▶ Distrusted Sources
 - ▶ Transmission Errors
 - ▶ Noise or Distance
 - ▶ Message not Clearly Encoded
 - ▶ Saying “it is a bad idea”
 - ▶ Hostility
 - ▶ Culture
 - ▶ **Communication Enhancers:**
 - ▶ Make the Message Relevant for the Receiver
 - ▶ Reduce the Message to Its Simplest Terms
 - ▶ Organize the Message into a Series of Stages
 - ▶ Repeat the Key Points

Communication enhancers are used in presentation techniques and facilitation techniques. Notice that:

- 55% of the message transmitted comes through body language
- 38% of the message transmitted comes through vocal inflection (paralingual)
- Only 7% of your message consists of the actual words that you use.³⁸

Here is a case in point:

Almost every child has played some version of the ‘telephone game’: people sit in a circle and the initiator starts a message, which he whispers into the ear of the person sitting next to him. The rule of this game is that you can only say the message once, and the person who receives it has to pass on whatever they *think* they heard to the person sitting next to them. This process repeats itself until it reaches the end of the circle. At that point the message usually bears no resemblance to the initial message, resulting in great hilarity among the telephone game participants.

Think of the consequences if some version of this happens on your projects in a business context - a meeting of stakeholders, a telephone conference, a distributed questionnaire or some other communication. If misinterpreted, the results can be disastrous. Therefore, when attempting to solicit information or get a message across, be aware of the communication barriers and do whatever you can to reduce their impact.

Types of Communication

There are four fundamental types of communication that occur under two standard headings: formal and informal. The four types are:

- Formal Written
- Formal Verbal
- Informal Written
- Informal Verbal

The grid below represents communications and their best practice usages:

Formal Written	Formal Verbal	Informal Written	Informal Verbal
<ul style="list-style-type: none"> •PM Plans •Project Charter •Long distance communications •Complex technical problems 	<ul style="list-style-type: none"> •Presentations •Public Speeches •Keynote addresses 	<ul style="list-style-type: none"> •Memos •E-mails •Meeting minutes 	<ul style="list-style-type: none"> •Meetings •Ad hoc conversations

³⁸ “Silent Messages”, Mehrabian, Albert, Wadsworth Publishing Company (January 1971)

Communication Situations

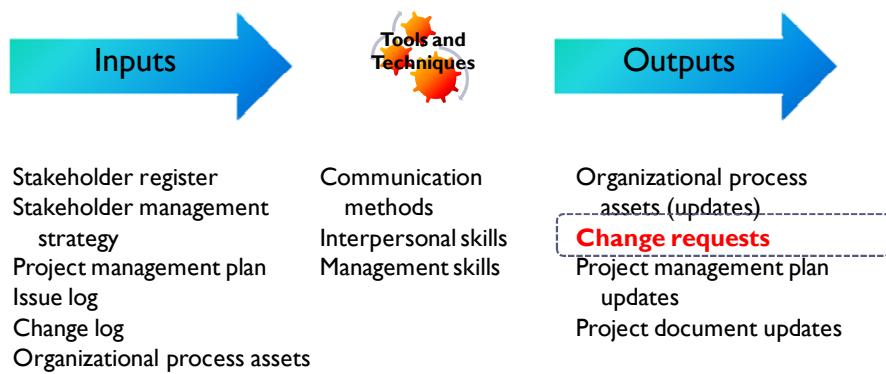
Here's a quick quiz for you: look at the grid above and decide what communication method you would apply to the situation on the left-hand side of the grid.

- Formal written?
- Informal written?
- Formal verbal?
- Informal verbal?

Situation	Communication Type
Schedule a meeting	
Deliver oral presentation at a bidders conference	
Discussion with a team member regarding a project problem	
Notes taken during a conference call	
Changes to technical requirements	
Informing a team member of insubordination	

(answers: informal written, formal verbal, informal verbal, informal written, formal written, formal written)

Manage Stakeholder Expectations



The Manage Stakeholder Expectations process focuses on communicating and working with stakeholders to meet their needs and addressing project issues as they occur. Managing stakeholder expectations increases the probability that the project will be successful at helping stakeholders understand the benefits of the project and identifying risks.

Communication Methods

Contemporary communication methods typically include:

- Group meetings
- Video Conferences
- Intranet wikis (web based)
- E-mail, voicemail, fax
- Conferencing tools (e.g. Webex®)
- Web based PM software, portals

Communication methods are a tool and technique of both Distribute Information and Manage Stakeholder Expectations.

Managing stakeholder expectations relies on effective communications. The communication methods listed above can all be implemented based on the needs of the stakeholder, and applied where appropriate. It is the project manager's job to identify for each stakeholder their preferred method of communication.

The project manager must also apply interpersonal skills and management skills to help build trust, resolve conflict, and overcome resistance to change by the artful application of management skills which may include some of the following:

- Strong presentation and speaking skills
- Excellent negotiation ability
- Effective writing skills

Interpersonal and Management Skills

From the point of view of the project manager, one of the critical aspects that will drive the success of the project manager on any project is the project manager's interpersonal skills and management skills. Aligning stakeholders to the goal of the project, and getting them on your side, is a key element in making any project successful. In order to do this, the following management and interpersonal skills are used throughout the project:

- **Interpersonal skills**
 - Build trust with your stakeholders and project team members
 - Resolve conflict for the positive outcome of the project
 - Use active listening techniques to capture needed information
 - Help stakeholder overcome their fears of and resistance to change
- **Management Skills**
 - Strong presentation and public speaking skills are key to communicating the goals and needs of the project
 - Negotiating skills, especially for needed resources, are a major asset

- The ability to communicate clearly and effectively via the written word is a key skill for all project managers

Issue Logs

Issues Log								
Project		Project #						
Project manager		Sponsor						
Project artifacts		Updated						
I D	Issue Description	Project Impact	Action Plan/Resolution	Owner	Importan ce	Date Entered	Date to Review	Date Resolved
1								
2								
3								

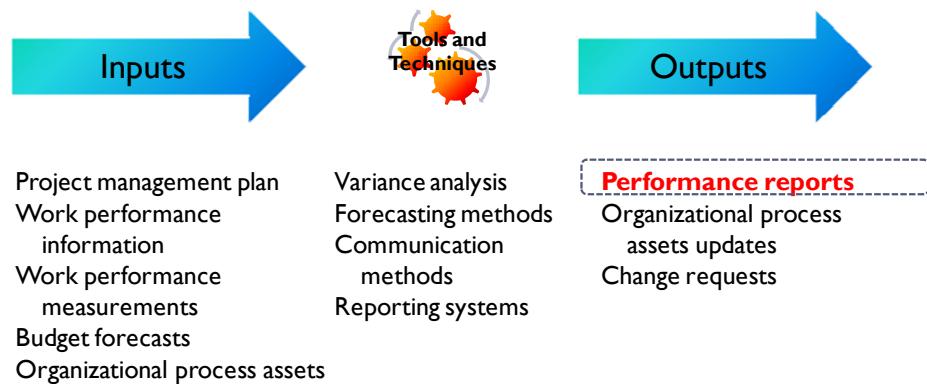
The issue log or action item log is a key tool used by the project manager to identify issues, define the impact, priority and urgency of the issues, assign ownership of those issues, and establish due dates for resolution. It is the project manager's responsibility to create and track issues on the project with the goal of bringing them to a successful resolution, or escalating them to senior management if the issues fall outside the project manager's area of authority. You may see a question on the exam that resembles the following:

Q: You have just inherited a project from a project manager who has just left the organization. In performing your assessment of the current state of the project, a number of stakeholders have complained to you that there are issues on the project that manifest themselves as 'discovery' or at worst, a complete surprise. These issues need a timely resolution. The most likely cause of this situation is:

- The previous project manager did not have time to resolve these issues because he was leaving the project.
- The previous project manager did not maintain an issue log.
- Disagreements between stakeholders were so contentious, it was impossible to implement resolution of the issues.
- The previous project manager attempted to resolve the issues, however the stakeholders could not accurately pinpoint the actual issues.

(answer: b)

Report Performance



This process controls the collection and distribution of performance information, which includes forecasts, progress reports, status reports and variances. Typical status or progress reports include elements such as:

- Project milestones reached
- Risk and issue status
- Requested changes
- Accepted and rejected changes
- Escalation status of Jeopardy items
- Expected deliverables due by the next status report

Report types:

- Status: Where the project now stands
- Progress: What has been accomplished
- Variance: Compares actuals to performance measurement baseline
- Trend Report: Measures performance over time to determine if performance is improving or deteriorating
- Earned value reports: reports on schedule, budget and scope to assess project progress
- Forecasts: Prediction of future performance

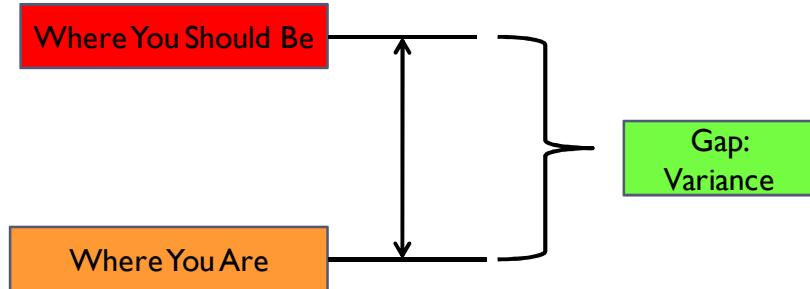
Variance Analysis

The Variance Report

This compares actual results against a planned a baseline. Ensure the following is done when constructing a variance report:

- Verify the quality, completeness and accuracy of the information
- Determine variances, including the use of earned value reports

- Determine the impact of the variances on project budgets, scope, timeline and other project elements (e.g. quality and risk).



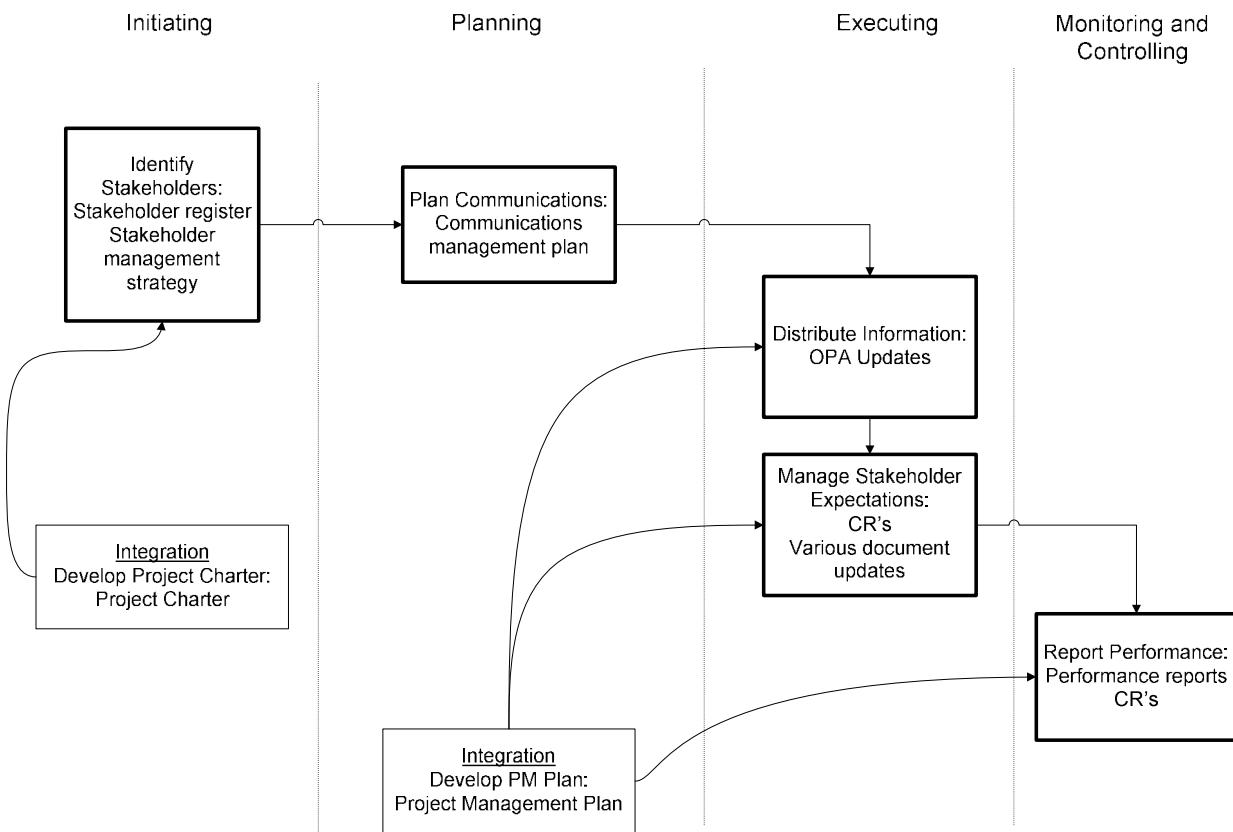
Forecasting Methods

Forecasting is the process of predicting future performance based on actual performance to date. The key forecasting methods are detailed below:

- **Time Series Methods** - this approach uses historical data to determine future outcomes. These methods typically include earned value analysis, moving average, extrapolation, linear prediction, trend estimation, and growth curve.
- **Causal/Econometric Methods** - this is a forecasting method based on the use of conditional probability. For example: it is a cloudy day and it may rain. What is the probability that it is going to rain, given that you just heard thunder? Other causal relationships may include conditions such as: an increase in cases of flu may give rise to an increase in requests for flu vaccinations. If the causes and the effects are clearly understood, the influencing variables can be used in the forecast. Examples of this approach are the regression/trend analysis, autoregressive moving average (ARMA), and econometrics.
- **Judgmental Methods** - this approach uses expert judgment to create the estimate. Approaches in this area include surveys, the Delphi method, scenario building, technology forecasting, and the forecast by analogy.
- **Additional Methods:** Simulation, probabilistic, ensemble

Project Communications Management: Key Process Interactions

The key inputs from the other Knowledge Areas to Project Communications Management processes are shown below. *Know these process interactions for the exam.*



In Summary...

This section discussed communications management, including:

- Active listening and communication skills
- Percent of a project manager's time spent on communicating
- Stakeholder identification, managing stakeholder expectation, stakeholder management strategy
- Best practices for holding effective meetings
- Lines of communication and communication methods
- How to use an issue log
- Variance analysis and forecasting
- Reporting and information distribution

Chapter Ten Memory Check

1. _____ is the process of identifying all individuals or organizations that can be positively or negatively impacted by the project
2. Identifying all potential stakeholders, their potential impact on the project and assessing how key stakeholders may respond to specific situations is called _____
3. The _____ includes all information about the stakeholder, including his/her power, impact, and influence level on the project
4. An approach to increase the support for the project and minimize negative stakeholder influence is called a _____
5. Only ___ % of your message is conveyed in the words themselves, while ___% of the message is conveyed in vocal tone and inflection and ___ % in body language
6. The formula that determines the number of communications channels is expressed as

7. The key output of the Plan Communications process is the _____
8. The three fundamental communications methods are known as _____, _____, and _____
9. Distribute Information and Manage Stakeholder Expectations occur in the _____ process of the Project Management Life cycle
10. The process of attentively responding and verifying what the sender of a message is communicating to you is called _____
11. The four basic types of communications are known as: _____, _____, _____, and _____
12. A _____ report describes where the project now stands, while a _____ report describes what has been accomplished, and a _____ report compares actuals to the performance measurement baseline
13. A project manager spends ___% of their time on communication activities
14. The three types of forecasting methods are described as: _____ methods, _____ / _____ methods and _____ methods
15. The Report Performance process has as a key output, _____, and occurs in the _____ process group

Chapter 10 Test

1. ARMA is a?
 - a. Econometric method
 - b. Time series method
 - c. Judgmental method
 - d. Probabilistic forecasting method
2. The project manager is managing a nine member team. Two members are removed and reassigned from the team. How many lines of communication have been removed from the team?
 - a. 17
 - b. 16
 - c. 15
 - d. 14
3. You are managing a project in which there is a large procurement activity. One of the stakeholders approaches you with the need for a change. You have an off-line meeting with the stakeholder and discuss the change, decide it can be done and agree to implement. What mistake has the project manager made here?
 - a. You forgot to consult with senior management
 - b. You forgot to consult with other stakeholders on the team
 - c. Contract changes require a formal written approval
 - d. You forgot to perform an impact assessment
4. You have just finished a recent progress meeting when an important technical issue emerged. With the help of two technical team members, you craft a detailed document, which is e-mailed to the rest of the team describing the issue and what can be done about it. What percentage of the message is actually going to be understood by the recipients?
 - a. 55%
 - b. 7%
 - c. 38%
 - d. 93%
5. All of the following are Forecasting methods with the *exception* of:
 - a. Econometric methods
 - b. Time series methods
 - c. Judgmental methods
 - d. Analogous methods
6. A variance analysis is used for:
 - a. Comparing baselines to actuals
 - b. Determining future performance
 - c. Status reporting
 - d. Statistical modeling
7. The *key* element needed in an issue log is?
 - a. A resolution
 - b. An owner
 - c. A due date
 - d. The issue priority ranking

8. You have been asked for a report by senior management that indicates current budget, current schedule, and where the project may complete in terms of budget and timeline. The best type or report to use in this situation is called:
- A forecast report
 - A status report
 - A progress report
 - A cumulative report
9. You just completed a meeting in which the stakeholders were tasked with various deliverables due at the next meeting. After the meeting, you sent down meeting notes to all the stakeholders reiterating the deliverables and the owners of those deliverables. At the next meeting, however, one of the stakeholders did not have their deliverable complete. They complained about having too much work and not receiving the follow-up e-mail message containing the meeting notes and the deliverable assigned to them. What would have been the *best* method for preventing such an occurrence?
- Contact the stakeholder's manager for possible remediation and or removal from the team, so that they can be replaced with a more responsible resource
 - Confirm message receipt and review for misunderstandings with the stakeholder
 - Change the communication channel to a more effective method
 - Implement a verified pull system
10. When discussing a key technical issue with the team members on your project, which form of communication is most likely to help you best transmit your message?
- E-mail + IM (Instant messaging)
 - Teleconference
 - Face-to-face
 - Face-to-face with whiteboard
11. When a message is being sent to a single receiver or a group of receivers, whose responsibility is it that the message is correctly understood?
- The receiver – by giving the ender feedback
 - The sender – by correctly encoding the message in a form the receiver can understand
 - Both the sender and the receiver
 - It depends on the communication medium
12. All of the following are key elements in the active listening process *except*:
- Giving feedback to the sender
 - Challenging unsubstantiated facts
 - Showing interest in what the other person says
 - Confirming and summarizing the message periodically
13. The stakeholder register is a key output of what process group?
- Planning
 - Initiating
 - Executing
 - Monitoring and Controlling
14. The principle difference between Effective communication and Efficient communication means that:
- Efficient communications provide only the information that is needed whereas effective communications ensure the timeliness and the format of the communications
 - Efficient communications provide information to only the stakeholders who need it whereas effective communications ensure the guaranteed delivery of the communication

- c. Efficient communications focus on the most appropriate communication channel whereas effective communications focus on the fastest communication channel
 - d. Efficient communications are optional whereas effective communications are required
15. You are managing a complex onshore team with resources from India, Ukraine, Nairobi, Ireland, Italy, France, Israel, and the United States. Several stakeholders have been invited to your most recent progress meeting. At the meeting, one of the stakeholders asked a question of one of the resources from India. The resource from India responded by using a head gesture that was misinterpreted by the stakeholder (the stakeholder thought he was saying 'no' when, actually, the resource was indicating 'yes'). What type of barrier to communication does this describe?
- a. Culture shock
 - b. Cultural difference
 - c. Distrusted resource
 - d. Noise
16. Describing stakeholders based on their power (ability to impose will), urgency (need for immediate attention), and legitimacy (their involvement), describes what type of grid or model?
- a. Power/Influence grid
 - b. Salience Model
 - c. Influence/Impact grid
 - d. Power model
17. Which of the following *best* describes a stakeholder?
- a. Someone who is thinking about buying your product
 - b. A reviewer of your product in an industry trade journal
 - c. A project team member
 - d. The CFO in another division of your company
18. The stakeholder analysis matrix is part of ...?
- a. Part of the Stakeholder Management Strategy - an output of identify stakeholders
 - b. An output of Plan Communications
 - c. Part of the stakeholder register
 - d. Part of Performance Reporting
19. You are managing three offshore teams: one in India, one in the Ukraine, and one in South America. What would be the best approach for handling communications with these offshore entities?
- a. E-mail
 - b. Instant messaging (IM)
 - c. Video-teleconferencing
 - d. E-mail + IM
20. The team members on your project have approached you with a need for some training. You discuss the issue with the stakeholders and decide that an e-learning system online would be the best way to handle the situation. What type of communication best describes this approach?
- a. Push method
 - b. Pull method
 - c. Interactive method
 - d. Collaborative method
21. How much does noise add to a missed communication?
- a. 20%
 - b. It depends on the message

- c. The noise doubles for every level up the organization hierarchy it travels
 - d. It depends on the type of communication channel being used
22. What is the key benefit in utilizing the Stakeholder Management Strategy?
- a. It simplifies the job of the project manager
 - b. It increases the support and minimizes negative impacts of stakeholders
 - c. It reduces unnecessary changes to the project
 - d. It improves senior management visibility into the project
23. The distribute information process yields:
- a. OPA updates- an output of the Executing process group
 - b. Status reports - an output of the Monitoring and Controlling process group
 - c. Performance reports - an output of the Report Performance process
 - d. Project document updates – an output of the Plan Communications process
24. Almost every child has played the telephone game at some time. A number of people sit in a circle and the initiator of the message whispers a message to the person on their right. That person, in turn, whispers the message to the next person in the circle, and so on, until it reaches the last person in the circle. No questions may be asked of the person sending the message. The message is sent by each person only once. In terms of the sender-receiver model, what does the telephone game demonstrate about the communication process?
- a. It describes a message encoding issue
 - b. It describes a transmission and feedback issue
 - c. It describes a failure on the part of the receiver
 - d. It describes a translation and re-encoding issue
25. The stakeholders on your project are very concerned about the outcome of the project. The organization is attempting a project in which there are significant unknowns, attempting technologies they have never used before. The stakeholders are looking to you, the project manager, for direction, problem solving, conflict resolution, and the ability to build a consensus for the new technologies in which there will be considerable resistance to change. What are the *most effective* tools or methods you can use to help build stakeholder trust?
- a. Expert power
 - b. Formal authority
 - c. Interpersonal skills and management skills
 - d. Compromise and consensus building

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Chapter 10 – Answers

1. A – An econometric method. (*PMBOK® Guide*, 4th edition, p. 269)
2. A – Did you forget the PM in the team count? $(10*9)/2 = 45$. $(8*7)/2 = 28$. $45 - 28 = 17$
3. C – Don't get fooled by this question. It addresses a procurement issue, but it's really about the correct form of communication to use in the situation. Contracts always require a formal written approval if change to the contract is needed
4. B – Paralingual studies show that only 7% of the message is contained in the words. 38% is contained in the vocal pitch and tone. 55% is contained in the body language. Per analytical research from Albert Mehrabian in his book "Silent Messages".
5. D – Analogous is an estimating method, not a forecasting method
6. A – This is the definition of a variance analysis. (*PMBOK® Guide*, 4th edition, p. 268)
7. B – Without an owner, the issues do not get resolved
8. A – A forecast defines the potential future state of the project in terms of budget and timeline. Status tells you where you are now. Progress tells you what has been delivered to date. Cumulative is a made up term
9. B – Confirm receipt of the message and verify understanding with the stakeholder. Answer A is not a preventive approach. C and D might be potential solutions after you have determined the real issue
10. D – Face-to-face with a whiteboard is the most effective followed by C, B and A
11. B – The sender is responsible for encoding the message in a form the receiver will understand. The receiver will confirm receipt in the form of feedback and ask for clarification, if needed (answer A). C is not a possible scenario. D is subsumed in answer B – the sender is responsible for picking the best medium.
12. B – Active listening is not a 'challenge' process – it is a listening process
13. B – It is Initiating, which includes processes for only the following KA's: Integration and Communication
14. A – Efficient communications provide only the information that is needed, whereas effective communications insure the timeliness and the format of the communications. *PMBOK® Guide*, 4th edition p. 252
15. B – Cultural difference is the communication barrier. While the questioner may experience culture shock (!), it is usually the result of a communication barrier. There is no evidence to support the answers in C or D.
16. B – This exactly describes the Salience model. *PMBOK® Guide*, 4th edition, p. 249
17. C – The team member is the stakeholder. Answer A describes a potential stakeholder. Answer B gets paid to review the product whether they use it or not (although their opinion may impact your sales!). Answer D is probably working to her own P&L, has nothing to do with your product and probably hasn't heard of it.
18. A – It is part of the Stakeholder Management Strategy, which is an output of identify stakeholders. *PMBOK® Guide*, 4th edition, p. 251
19. C – Since 7% of your message is conveyed through the words alone, a formal written approach may not be the best given differences in language. A video teleconference is the next best thing to being there: words + vocal inflection + body language
20. B – e-learning systems are de facto 'pull' methods – the user pulls value from the system on demand. *PMBOK® Guide*, 4th edition, p. 256
21. C – Per Peter Drucker. On any communication heading up the corporate communication hierarchy, the noise level doubles when passing through each level in the organization
22. B – It increases the support and minimizes negative impacts of stakeholders. *PMBOK® Guide*, 4th edition, p. 251
23. A – Updates to the OPA (organizational process assets). *PMBOK® Guide*, 4th edition , p. 260
24. B – It describes a transmission and feedback issue: the signal is weak and feedback is prevented. Answer A is only partially correct. Since the message is whispered, it is not being put in the most effective form for this receiver to understand it. There is no evidence to support answer C or D
25. C – This scenario describes a stakeholder expectation scenario and, as such, the key tools and techniques for managing stakeholder expectation are interpersonal skills and management skills

Chapter 11 : Project Risk Management

Section Topics:

- ▶ Plan Risk Management
- ▶ Identify Risks
- ▶ Perform Qualitative Risk Analysis
- ▶ Perform Quantitative Risk Analysis
- ▶ Plan Risk Responses
- ▶ Monitor and Control Risks

Section Objectives

After completing this section, you will be able to:

- List the various categories of risk
- Create and update a risk register
- Assess the impact of risk to your project
- Quantitatively evaluate the impact of each risk and total risk
- Describe the seven risk response strategies
- Define workarounds

Project Risk Management Process Summary

The high level Project Risk Management output elements, by Process Group are:

Initiating	Planning	Executing	Monitoring and Controlling	Closing
	Risk management plan		-Risk register updates -CRs	
	Risk register		Various document updates	
	Risk register updates			
	Risk related contract decisions			

Risk Management Overview

The key aspect in understanding risk management is this:

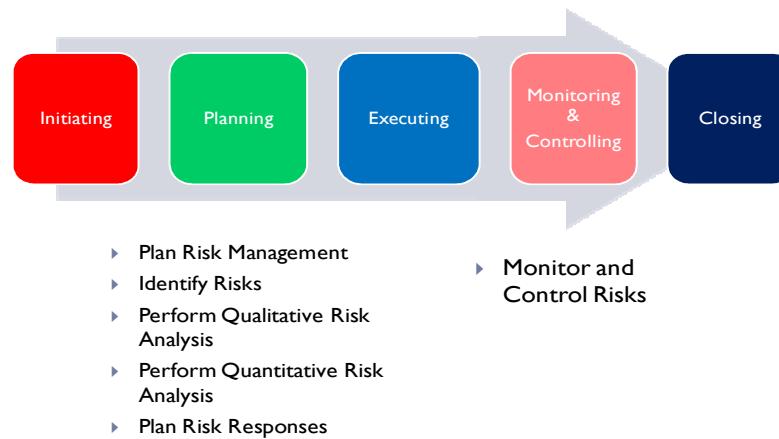
For the most part, risk management is done poorly on most projects and it is usually done very poorly (if at all) on technology or software projects.

There are entire project management methodologies based on a risk-driven approach to managing projects. Risk identification, management and response strategy impacts every area of the project management life cycle and the nine key knowledge areas identified in the *PMBOK® Guide*, 4th edition.

Risk management touches on these key areas:

- Identify, quantify, evaluate, and manage risks
- Known risks vs. unknown risks
- Monitor identified risks for triggers or a change in severity
- Monitor for new risks
- Risks: can have positive or negative impacts

Project Risk Management

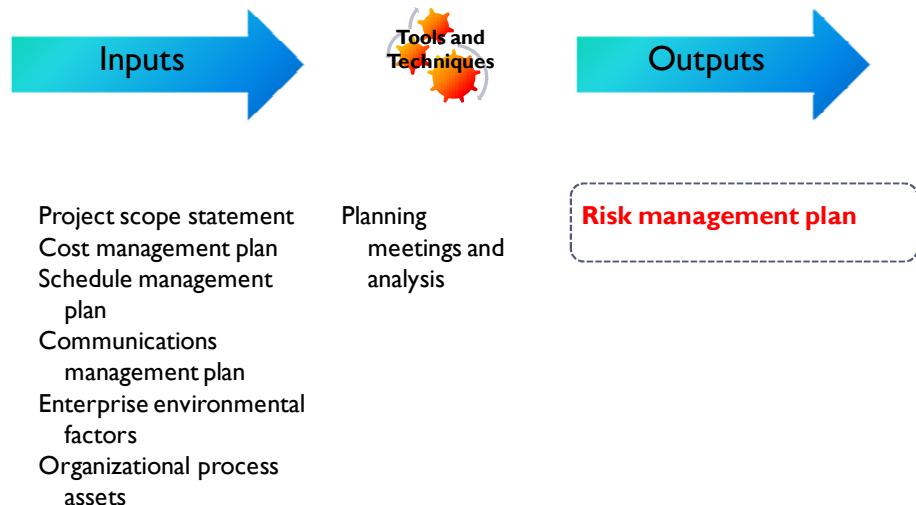


A key objective of performing project risk management is to increase the probability of project success by minimizing or eliminating negative risk events and increasing the probability of positive events.

For the exam, understand the following concepts:

- Risk Management includes the processes of planning risk management, identifying risks, performing qualitative and quantitative analysis of risks, planning responses to risks, and finally monitoring and controlling risks on the project
- Risk is always in the future
- Risk involves uncertainty - it may or may not occur
- Assess your organization's tolerance for risk: are they risk tolerant or risk averse?
- There will be known risks and unknown risks
- Risks can be negative or positive and are identified as threats or opportunities
- Risk is considered from the moment the project is conceived

Plan Risk Management



This process defines how you will conduct risk management activities for a project. It includes the process of defining and providing sufficient resources and time to perform risk management activities.

Planning for risk management begins when the project is originally conceived and should be completed early in the Planning process group. Understand that if risk is a significant aspect of your project management planning, you may need to enlist the help of risk management professionals within your organization or external to your organization.

Just as with quality, there is a cost in addressing the risk aspects of your project. However, understand that failure to address risks in a project can ultimately be much more costly, not only to the project, but also to the organization as a whole.

The Risk Management Plan

- ▶ Components Include:
 - ▶ Methodology
 - ▶ Roles and responsibilities
 - ▶ Budgeting
 - ▶ Timing
 - ▶ Risk categories
 - ▶ Definitions of probability and impact
 - ▶ Stakeholder tolerances
 - ▶ Reporting formats
 - ▶ Tracking
- ▶ Which Define:
 - ▶ How you will do risk management
 - ▶ Who will do what
 - ▶ What risk mgt. will cost
 - ▶ When we do risk mgt.
 - ▶ E.G. internal, external
 - ▶ Will it happen and how severe the risk may be
 - ▶ Risk tolerant or risk averse
 - ▶ What goes into the report
 - ▶ Audit of risk process

The output of the Plan Risk Management process is the creation and completion of the Risk Management Plan. The major categories in a risk management plan include:

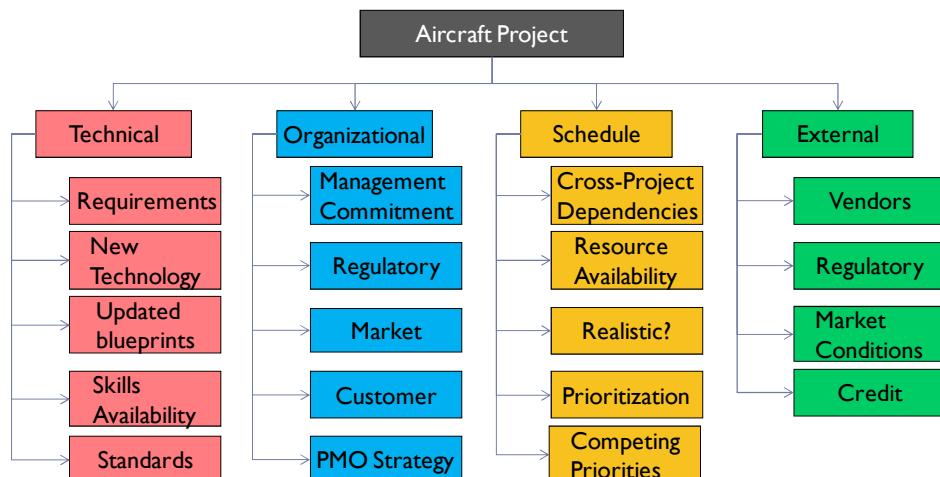
- Risk management methodology
- roles and responsibilities
- Budgeting
- Timing
- Risk Categories
- Definitions of probability and impact
- Probability and impact matrix
- Revised stakeholder's tolerances
- Reporting Formats
- Tracking

Risk Breakdown Structure

The risk categories in a project management plan can be graphically represented with a tool that is similar to the work breakdown structure (WBS) called a Risk Breakdown Structure (RBS).

The RBS enables you to see all project risks grouped by basic themes and the specific risk areas occurring in relation to each theme.

In the example shown above, notice there are high-level categories followed by subcategories in the risk breakdown structure. The categories demonstrated here are simply examples of what you can find in a risk breakdown structure. In reality, the number of risk categories and subcategories can number into the hundreds depending on the size of the project. An example appears below:



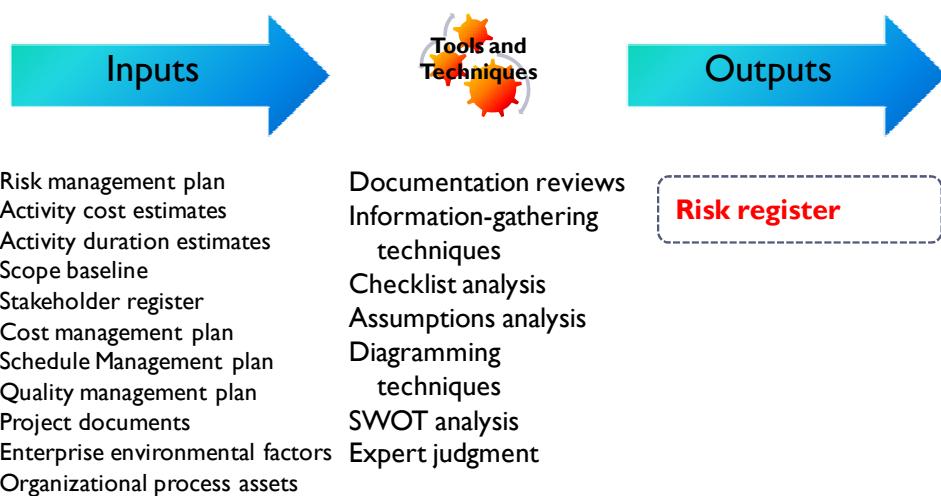
Categories of Risk

As we saw in the RBS, there can be any number of risk categories on a project - categories can number into the hundreds for a large project.

Tom DeMarco and Tim Lister in their 2003 book, *Waltzing with Bears*, identified five key risk categories on a software project:

- Scope Creep – from the stakeholders
- Inherent schedule flaws – usually due to unknown and uncertain elements, and also due to a miscalculation on the size of the product to be built
- Employee turnover – this possibility is usually left out of the estimation process, especially the time needed to ramp up replacement resources
- Specification breakdown – this is a show stopper, in which the customer cannot agree on what is being delivered, effectively bringing the project to a standstill. However, in reality, the conflict is usually so deep that it is often covered up and the project goes ahead with a flawed, ambiguous target. This will result in a project that is either canceled or does not meet customer expectation.
- Poor productivity – usually a result of the impact of the previous four risks described

Identify Risks



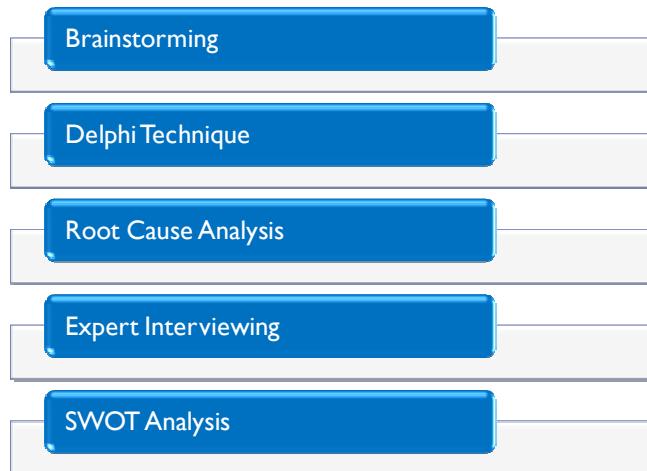
This process is used to determine which risks may affect the project, and can include the following resources when performing risk identification activities:

- Project manager
- Project Team
- Risk team
- Stakeholders

- Customers
- Subject matter experts

Identifying risks is an iterative process - new risks may become apparent as the project evolves. The tools and techniques of identifying risks on a project will be elaborated on the following pages.

Risk Information Gathering Techniques



The above-mentioned risk information gathering techniques are well established and have been in use for many years.

You may see reference to any one of these risk gathering techniques in an exam question.

Brainstorming and Delphi

Brainstorming is a technique developed by Alex Osborn (The 'O' in the advertising firm of BBD&O) in his book, *Applied Imagination*. The four fundamental steps to brainstorming are as follows:

1. **Focus on quantity:** The idea is to facilitate problem solving through the concept, *quantity breeds quality*. The idea assumes that the greater the number of ideas generated, the greater the chance of producing an effective solution.
2. **Withhold criticism:** In brainstorming, criticism of ideas generated is postponed until the team is ready to analyze the input. Instead, participants focus on extending or adding to ideas. By suspending judgment, participants will feel free to generate unusual ideas.
3. **Welcome unusual ideas:** To get a good and long list of ideas, unusual ideas are welcomed. They can be generated by looking from new perspectives and suspending assumptions. These new ways of thinking may provide better solutions.
4. **Combine and improve ideas:** Good ideas may be combined synergistically, to form a single improved good idea, as suggested by the counterintuitive "1+1=3". It is believed to stimulate the building of ideas by a process of association.

The Delphi Technique was developed by the RAND Corporation (an acronym for Research AND Development) in the 1960s and was created as an interactive forecasting method that relies on a panel of independent experts. Usually, all participants maintain anonymity. Their identity is not revealed even after the completion of the final report. This stops them from dominating others and using their authority or personality. This frees participants from their personal biases, minimizing the "bandwagon effect" or "halo effect", allowing them to freely express their opinions, encouraging open critique and admitting errors by revising earlier judgments.

Root Cause Analysis (RCA) and Expert Interviewing

RCA is a reactive method of problem detection and solving, initially. The analysis is performed **after** an event has occurred. This allows practitioners to identify process 'triggers', so that RCA becomes a proactive method. In other words, RCA is able to **forecast** the possibility of an event **before** it might occur.

RCA is not a single, sharply defined methodology; there are many different tools, processes, and philosophies of RCA in existence. However, most of these can be classed into five, very-broadly defined "schools" that are named here by their basic fields of origin: safety-based, production-based, process-based, failure-based, and systems-based.

- Safety-based RCA descends from the fields of accident analysis and occupational safety and health.
- Production-based RCA has its origins in the field of quality control for industrial manufacturing.
- Process-based RCA is basically a follow-on to production-based RCA, but with a scope that has been expanded to include business processes.
- Failure-based RCA is rooted in the practice of failure analysis as employed in engineering and maintenance.
- Systems-based RCA has emerged as an amalgamation of the preceding schools, along with ideas taken from fields such as change management, risk management, and systems analysis.

Several RCA techniques include Kepner-Tregoe, FMEA, Pareto Analysis, Bayesian inference (conditional probability), Ishikawa diagrams and many others.

Expert Interviewing is the process of interviewing subject matter experts to obtain critical information for the project.

SWOT Analysis

	Strengths	Weaknesses
Opportunities		
Threats		

This one analysis is generally set up as a grid with strengths and weaknesses as the two major columns, and opportunities and threats as the two major rows in the grid. The idea is to see where the organization's strengths and weaknesses play against opportunities and threats using the four following comparisons:

- **Strengths-Opportunities** -identifies how organizational strengths help the organization to capitalize on opportunities
- **Weaknesses-Opportunities** - identifies organizational weaknesses, from the perspective of making the necessary improvements, to enable the organization to capitalize on opportunities
- **Strengths-Threats** - identifies how our organizational strengths help us deal with competitors or threatening situations
- **Weaknesses-Threats** - identifies how our organizational weaknesses leave us vulnerable to external competition or threats

SWOT analysis came from the research conducted by Albert S. Humphrey at the Stanford Research Institute from 1960-1970. The development of SWOT stemmed from the need to find out why corporate planning frequently failed. The research was funded by the fortune 500 companies to find out what could be done about this failure.

The Risk Register

Risk Register													
Project				PM									
Project ID				Updated									
Sponsor				Version									
Risk Priority	Description	Probability	Impact	Result	Risk Category	Risk Trigger	Response Strategy	Contingency strategy	Owner	Entry Date	Response Due Date	Actual Date	Risk Realized?
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0

The risk register becomes a key planning tool for the project. Understand that although a risk identifies only the *probability* of an event occurring, the possibility of the event is deemed to be real, true and requires assistance in monitoring.

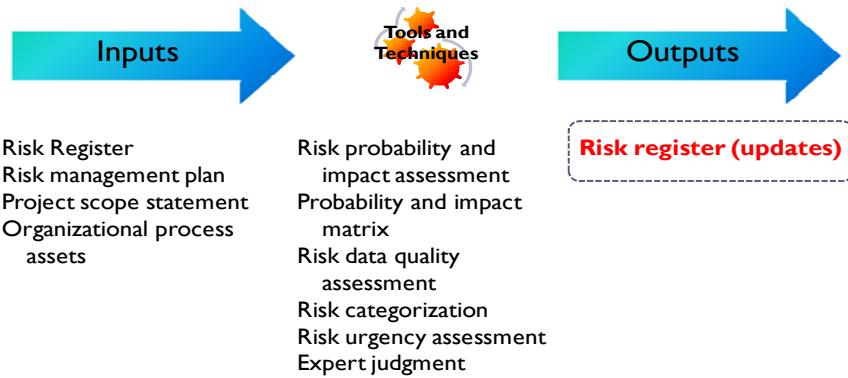
The risk register example shown above contains a description of the risk, its probability, its impact in dollars, a category of risk, the triggering event that indicates the risk is about to occur, the risk response strategy, the risk owner, the date the risk was identified, a due date for resolution and most importantly, the risk's priority.

Also understand this key point about risks in the risk register:

Any risk with a probability percentage of 70% or greater is no longer a risk, it's an issue!

In other words, your risk just became an issue (now an issue in the issue log) that needs to be dealt with in proactive terms.

Perform Qualitative Risk Analysis



The only output to the qualitative risk analysis process is updates to the risk register. To perform these updates, we use a battery of tools and techniques to help us perform qualitative risk analysis.

An example of a risk assessment matrix appears below:

Qualitative Risk Assessment Matrix

The qualitative risk assessment matrix offers a summary level of the potential impact of the risk, based on approximate percentages. Notice that this matrix shows general percentages that are not tied to specific dollar amounts or timelines. Another way of showing a qualitative impact is to rank the probabilities as high, medium or low:

Risk	Impact	Likelihood
Shipments are delayed	High	Low
Long lead times for hardware	Medium	Medium
Resource unavailability	Medium	Low
Rework issues	Low	High

Risk Register Updates

Partial List of Risk Register Updates:

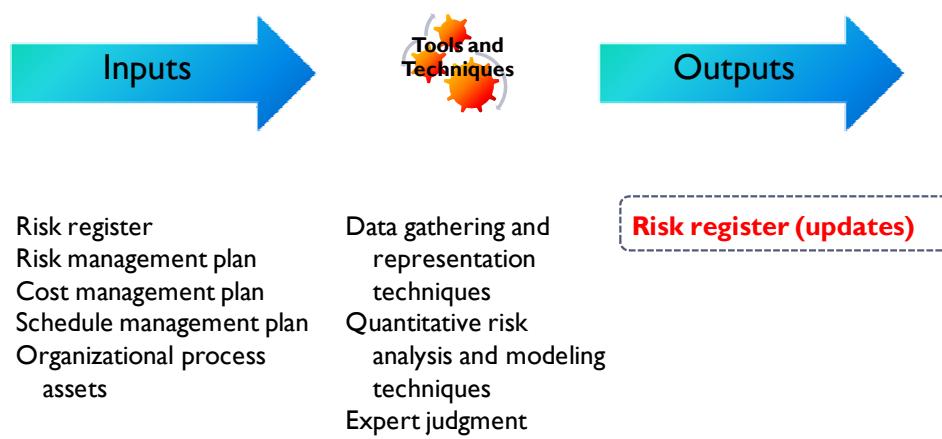
- Ranking and prioritization of project risks
 - Grouping risks by categories
 - Risks requiring near-term response
 - Risks requiring additional analysis and response
 - Low priority risks to monitor
 - Look for trends in results – regression analysis or trend charts

Risk register updates will generally include the outcome of risk assessments, risk audits, and periodic risk reviews. This can include identification of new risk events or updates to risk probability, risk impact, risk priority and risk response plans.

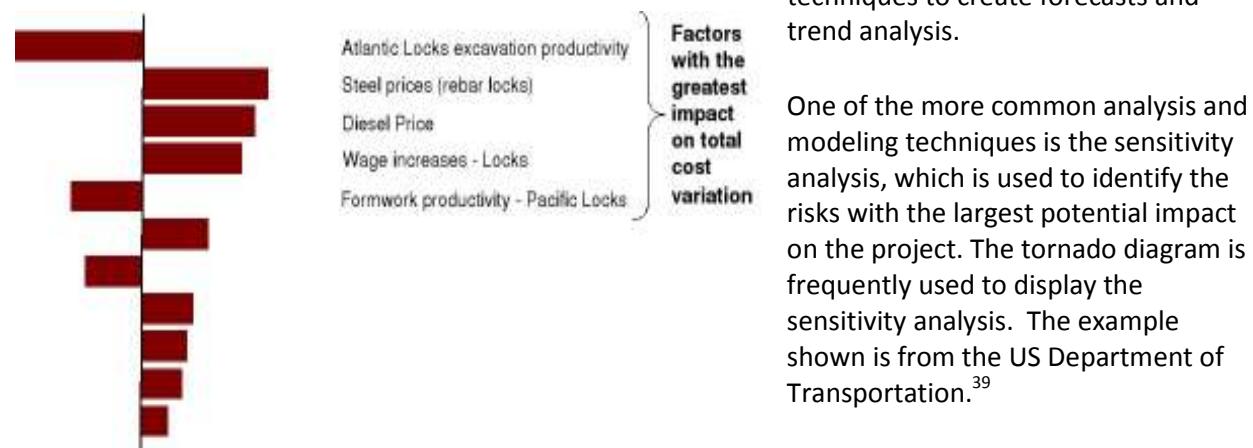
An important use of the risk register is to view the actual outcomes of the project risks and risk responses against anticipated risks. This data can help project managers plan for risk as the project moves forward.

For the Exam: Risk Register updates are an output of Perform Qualitative Risk Analysis, Perform Quantitative Risk Analysis, Plan Risk Responses and Monitor & Control Risks.

Perform Quantitative Risk Analysis



Quantitative risk analysis involves the numerical quantification and measurement of the effects of identified risks on the project. It frequently involves the use of sophisticated mathematical modeling techniques to create forecasts and trend analysis.



³⁹ http://international.fhwa.dot.gov/riskassess/images/figure_17.cfm

Failure Modes Effects Analysis (FMEA)

Potential Failure Mode and Effects Analysis (Design FMEA)										
Item	Requirements	Potential Failure Mode	Potential Effect(s) of Failure	Severity	Potential Cause(s) / Mechanism(s) of Failure	Current Design Controls Prevention	Occurrence	Current Detection Design Controls		Detection R.P.N.
								Cause	Failure Mode	
Name,	Requirements of function being analyzed	Manner in which system could fail:	Effects of failure as perceived by customers.	List every potential cause and/or failure mechanism:	List prevention activities	List Causes	List detection activities		0	

FMEA: Failure Modes Effects Analysis. The FMEA is useful for manufactured product or where risk may be undetectable:

- ▶ Utilizes three measures: 1) Severity, 2) Occurrence, 3) Detectability to produce the Risk Priority Number (RPN) : The higher the RPN, the greater the risk
- ▶ This is also referenced as a 'proprietary' approach to quality management in the Project Quality Management chapter (Chapter 8)

A key aspect of the failure modes and effects analysis, or FMEA, is that it uses three measures to determine the Risk Priority Number:

- **Severity** of the risk - represented on a numeric scale from 1 to 10, 1 representing no effect, to 10 representing a high hazard (unsafe without warning)
- **Probability** of occurrence – 1 representing the current probability of less than .0007%, to 10 representing a probability of 20% (almost continuous failure) or greater
- **Detectability** of the risk – 1 representing a risk that is highly detectable, to 10 representing a risk that is completely undetectable (failure without warning)

The three numbers are multiplied together to produce the RPN (Risk Priority Number)

This risk register type is particularly effective for manufactured products or for software products in which the software controls mechanical devices that could potentially cause serious injury or loss of life if the software (and therefore the device itself) were to fail.

While the FMEA is initially described in the Quality Management knowledge area as a 'non-proprietary' quality management approach (*PMBOK® Guide*, 4th edition, p 190), it was invented by the US Army in 1949 and was designed to assess high risk elements:

"Each potential failure is ranked by the severity of its effect in order that appropriate corrective actions may be taken to eliminate or control the high risk items"⁴⁰

Expected Value/ Expected Monetary Value

Expected value or Expected Monetary Value (EMV) is computed by multiplying the probability of an event by its impact. Examples appear below:

Risk #	Probability	Impact	Expected value
1	30%	-\$20,000	- \$6,000
2	25%	28 Days	7 days
3	11%	-\$95,000	-\$10,450
4	40%	-\$38,000	-\$15,200
5	20%	+\$40,000	+\$8,000

Example #5 is an example of an opportunity: There is a 20% chance of saving \$40K which results in a potential EMV savings of \$8K. Notice that the impact values can be expressed in time or dollars.

QUANTITATIVE RISK ASSESSMENT MATRIX			
Risk Description	Business Impact	Probability of Occurance	Expected Monetary Value (EMV)
	In Dollars (\$)	As a percent	In Dollars (\$)
Lead Architect Leaves	\$ 50,000.00	15%	\$ 7,500.00
Technology does not work as planned	\$ 250,000.00	5%	\$ 12,500.00
Timeline underestimated	\$ 150,000.00	25%	\$ 37,500.00
Vendor delivers 1 month late	\$ 75,000.00	20%	\$ 15,000.00
			\$ -
			\$ -
			\$ -
			\$ -
			\$ -
			\$ -
			\$ -
		Total Risk	\$ 72,500.00

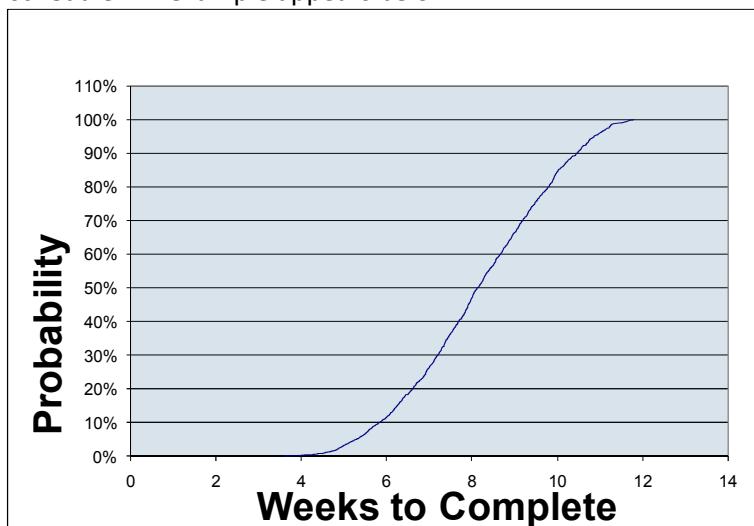
⁴⁰ MIL-STD-1629A, Procedures for Performing a Failure Modes and Criticality Effects Analysis" November 1980, p7

Monte Carlo Analysis

Monte Carlo analysis is a mathematical modeling technique requiring the use of statistical analysis tools to render the model. The graphic above demonstrates what is called a cumulative distribution, otherwise known as an 'S' curve.

The Monte Carlo analysis can use PERT or triangular distributions to model data. Whereas the PERT estimate uses a single optimistic, most likely, and pessimistic estimate to derive a weighted average, the Monte Carlo analysis can use hundreds or even thousands of data points that can be combined into an overall model.

The graphic above utilized the PERT estimate coupled with a random variable to produce a thousand data points. The data points were then graphed in the chart you see above. The Monte Carlo can be run for budget as well as schedule. An example appears below:



Decision Tree Analysis

The decision tree analysis is another form of EMV that is used for more complex decision making in which there are multiple decisions possible and complex uncertainties. The decision tree utilizes two type of branching:

- **Decision Path** : illuminates a possible path forward based on the decision made by the business
- **Uncertainty Branch** : illuminates the probability of success based on certain conditions

The example below demonstrates a build or buy decision scenario.

The decision branches:

- Buy the product for \$85K
- Build the product in-house for \$200K

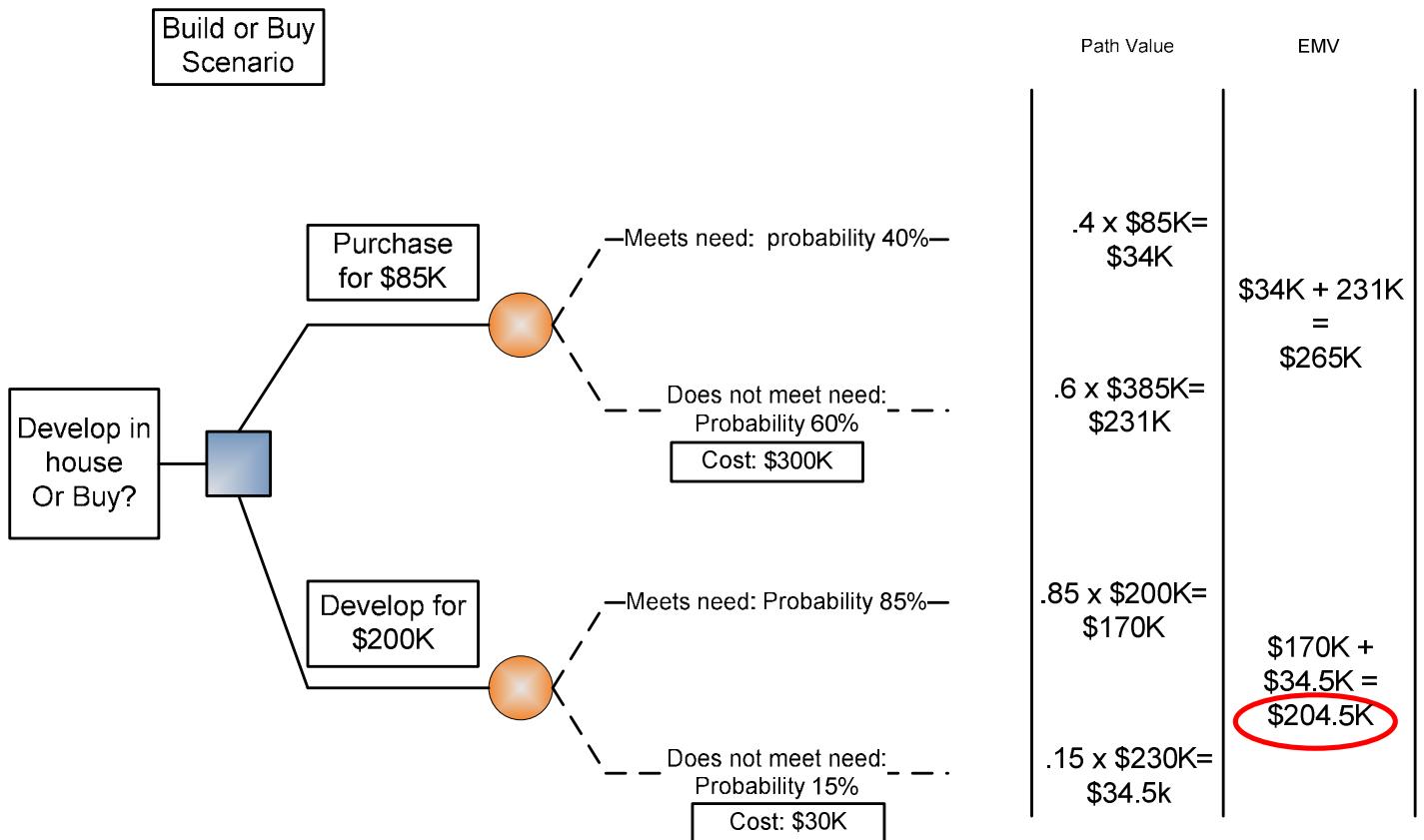
The uncertainty branches for the 'buy' scenario:

- The product meets the need (40% probability)

- The product does not meet the need (60% probability)

The uncertainty branches for the ‘build’ scenario:

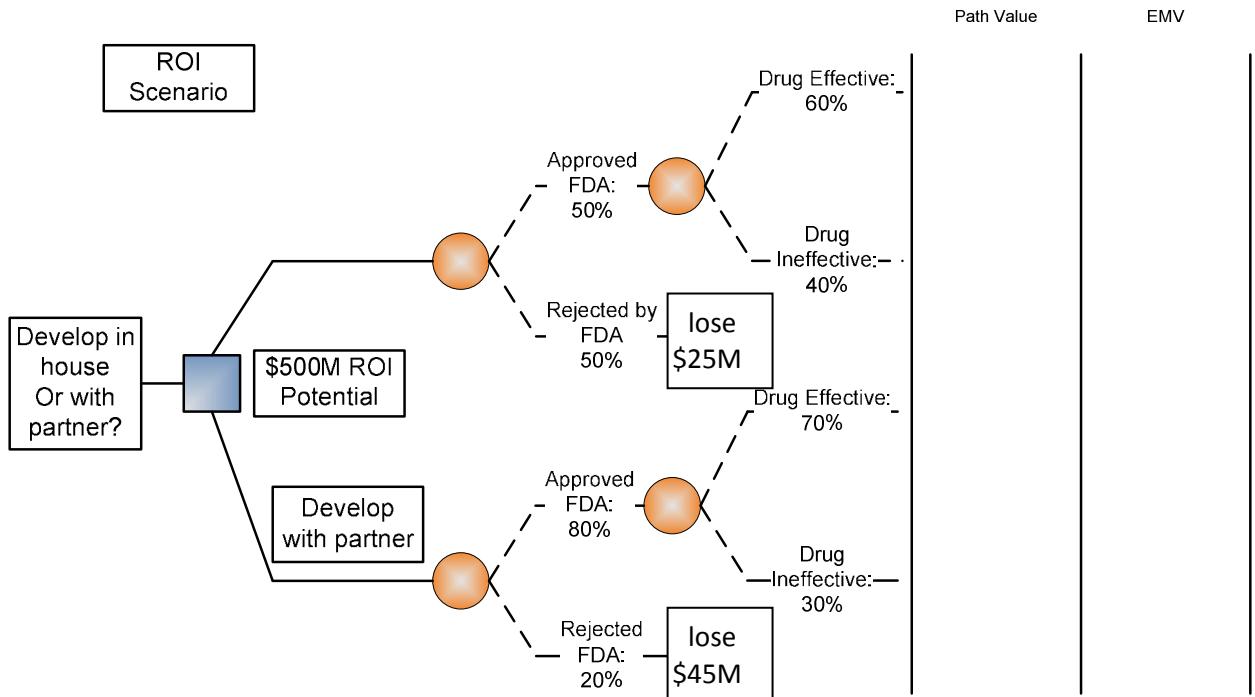
- The product meets the need (85% probability)
- The product does not meet the need (15% probability)



Notice that for each ‘uncertainty’ path, the same EMV calculation is performed as it was before in previous examples: Impact in dollars times the probability. Each calculation produces a ‘path value’ as shown in the first column entitled; Path Value. The probability percentages can be derived via a PERT estimate or expert judgment.

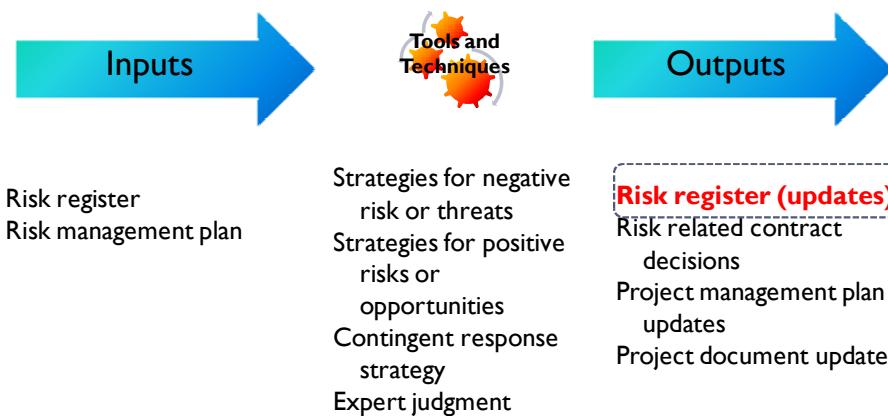
Finally, the uncertainty path values for each decision branch are added together to produce the EMV as shown in the far right column. For the scenario above we are looking for the lowest cost option. In this case the decision tree shows that the ‘develop in-house’ scenario offers the lowest cost: \$204.5K.

Try your hand at this. Below is a different example that addresses an ROI (return on investment) scenario. Solution is on page 11-23:



Your share of the ROI is 60% if you develop with a partner.

Plan Risk Responses



After risks are identified and evaluated from a qualitative and quantitative perspective, we can plan our responses to risk, and either to enhance opportunities, or reduce threats for the project.

There are a number of risk response strategies that can be employed on a project, however, all of the responses fall into the following basic categories:

- Implementing actions to prevent the risk from occurring
- Implementing actions in response to a risk occurrence
- Implementing actions to mitigate or reduce the risk occurrence

- Implementing actions to promote opportunities
- Implementing fallback or contingent responses, in the event risk response plans do not work

Risk Response Strategies

For the exam, understand there are two fundamental types of risks; negative risks and positive risks (otherwise known as opportunities).

Examples of Risk Strategies – Negative Risks

- **Avoid** _____ – Elimination of the potential threat. For example, you are dealing with a vendor and there is the threat of a potential major strike. Your avoidance strategy would be to switch vendors to an organization that does not have unions at all.
- **Transfer** _____ – This involves shifting some or all of the negative impact of a threat, along with the ownership of the response, to a third party. Examples include purchasing insurance, performance bonds, warranties, or other forms of guarantee.
- **Mitigate** _____ – this involves a reduction in the probability or impact of the risk. Designing fault tolerance into a system is a risk mitigation strategy. Instead of shouldering the full cost of the development of a new high risk product, you find three or four partners who can share the expense of development. In case of failure, your exposure to loss has been cut by 75-80%
- **Accept** – Acceptance means that you cannot eliminate, transfer, or mitigate a threat, and there is no other suitable response strategy. You can actively or passively accept the threat:
 - Passive acceptance means you take no action and deal with the risk if it occurs
 - Active acceptance commonly means you have set aside contingency reserves to deal with any potential risks

Examples of Risk Strategies – Positive Risks

- **Exploit** _____ – is used when the organization wants to ensure an opportunity is realized. Saving funds by using existing equipment or facilities is an exploit strategy.
- **Share** _____ – occurs when the organization transfers ownership of the opportunity, in part or altogether to a third party to ensure the opportunity occurs. Engaging a sub-contractor with specialized skill sets not available in your organization can help you capture an opportunity that may have been out of reach otherwise.
- **Enhance** _____ – used to increase the impact or probability of an opportunity. Ending a project early by using highly experienced resources, or utilizing specific schedule compression techniques, is an enhancement opportunity.
- **Accept** – willing to take advantage of an opportunity without actively pursuing it.

Quick Quiz: You will need to know and understand the risk response strategies listed above. Look at the table below and see if you can quickly identify what type of risk response strategy is being employed in each situation:

Risk Description	Response Strategy?
There is a risk your lead architect may leave the project before her job is completed. As a result you cross-trained one of the developers to handle lead architect responsibility.	
The database for your software project is expected to run into multiple terabytes. After consulting with the infrastructure team you discover there are terabytes of available storage in the data center that can be secured at a much lower cost than purchasing new equipment.	
An out-of-state vendor on your project has expressed concerns about meeting delivery due dates. You engage a local vendor that can easily meet the delivery dates without issue.	
Staffing up for customer service on your project will take too long and be too expensive. You identify a vendor that will exceed your customer service requirements and will pay penalties if their service falls below stated quality levels.	
In your RFP response you identify a potential partner that will increase the likelihood you will secure a contract and achieve the opportunity	
You're running a product launch outdoors on the California coast. You can't afford rain on the date. You contact a tent company to erect tent that will hold up to a thousand guests in the event of rain.	
Your client stated that you can obtain incentive fees by turning in daily status reports (DSR). Your lead developer created a small DSR application that can be beamed to every consultant's smart phone that helps to automate the DSR process and help to ensure compliance.	

(answers: mitigate, exploit, avoid, transfer, share, accept-active, enhance)

Contingency Plans

Contingency plans are developed for a specific risk. Contingency plans are generally developed when you have accepted a risk and now have developed a plan 'B' or plan 'C' as a contingent response. These plans are executed only under predefined conditions, and when there is sufficient warning to implement the plan.

Fallback plans are implemented when a contingent response is not effective.

Residual and Secondary Risks

Residual risks are identified as risks that remain after a risk response strategy was implemented. It is possible that residual risks can be identified in the risk planning process, in which case they are subject to contingency and fallback planning.

For example, if you know that certain key personnel on the project might leave before the project is over, your risk response strategy may include required cross-training of other lower level resources. There is a potential residual risk that even with cross-training, the lower level resources might not perform to the level expected. In this event, you may have identified a contingent or fallback plan to address the residual risk.

A secondary risk is a risk that results from implementing a risk response strategy. Secondary risks can be identified in the planning process, or they might occur as a result of discovery.

For example, you implemented a risk avoidance strategy by replacing an unreliable vendor with a highly dependable vendor on a project. However, unknown to you at the time, the dependable vendor was in negotiations to be bought out by a larger company. The secondary risk with the dependable vendor may include elements such as unexpected price changes, changes in resource availability, or a complete change in the business model.

Contingency and Management Reserve

Contingency risk reserve handles ‘known unknowns’:

- Risks have been quantified
- Risk category has been determined

Management reserve handles unknown risks i.e. ‘unknown unknowns’:

- Assessment of overall project uncertainty or project unknowns is needed
- Risk occurrences are usually described as ‘discovery’

Exam Tip:

Contingency reserves, aka money allocated for known risks (or known ‘unknowns’), are part of the **cost baseline** of the project.

Contingency reserves plus management reserves (money allocated for unknown risks) are part of the **project budget** of the project.

Risk Register Updates

The risk register is completed at this point and can include:

- Identified risks and descriptions
- Triggers
- Response strategy
- Specific actions taken if risk occurs

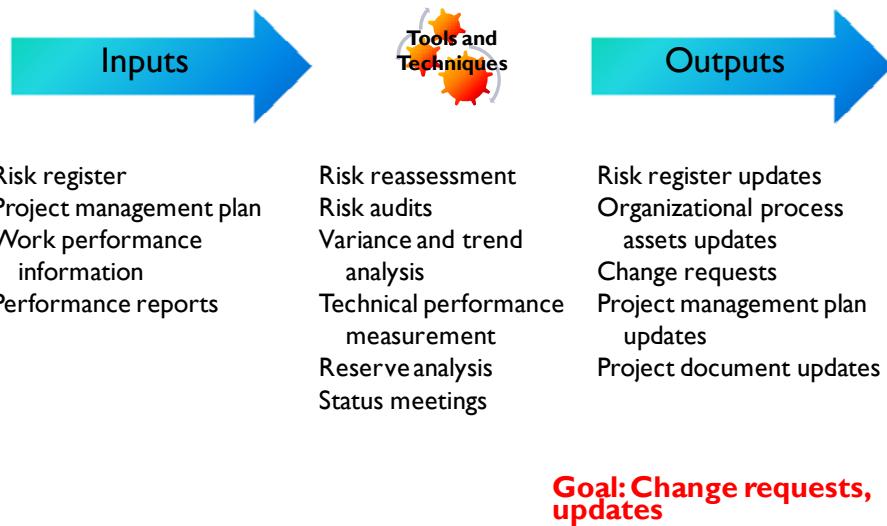
- Responsible party or owner
- Results from qualitative and quantitative risk analysis process
- Primary and secondary responses for each risk
- Residual risks that are expected to remain
- Risk budget
- Contingency and fallback plans
- Contingency reserves for time and cost

The risk register is designed to be written to a level of detail that corresponds with the priority ranking of the risk and its associated response. Frequently, the lower level, low priority risks are placed on a 'watch list' for periodic review and monitoring. The listing above is a partial listing of elements that can be included in the risk register.

Exam Tip: Know the following for the exam

Risk Register Updates (Outputs)	
Qualitative Risk Analysis	Quantitative Risk Analysis
Risk ranking	Probabilistic analysis of project
Group risks by category	Probability of meeting cost/time objectives
Risks needing special attention	Prioritized list of quantified risks
Risks needing near term responses	Trends in quantitative risk analysis results
Watchlists of low priority risks	
Trends in qualitative risk analysis results	

Monitor and Control Risks



As in other monitor and controlling activities, it is assumed you have performed all the necessary elements to identify and quantify project risk, and have created the necessary strategies to respond to risk on the project. *For the exam, it is assumed that the project has a lower risk profile as a result of your risk and project management planning activities.*

Part of the process of monitoring and controlling risks is to perform risk reassessments of the project on a regular basis:

- Have the risk elements changed?
- Have lower level, low priority risks become high priority risks?
- Have certain risks been addressed, and be considered closed on the risk log?
- Do contingency or management reserves need to be adjusted?

The exam assumes that you are doing these things throughout the project.

Other risk monitoring and controlling elements are listed on the following pages.

Risk Audits and Reviews

In most large organizations, there are individuals who specialize in risk auditing and conducting risk reviews. You would do well to learn as much as you can from these individuals about project risk - it will help you do a better job of identifying risks and planning risk responses. Usually, risk audits are periodically scheduled throughout the project. They are typically conducted by people outside of your immediate organization. Why do you think that is so?

There are several reasons why auditors are not part of the project team:

- Provides for an objective review of risks
- Provides a fresh pair of eyes to review risk elements from a different perspective
- Can help identify risks not considered by the team

► **Risk reassessment or risk reviews**

- Periodic and scheduled
- Should occur to determine if any risk priorities or ratings have changed

► **Risk audits**

- Carried out throughout project life
- Typically performed by experts outside project team



Additional Risk Tools

Variance and Trend analysis compares planned results to the actual results. Variance tools such as earned value analysis can be used for monitoring overall project performance. As a result, potential forecasts of deviation at the project's completion from cost and schedule targets are possible.

Technical Performance Measurement compares technical accomplishments during project execution to the project management plan schedule of technical achievement. Quantifiable measurements are taken and compared against actual results.

Reserve Analysis compares the amount of contingency reserves remaining to the amount of risk remaining at any time in the project.

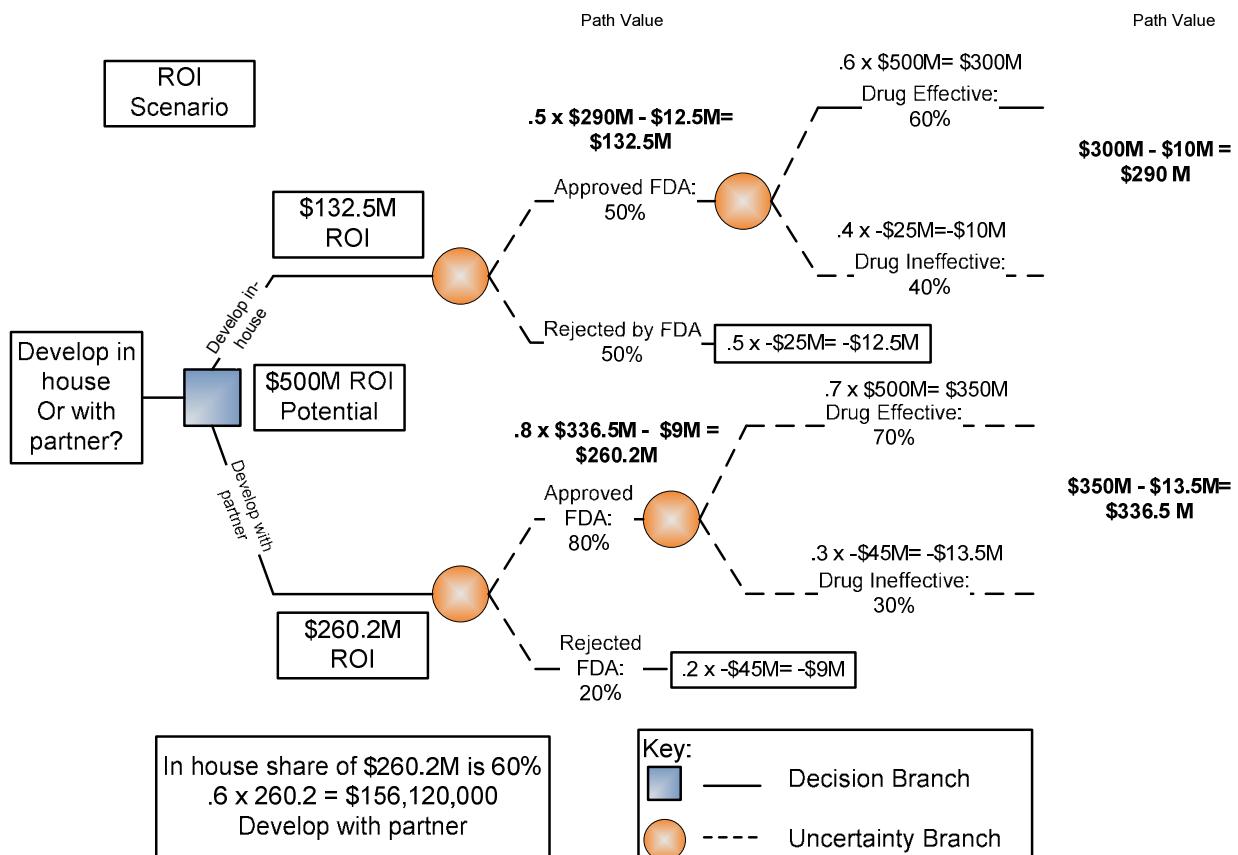
Exam Tip: reserve analysis and the funds set aside for contingencies apply *only* to the specific risks on the project for which they were set aside.

Workarounds



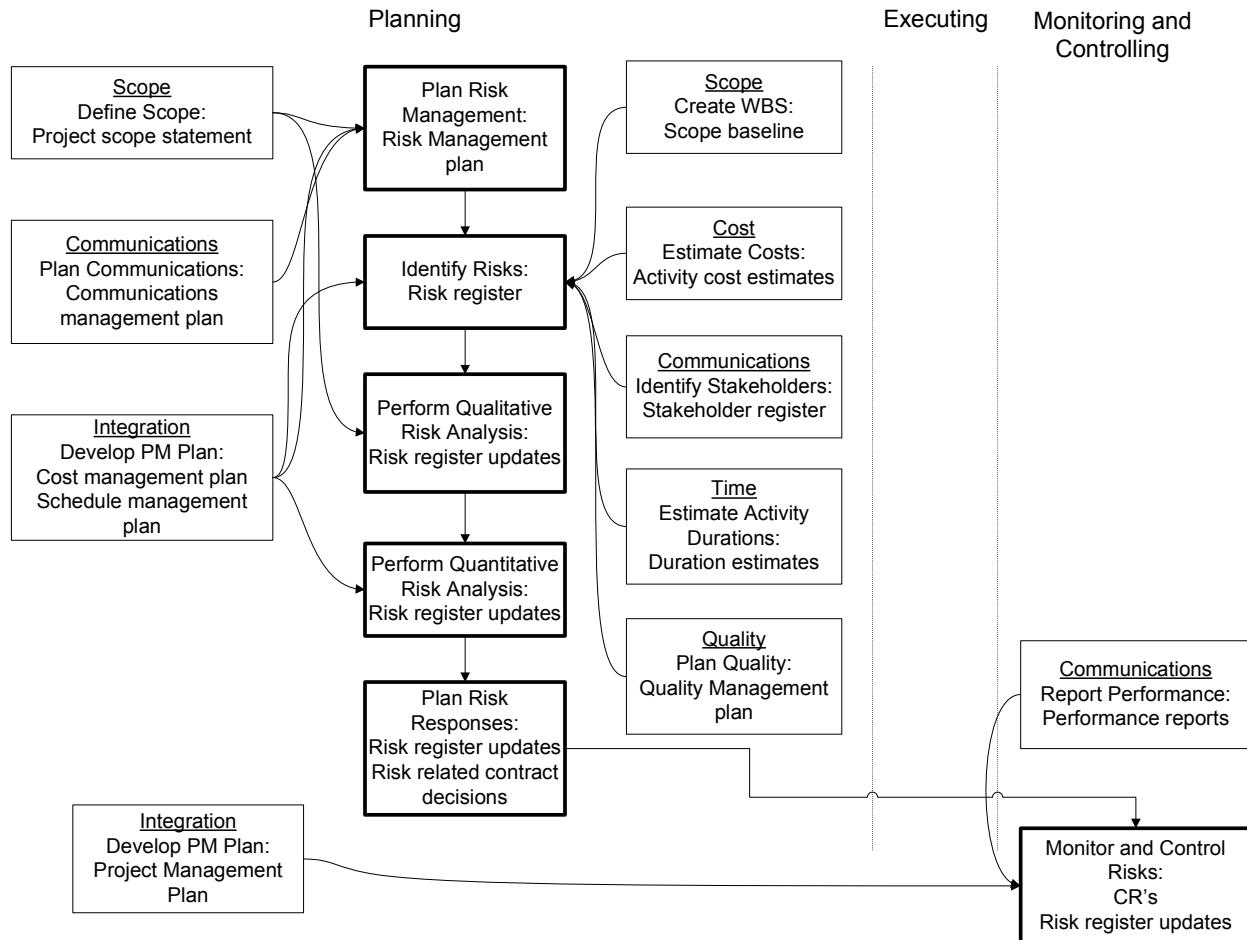
Workarounds are usually employed when no contingency plan exists, and are generally executed 'on-the-fly' to address some unplanned event. The result of implementing a workaround can be the identification of an undiscovered risk for which the contingency and fallback planning can now be addressed.

Solution to Decision Tree from p. 11-16:



Project Risk Management: Key Process Interactions

The key inputs from the other Knowledge Areas to Project Risk Management processes are shown below. *Know these process interactions for the exam.*



In Summary...

This section discussed risk management, including:

- The benefit of using a risk breakdown structure
- Information gathering techniques: brainstorming, Delphi technique, interviewing, root cause identification, and SWOT analysis
- Importance and components of the risk register
- Using decision trees and Monte Carlo simulation to assess the quantitative impact of each risk item
- Deciding on the best risk response strategy: avoid, transfer, mitigate, exploit, share, enhance, or accept risk events
- The purpose of risk response audits

Chapter Eleven Memory Check

1. The risk categories in a project management plan can be graphically represented with a tool called a _____
2. The five Planning steps in Risk Management are, in order: _____, _____, _____, _____, and _____
3. The tool that is used to determine where the organization's strengths and weaknesses play against each other is called a _____ grid
4. A risk register that measures probability, impact, and detectability is known as a _____
5. A decision tool that is best used when the participants could become contentious is known as the _____
6. A reactive method of problem detection and solving in which the analysis is performed *after* an event has occurred is called a _____
7. A repository for all known risks on a project that identifies risk responses and owners is called a _____
8. Multiplying the Impact of an event in dollars times its probability is called the _____
9. Three types of responses to negative risks are known as _____, _____, and _____
10. A decision tool that illuminates a possible path forward based on a decision made by the business and the probability of success of each decision path is called a _____
11. The types of responses to positive risks are known as _____, _____, and _____
12. The risk response plan that is used when the risk has been accepted is called a _____ plan
13. A minor risk that remains after the risk response strategy has been implemented is called a _____ risk, whereas a risk that occurs as the result of implementing a risk response strategy is called a _____ risk
14. A _____ is developed when a selected risk strategy is not fully effective or if risk has a high impact
15. _____ are used to provide funding for the 'unknown' unknowns of a project – while _____ are used to handle the known unknowns
16. An unplanned response to risk when no contingency plan exists is called a _____
17. A risk response that is used for both positive and negative risks is called _____
18. A statistical modeling tool used to create cumulative distributions and what-if scenarios is called a _____
19. A risk information gathering technique that collects as many ideas as possible is called _____
20. A document that describes how you will manage and plan your risk responses is called a _____

Chapter 11 Test

1. The tool that lists the categories and subcategories of risk on a project is known as a:
 - a. Risk breakdown structure
 - b. Quantitative risk analysis matrix
 - c. Probability and impact matrix
 - d. Stakeholder tolerance matrix
2. An assumptions analysis is used to:
 - a. Identify historical information for risk analysis
 - b. Identify root causes
 - c. Assess the validity of risk assumptions
 - d. Assess the effectiveness of potential risk responses
3. The project manager overhears two stakeholders discussing the current project. Each stakeholder is discussing the risk impacts of the project on each of their departments. The first stakeholder states that the project will have impact on her department, but states that the team has effective strategies for dealing with it. The second stakeholder is voicing great concern because it may cause them to double their workload. They are looking to acquire additional headcount to meet the need but the company just implemented a hiring freeze (!) At this point, the second stakeholder does not know how serious the impact on her department will be. At the next stakeholder meeting, what will you *most likely* discuss with the stakeholders?
 - a. Stakeholder register
 - b. Stakeholder risk tolerances
 - c. Risk management plan
 - d. Risk avoidance strategies
4. SWOT means
 - a. Strengths, Warnings, Observations, Threats
 - b. Strengths, Waste, Omissions, Terminations
 - c. Stealth, Warrant, Optimize, Transcend
 - d. Strengths, Weaknesses, Opportunities, Threats
5. You have called a meeting with your key stakeholders and team members to resolve a difficult project issue. You are attempting to generate a large number of ideas so that you can create the largest number of options and alternatives to address the problem. What tool are you *most likely* to use in this situation?
 - a. Brainstorming
 - b. Root Cause analysis
 - c. Delphi Technique
 - d. SWOT analysis
6. What is the purpose of a root cause analysis?
 - a. To find defects in a product or process
 - b. To identify problem resolutions for difficult issues
 - c. To identify the individual(s) responsible for the failure
 - d. To find the ultimate precipitating event that caused the failure
7. A series of stakeholder meetings were called to address the needs of stakeholders for the upcoming project. A list of 150 requirements was drawn up. After reviewing the list and developing a high level estimate, the PM reported back to the stakeholder group that due to the budget limitations on the project, it would be possible to deliver 75 of these requirements. A new meeting was called to cull the list from 150 to 75. The stakeholders, all PhD's, were going through the list, when there was serious

contention about a group of requirements. The disagreement escalated to a shouting match, and several stakeholders left the meeting infuriated. What risk tool would have *best* prevented this situation?

- a. Brainstorming
 - b. SWOT analysis
 - c. Delphi Technique
 - d. Nominal Group technique
8. All of the following are key risk register components with the *exception of*:
- a. Identification of the risk trigger
 - b. The risk owner
 - c. Who identified the risk
 - d. The risk response strategy
9. A unique aspect of the quantitative risk analysis process is that PMI recommends that quantitative risk analysis:
- a. Should be performed in conjunction with quality assurance
 - b. Should be repeated after Plan Risk Responses to determine if project risk has decreased
 - c. Can be used in place of Perform Qualitative Risk Analysis
 - d. Can be used to make unknown risks, visible to the project team
10. What is the expected monetary value (EMV)?
- a. The potential cost/benefit of a risk, positive or negative
 - b. What the project ROI will be
 - c. The amount of the risk contingency budget
 - d. The cost baseline minus the risk contingency
11. Your project is completed and is ready to roll into maintenance and support mode. You are weighing the risk of having the internal organization handle support; or contracting an external company that has guaranteed 99.9% response time within an hour for all support issues. There are financial penalties for the external company if it does not meet its guaranteed response time. You decide on the external vendor. This risk response strategy is known as?
- a. Accept
 - b. Transfer
 - c. Exploit
 - d. Mitigate
12. You decide to develop a new product with a partner because the likelihood of product acceptance and success in the marketplace increases by a factor of three with this partner. This type of risk response strategy is *best* described as:
- a. Accept
 - b. Enhance
 - c. Exploit
 - d. Share
13. The risk register has been reviewed for completeness at this point in time. Risks have been prioritized based upon urgency and potential impact. As the team was working on the project, an event occurred that was not identified in the risk register. Since something needed to be done to handle the emergency, the technical team implemented a temporary fix until the issue could be discussed and a permanent resolution installed. This is best described as a:
- a. Secondary risk response
 - b. A workaround risk response
 - c. A residual risk response

- d. A contingency risk response
14. Your risk register is reviewed by an external team every two weeks so that ‘fresh eyes’ are looking at all potential risks. One of the risk response strategies to a specific risk is met with some skepticism by one of the assessors. “You may need to develop an additional response strategy in case this one creates additional problems for you.” What kind of risk is she referring to?
- Secondary risk
 - Fallback plan
 - Residual risk
 - Workaround
15. You are developing a revolutionary new product for the telecom industry. It is a switching product that provides voice, video and data over the same pipeline, but uses a technology that has never been tried before. The potential return on investment for this product is \$5 billion. Your estimated development costs are \$150 million. If you go it alone, there is a 65% chance that you will succeed. You also decide to look into developing the product with a partner that has specific experience with this new technology. With a partner, there is an 85% chance that you will succeed, but development costs in this case are \$250 million, of which the partner is carrying \$50 million. Because you are shouldering 80% development costs, you decide to split the ROI with 80% going to you and 20% going to the partner if the project succeeds. What is the best EMV scenario from your organization’s point of view?
- Build the solution alone for \$3.25 billion in potential return
 - Build with a partner with a \$4.25 billion in potential return
 - Build with a partner with a \$3.37 billion in potential return
 - Build the solution alone for \$3.35 billion in potential return
16. Risk register updates typically include the following *except*:
- Trends in risk analysis results
 - Probability of achieving cost and time objectives
 - Risk management reserves
 - Prioritized risk ranking
17. The impact of risk and the probability of experiencing a risk event are *best* described in?
- Probability and impact matrix
 - Risk Management Plan
 - Risk Register
 - Random Access Matrix
18. Which risk tool is the *most effective* for modeling what-if scenarios?
- Pareto Analysis
 - Monte Carlo analysis
 - Brainstorming
 - Nominal group technique
19. The process of determining which risks have the *most* potential impact on the project is known as a?
- Risk probability and impact assessment
 - Risk data quality assessment
 - Sensitivity analysis
 - Expert judgment
20. You are managing a project in which measurement accuracy is of paramount importance. Which of the following would have the *largest impact* to decrease the risk of obtaining inaccurate measurements?
- Secure resources with the most experience in measurements

- b. Make sure the measurements are taken at the same time of day
 - c. Have the QA team audit the process
 - d. Have the resources take measurements against previously measured elements that have established, verified results
21. You are managing a large project team of over 75 people. This computes to a minimum of 2775 potential lines of communication between all the team members. As the project manager, what is your *largest* risk concern?
- a. Crashing the e-mail system
 - b. Controlling the communication hierarchy
 - c. Shielding potentially embarrassing communications from senior executive staff
 - d. Ensuring communications are clear
22. Your project has implemented several risk response strategies along the way. While the risk response strategies have generally worked, the project manager wants to explicitly evaluate the success of those risk response strategies. The tool that would *best* help the project manager make this determination is:
- a. Risk analysis
 - b. Trend Analysis
 - c. Quantitative analysis
 - d. Variance analysis
23. You have just experienced a risk trigger on your project. What type of risk response *usually* occurs when a risk is triggered?
- a. Mitigation response
 - b. Contingency response
 - c. Avoidance Response
 - d. Workaround response
24. Who owns the resolution of any given risk on the project?
- a. The team
 - b. The sponsor
 - c. The PM
 - d. It depends on the specific risk response being utilized
25. All the answers below are reasons for performing risk management *except*?
- a. Reduce the impact of threats
 - b. Ensure the occurrence of opportunities
 - c. Elimination of issues
 - d. Planning for known and unknown events

Chapter 11 Test – Answers

1. A – This is the definition of an RBS. *PMBOK® Guide*, 4th edition, p. 280
2. C – Assesses the validity of assumptions as they apply to the project. *PMBOK® Guide*, 4th edition, p. 287
3. B – In this instance, the stakeholders are discussing their tolerance for risk. The first stakeholder can deal with it well, while a second stakeholder will have real difficulty. The risk register (A) is a risk repository for all risks; the risk management plan (C) focuses on how risk will be managed and audited, and a risk avoidance strategy (D) is a specific risk response may not be possible.
4. D – The SWOT acronym means: strengths, weaknesses, opportunities, threats. *PMBOK® Guide*, 4th edition, p. 288
5. A – Brainstorming is the tool that is used when attempting to create a large number of ideas to address a potential risk or problem
6. D – Root cause analysis identifies the precipitating event that caused the failure. Frequently organizations focus on the point of failure to address their corrective activities. The point of failure is simply a symptom of the real problem that started much further upstream. The point of the root cause analysis is not to fix the symptom, but to find the cause and eliminate it.
7. C – With the Delphi technique, participants remain anonymous to each other so that they can simply focus on the facts without having to deal with the emotional components of the problem.
8. C – Who identified the risk is not an important part of the risk register
9. B – Quantitative risk analysis should be repeated after plan risk responses to determine if the project risk has decreased. *PMBOK® Guide*, 4th edition, p. 295
10. A – The expected monetary value (EMV) outlines the potential cost of a negative risk or the potential benefit of a positive risk.
11. B – You have transferred the risk to a third party. If they do not meet their service-level agreements, there are financial penalties levied against the performing organization
12. D – Here, you are sharing a potential benefit via a JV and a greater return on your investment
13. B – A workaround is defined as a response to a negative risk that was not part of original risk planning. It is usually a solution developed "on-the-fly" until a permanent solution can be derived
14. A – In this case, the fact that the risk response may create 'additional problems for you' defines the secondary risk
15. C – This is a decision tree question. The decision branch for going it alone computes as follows: 65% of \$5 billion = \$3.25 billion. 35% of \$150 million = \$52.5 million. The EMV equals 65% of the ROI minus 35% of the potential failure costs, or \$3.25 billion - \$52.5 million = \$3,197,500,000. The decision branch for sharing the development with a partner computes as follows: 85% of \$5 billion = \$4.25 billion. 15% of \$200 million (your share of the \$250 million development costs) = \$30 million. However, do not forget that your share of the ROI is 80% of the \$4.25 billion. This nets out to \$3.4 billion. \$3.4 billion - \$30 million = \$3.37 Billion. All in all, developing with a partner gets you a higher return on investment
16. C – Risk registers typically do not include management reserve amounts. *PMBOK® Guide*, 4th edition, p 306
17. A – This is best described as a probability and impact matrix. *PMBOK® Guide*, 4th edition p. 281
18. B – What-if modeling scenarios are best created with the Monte Carlo Analysis
19. C – The question is the definition of a sensitivity analysis. *PMBOK® Guide*, 4th edition, p. 298
20. D – The only approach mentioned here that will determine your measurement accuracy is to have the technical team take measurements against elements that already have a known result. In other words, have the team measure something that is already producing a consistent and accurate result to see if the team gets the same result.
21. B – Three of the answers are, to a degree, *somewhat* correct. However, controlling the communication hierarchy is the only answer that will enable you to control the complexity of communications on the project
22. D – The tool that is used to explicitly evaluate the success of risk response strategies is called a variance analysis. *PMBOK® Guide*, 4th edition, p.310
23. B – The contingency response is the most common in this case

24. D – Once again, three of the answers are somewhat correct depending on the situation however, the best answer is it really depends on the specific risk response as to who owns the risk.
25. C – Issues are not addressed in risk management – issues are not risks, they are *FACTS*

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Chapter 12 : Project Procurement Management

Section Topics:

- ▶ Plan Procurements
- ▶ Conduct Procurements
- ▶ Administer Procurements
- ▶ Close Procurements

Section Objectives

With this section, you will be able to:

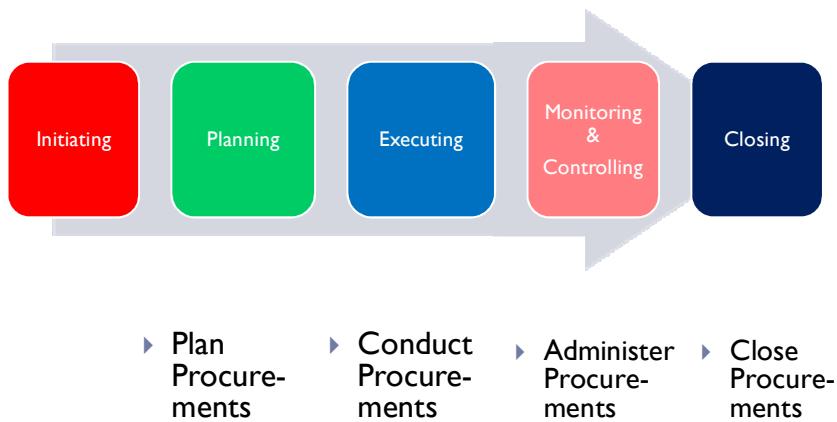
- List the required elements of a contract
- Describe the various types of contracts
- List the types of procurement documents
- Define various legal terms to know for the exam
- Calculate PTA – Point of Total Assumption
- List various negotiation tactics
- List contract closeout activities

Project Procurement Management Process Summary

The high level Project Procurement Management output elements, by Process Group are:

Initiating	Planning	Executing	Monitoring and Controlling	Closing
	-Procurement management plan -Procurement SOW -Make-or-buy decisions	-Selected sellers -Procurement contract award	CR's	Closed procurements

Project Procurement Management



The procurement process formalizes how organizations obtain goods and services from outside the organization. As a result, process can involve make or buy decisions, securing expertise not available within the organization, potential lease decisions, and the best type of contract to use when obtaining goods or services.

This can include the use of local sourcing or off-shore teams. If the resources are within the United States, the local, state and federal laws and regulations governing business transactions apply. In the case of obtaining off-shore procurements, understand the local laws and customs that are at work in these locales. What is illegal in the United States may be ethical (and expected) in another country.

Understand that the procurement activity involves the creation of a 'Procurement Statement of Work' (SOW). This is a legal document subject to legal reviews – breaches of contract may be addressed in the US court system. The seller is legally bound to what is contained in the contract SOW, and no more. Therefore, when establishing a contract SOW, it is in the best interests of the purchaser/buyer to make the document as detailed and accurate as possible, to avoid misunderstandings and misinterpretations that can lead to legal disputes.

There are usually specialized parts of the organization that deal with procurement activities regularly and that have developed significant expertise in these areas. If you have never dealt with these areas as a project manager, this aspect of the exam may prove to be more difficult than some of the other areas. Pay particular attention to the details in this chapter.

Procurement for the Exam

Unless stated otherwise, assume you are the buyer/purchaser of goods and/or services for your organization. The contract will include *terms and conditions* that specify what the seller is to deliver to the buyer, and it is the project team's responsibility to insure that procurements meet the explicit needs of the project.

On exam questions, sellers may be identified as prime contractors, sub-contractors, vendors, service providers or suppliers, and the seller is external to the project team. It is also assumed that the contract between the buyer and seller is a formal written agreement. To summarize:

- Questions are from the ***buyer's perspective unless the question states otherwise***
- Seller is offering goods or services
- Buyer is buying goods or services
- Contract outlines terms of agreement between buyer and seller

Required Contract Elements

All contracts between the seller and the buyer must contain the following elements:

- The **offer** describes the product or service the seller may offer the buyer.
- The **acceptance** is performed from the buyer's point of view - it describes the explicit criteria under which the buyer will accept the product or service delivered by the seller
- **Capacity** means that the seller has the physical and/or financial capabilities to deliver the product or service according to the specifications in the contract
- **Consideration** is what the seller will receive for performing the work of producing the product or service for the buyer. This can be in the form of direct monetary compensation to the seller or some other form of compensation.
- **Legal purpose** means that the contract must be legal under US state, federal, or local laws. You cannot draw up a contract to commit a murder that would legally be supported in the courts of the United States. That is explicitly *not* a legal purpose

Project Manager's Role in Procurement

For the exam, you need to understand what role the project manager plays in the procurement process - there will be questions on the exam that will test your understanding of this critical role. Make sure you understand the following:

1. It is best if the project manager is assigned to the project before the contract is signed. There is a strong risk that the deliverables or the completion dates for the project may be jeopardized if the contract is signed without any regard to what is needed for the project.
2. Review your understanding of contract terms and conditions, so that there is no ambiguity when dealing with the contract.
3. Ensure you have input to tailor the contract to the needs of the project as the contract is being written.
4. Identify risks in a contract that may impact project deliverables or timelines.
5. Make sure the project schedule can be adjusted to include enough time for the completion of the procurement process.
6. Make sure you have access to procurement personnel to fully understand the procurement process for the project.
7. Make sure you are also involved in contract negotiations to help protect the relationship with the seller.

Centralized/Decentralized Contracting

► May be on the exam (not defined in PMBOK®)

Centralized:

Advantages	Disadvantages
Higher Expertise levels	Multiple projects
Continuous improvement	Difficulties for PM to obtain help
Standardized practices	
Defined career path	

Decentralized:

Advantages	Disadvantages
PM easier access to contract expertise	No home department for the procurement manager
Procurement manager more loyalty to project	Harder to maintain high level of contracting expertise
	Duplication of effort
	Little standardization
	No career path

There are two types of contracting mentioned on the exam that are not defined in the *PMBOK® Guide*, 4th edition at all: centralized contracting and decentralized contracting. This will let you know how the procurement department is organized, and what authority the procurement manager has in executing a contract.

In a centralized environment:

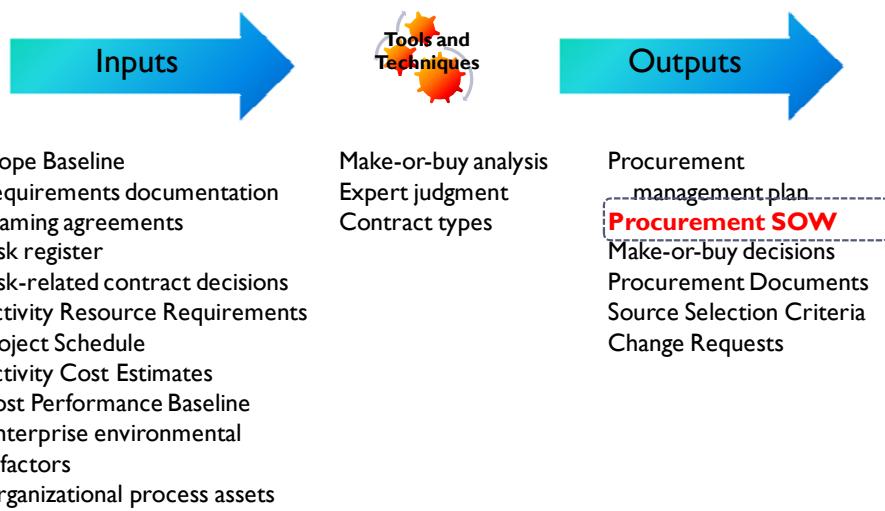
- The procurement manager may manage many contracts
- The general advantages support procurement managers with higher levels of expertise, as well as standardized company practices and clearly defined career paths in the procurement area.

- General disadvantages can include difficulties in obtaining contract expertise for your project, as well as the lack of a dedicated procurement resource for the project.⁴¹

In a decentralized environment:

- The procurement may be assigned specifically to the contract and may directly report to the project manager.
- General advantages are that the project manager has easier access to contracting expertise, and the procurement manager has more loyalty to the project.
- Disadvantages can include lack of contracting expertise, duplication of effort, no clearly defined career path for procurement personnel, or a duplication of effort.⁴²

Plan Procurements



This process focuses on determining whether or not to obtain products and services from outside the organization, and to identify explicitly what is needed. This will frequently be identified as a 'make or buy' decision.

- The schedule requirements of the procurement activities must be coordinated with the needs of the project so that the goods or services procured occur in a timely fashion.
- Risk considerations are reviewed with each make or buy decision – what are the risks the organization is taking by either doing the work in-house, or contracting a vendor to perform work or deliver a product?
- Teaming agreements or joint ventures are an important input to the Plan Procurement process. They are legal contractual agreements between two or more parties that define the buyer-seller relationship, and only last for the duration of the agreement. These agreements are usually

⁴¹ "Encyclopedia of Production and Manufacturing Management", Paul Swamidass, Kluwer Academic Publishers 1999, p. 606

⁴² "Decentralization, Hierarchies, and Incentives: A Mechanism Design Perspective", Dilip Mookherjee, *Journal of Economic Literature*, Vol. 44, No. 2 (Jun., 2006), pp. 367-390

arranged to pursue a new business opportunity or to synergistically optimize the strengths of each organization to produce a better product. As an output of Plan Procurements, specific *procurement documents* are created to solicit proposals from sellers. These documents vary depending on the type of contract being used, and generally fall into the following categories:

- RFP or Request for Proposal
- IFB or Invitation for Bid
- RFQ or Request for Quote
- RFI or Request for Information
- Tender Notice
- Invitation for Negotiation
- Seller Initial Response

Perform Make or Buy Analysis

Costs are evaluated on Make/Buy decisions as well as:

- In-house expertise
- Facility availability
- Resource Availability
- And other considerations

Buying or leasing may also be possibility because elements that involve trade secrets, product innovations or require strict controls may be better left in-house.

There are any number of considerations in performing a make or buy analysis for your organization. You may be asking yourself; do we have the required skill sets for the work(?), can our facilities handle the type of work that needs to be performed (?), if we job out the work, are there trade secrets we might potentially expose to competitors (?).

Other considerations can include, funding, availability of resources, mitigation of risk, potential partnering agreements and others. This information can be documented in formal organizational process assets, which may include templates using specific software tools that are able to perform a weighted analysis of the decision factors.

Procurement Statement of Work

The procurement statement of work is a document subject to legal review that is legally binding on both parties - the seller and the buyer - the provisions of which can be a redressed in US courts of law, should there be a contract dispute or any cardinal breach in the contract.

On large contracts, the procurement statement of work can run upwards of thousands of pages (!)

There are three fundamental procurement statements of work types which are detailed in the bullet points below:

- **Performance** – defines the level of performance required in the final product or service without specifying how the work should be done or the product's design characteristics e.g. this compound hunting bow will deliver a shaft to within 1 inch target at a range of 100 yards requiring a pull strength of no greater than 8 pounds.
- **Functional** – describes specific functions the product needs to perform while in operation e.g. the vehicle will warn the driver when the speed limit has been exceeded and will allow all four wheels to turn when parallel parking.
- **Design** – in which the vendor builds to a specific design specification e.g. the vendor machines component parts based on blueprint specs.

Contract Types and Risk Assessment

There are three basic types of contracts with variants of each type. The three types, including their variants are listed below:

Firm Fixed Price (FFP)

Advantages for Buyer

- Greatest risk to the vendor - they are on the hook to deliver
- Implemented when the product or process is well known
- You don't have time or resources to audit invoices
- SOW is detailed and specific, as are the product specifications
- You are buying "Just do it!"

Disadvantages for buyer

- The vendor's profit margin is unknown to the buyer
- Can be exposed to excessive change orders if the seller's profit margins are threatened or if the seller 'low-balled' the original contract offer
- Constitutes more effort on the buyer's part to create an explicit statement of work

Variants of the FFP include:

1. FPIF (Fixed Price Incentive Fee). Financial incentives are tied to superior performance from the seller, i.e. additional monies can be won for delivering the project ahead of schedule or for outstanding technical performance
2. FPEA or FP-EPA (Fixed Price with Economic Adjustment or Economic Price Adjustment). For a contract that spans multiple years, economic adjustment can take the form of pre-defined adjustments due to increased price for commodities over time, inflation or other changed conditions

3. PO (Purchase Order). Usually a fixed-price contract for off-the-shelf goods or service. Built-in price discounts can be applied depending on the volume of the purchase. These prices are usually published in the seller's catalog or website.

Cost Reimbursable (CR) Also called "Cost Plus"

Advantages for Buyer:

- Can be lower cost than a fixed-price vehicle
- Implemented when outcome may *not* be clear
- You are buying 'expertise' – specifications may not be known
- Procurement statement of work may be simplified

Disadvantages for Buyer:

- Greatest risk to buyer
- The seller has little incentive to control costs
- More effort is required to audit seller invoices to keep control of costs
- Because you are purchasing expertise, the total cost may be unknown at the beginning of the procurement

Variants of the CR contract include:

1. CPFF (Cost Plus Fixed Fee). The vendor is reimbursed for all allowable costs – the fixed fee is usually calculated as a percentage of the original costs
2. CPIF (Cost Plus Incentive Fee). The vendor is reimbursed for all allowable costs – an incentive fee can be applied based on the vendor's performance on the contract. In some instances there can be a sharing ratio; i.e. the vendor can receive additional monies for performance and the buyer may receive a discount if the vendor's costs are under the contracted amount
3. CPAF (Cost Plus Award Fee). The vendor is reimbursed for all allowable costs – the vendor can receive an award fee based on subjective criteria that are broadly defined in the contract. The actual fee is determined at the whim of the buyer.
4. CPPC (Cost Plus Percentage of Costs) Illegal for contracts with the US Government
5. Cost Contract – The seller does not receive a profit – usually set up with not-for-profit organizations
6. Best Efforts – obligates the seller to utilize their best attempts to accomplish the goal of the project, particularly when there is uncertainty about the ability to meet the goal

Time and Materials (T&M)

Advantages to Buyer:

- Usually set up with known costs and a 'not to exceed' amount
- A unit price type of contract - usually quick and simple to create
- Contract duration is generally short-term

Disadvantages to Buyer:

- Seller's profit is built into each billable hour - thus there is no incentive to control costs
- The buyer must constantly monitor the work being done on the project

Time and materials contracts are generally used for staff augmentation projects in which resources are contracted into the organization on a temporary basis. T&M type contracts can be useful for quick proof-of-concept type projects, or where the purchasing organization is implementing a 'try-before-you-buy' scenario.

Quick Quiz: what type of contract would best be suited for the following scenarios?

Scenario	Contract Type
You need two PL/SQL developers and a UNIX admin to supplement your staff for three months on an ongoing project	
You need a detailed and explicit procurement statement of work	
You do not have the in-house expertise to build the needed product and you need the job done very well	
You've just priced 35 laptops at CDW - the price looks reasonable and you're ready to purchase	
Since the contract is long-term, the vendor has concerns regarding inflationary issues or unexpected changes in the business environment	
You engaged a not-for-profit organization to perform the work	
The vendor does not guarantee the results of the project regarding budget, timeline, or risk	

(answers: T&M, FFP, Cost plus, PO, FP-EPA, Cost contract, Best efforts)

Point of Total Assumption

The point of total assumption is used in certain fixed-price contracts or fixed-price incentive fee contracts, and is used in the event that there is a cost overrun on the project. The point of total assumption is the point at which the seller assumes all additional costs for delivering a product of the project.

For a cost reimbursable contract, the Point of Total Assumption does not exist, since the buyer agrees to cover all costs – *unless* – an incentive arrangement with similar components, called a Fixed Price Incentive Fee (FPIF) contract, sometimes is used.

A typical example of a point of total assumption calculation appears below.

Fixed Price Plus Incentive – PTA

Seller Share (20% = 137,500)	Ceiling 2.45M
Buyer Share (80% = 112,500)*	PTA 2.3125M
Total Profit (200k)	Cost + Profit e.g. original total price to buyer
Total Cost (2M)	Target Cost e.g. original total cost w/o profit

- ▶ **The Point of Total Assumption (PTA) - the point at which the seller assumes all additional costs:**
 - ▶ Seller assumes 100% of costs
 - ▶
$$\text{PTA} = ((\text{Ceiling Price} - \text{Total Price}) / \text{Buyer's Share Ratio}) + \text{Target Cost}$$
- ▶ **For example, assume:**
 - ▶ Total Cost (Target Cost): 2,000,000
 - ▶ Total Profit: 200,000
 - ▶ Total Price: 2,200,000
 - ▶ Ceiling Price: 2,450,000
 - ▶ Share Ratio: 80% buyer–20% seller for overruns, 50%–50% for under runs
 - ▶
$$\text{PTA} = ((2,450,000 - 2,200,000) / 0.80) + 2,000,000 = 2,312,500$$



Brain Dump!

The ‘total cost’ , ‘estimated cost’,or ‘target cost’ (the three terms are synonymous), represents the contracted cost without the profit.

The ‘total profit’ is the profit on the project.

The ‘total price’ equals the total cost plus the total profit.

The 'ceiling price' is the highest price the buyer will pay for the product or service.

The 'sharing ratio' represents the buyer share of the cost overrun.

The PTA formula:
$$\text{PTA} = \frac{(\text{ceiling price} - \text{total price})}{\text{Buyer's share ratio}} + \text{Target Cost}$$

Question: what is the point of total assumption for a contract with a total cost of \$1.2 million, a profit of \$160,000, a buyer's share ratio of 70% and a ceiling price of \$1.5 million?

$$(\$1,500,000 - \$1,360,000) / .70 + \$1,200,000 = \$1,400,000$$

Unit Price and Time & Materials Contracts

Here is some additional information on unit price and time & materials contracts, (T&M).

With a unit price contract vehicle, the customer pays a fixed sum for each completed unit of work. The total payment to the contractor is based on the actual quantities multiplied by the respective quoted unit prices. Where the unit cost is not clear to the buyer, vendors may submit bids for the work. Therefore, the final price used to determine the lowest bid is based on the lump sum price: the quoted unit price multiplied by the quantity needed.

The T&M contract is generally used when the scope of work is not known, or when the buyer is attempting to acquire information about a particular product or service. For example, the buyer may need a help desk function on certain hardware or software purchases, but may not know at what level these purchases need to be supported. The buyer may initiate a three or six month T&M contract for the support of these elements. After three or six months, the data collected to support these hardware and software components will help the buyer identify needed support levels, so that they may eventually create a fixed-price contract.

To summarize:

Unit Price:

- Customer pays a fixed sum for each completed unit of work
- In construction contracts, “unit price bidding is used in projects for which the quantity of materials or the amount of labor involved in some key tasks is...uncertain.”⁴³

T & M:

- A cross between fixed price and cost reimbursable contracts
- PMI states: “T&M contracts can also resemble fixed, unit price arrangements when certain parameters are specified in the contract”⁴⁴ e.g. an hourly charge or a per item charge
- Usually where the scope of work is not known or for short term services

Standard Procurement Documents

There are three basic types of procurement documents associated with the contract type:

- The request for proposal (RFP) is usually used on a cost reimbursable vehicle. This is a situation where the buyer is purchasing expertise, and is usually looking for a Functional or Performance type, statement of work.
- The invitation for bid (IFB) or request for bid (RFB) contract is customarily associated with a fixed-price contract vehicle. This is a situation where the buyer is purchasing a product or service that is well understood. The statement of work is commonly, design specification based.
- The request for quote (RFQ) is primarily utilized with a time and materials vehicle and can use any of the previously mentioned of SOW types, depending on the needs the contract.

A graphic summary appears below:

⁴³ *Project Management for Construction*, Chris Hendrickson, Prentice Hall, 1989.

⁴⁴ *PMBOK® Guide* 4th Edition, p. 324

Document Type	Contract Vehicle	SOW Type
RFP – request for Proposal	Cost Reimbursable	Functional/ Performance
IFB (Invitation for Bid) or RFB (Request for Bid)	Fixed Price	Design
RFQ (Request for Quote)	T&M	Functional/Performance/ Design

Additional Terms

There are numerous terms and conditions, in addition to the terms we have already covered, that you need to be familiar with for the exam:

- **Agent** - authorized representatives from both the buyer's and seller's side
- **Assignment** - one party can assign its contracted rights or obligations to another
- **Cancellation:**
 - **For Convenience** - purchaser cancels the contract due to changing business conditions or changing direction. The buyers pay for all work up until the point of the cancellation - it is a 'no harm, no foul' situation
 - **For Cause** - this occurs when there has been a *cardinal breach/material breach* or *default* of the contract terms by either party. This leaves either party open to legal action by the other party and may result in liquidated damages. The party responding to the breach must do so timely, formally and in writing. If the breach is not addressed immediately, the aggrieved party may lose its right to take action on the breach later. A *cardinal breach* is identified as so serious that it may not be possible for the seller to complete the terms of the contract
- **Confidentiality** - certain information relating to the contract must be kept confidential. Failing to do so may result in a breach or default on the contract.
- **Escrow** - can be used as a contract provision if the purchaser has concerns about the viability or survivability of the seller. For software development projects, code may be placed in escrow in the event that the seller goes out of business and the buyer needs access to the code to continue its operations. This can be used specifically in situations where the seller does not want to give up its intellectual property rights for developed product.
- **Force majeure** - a standard disclaimer used in a contract that refers to 'Acts of God'. It describes a situation in which neither the seller nor the purchaser, can be held accountable or responsible for the events
- **Indemnification or Liability** - defines who is responsible for injury, damage, or accidents
- **Intellectual Property** - defines who owns any patents, designs, trademarks, copyrights, or product that was developed during the course of the contract
- **LOI** – Letter of intent. The buyer states they intend to hire the seller. This is not legally binding.
- **Ownership** - who will own the items that were used in the development of any deliverables that were part of the contract?

- **Payments** - this can include scheduled payments, late payments or fees, or withholding payments for cause, such as an inaccurate invoice.
- **Privity** - The prime contractor can use sub-contractors. Since the sub is contracted to the Prime and not to the buyer, the buyer has no contractual control over the sub.
- **Retainage** - specific payment amounts withheld from each payment to ensure delivery of the final product - usually in the 5-10% range.
- **Risk of Loss** - divides the risk of loss between the parties, should goods or services become lost or destroyed during contract execution.
- **Termination** - stopping work before it is complete
- **Time is of the essence** - this means that delivery dates are contractually binding, and that the procurement activity is fundamentally time constrained. In this case, delay can be considered a cardinal breach of contract.
- **Waivers** - these are contract statements specifying that rights under the contract may not be waived unless agreed to by both parties. As the project manager, make sure that you do not intentionally or unintentionally give up a right in the contract.
- **Work made for hire** - identifies all contracted work as owned by the purchaser

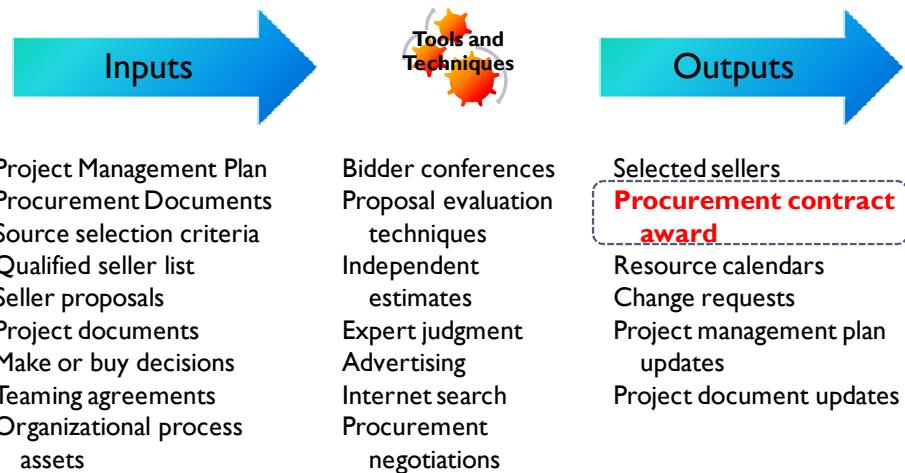
Non-Competitive Forms of Procurement

It is important to understand certain types of noncompetitive forms of procurement for the exam. There are reasons why this may occur; for example, a seller may be best in class, or may even be the only provider of a specific product or service.

A **sole source** provider is the only provider for the product or service available. One example of a sole-source provider is the musical licensing agency Harry Fox. Any recording artist wishing to record previously released material can only license this material through the Harry Fox agency, and Harry Fox provides this service for the entire music industry in the United States.

A **single source** provider is a preferred vendor, usually one that does an exemplary job and provides a high level of service for the particular product or service. The Toyota Corporation typically engages single source providers - vendors with whom they seek to form a long-term relationship - that deliver high quality, low prices, and very short turnaround times.

Conduct Procurements



This is the process of identifying qualified sellers that can actually perform the work, delivering the appropriate procurement documents to the sellers, and soliciting a response from the sellers so the selection of a seller can be completed.

In many instances, buyers will create an approved vendors list; vendors that they have identified as producing quality work with whom they have formed ongoing relationships. In many instances, a Master Services Agreement is set up that addresses the administrative details of performing projects, so that vendors on this approved vendor list can focus on the work at hand.

For situations in which there is not an approved vendor that can supply the skill set, or provide the product in question, the buyer may advertise in trade publications or newspapers in an attempt to identify a potential seller.

The Conduct Procurements process usually involves a formal weighting and/or evaluation process to assess the elements of the buyer's request against seller capabilities and responses. This way all potential seller responses can be ranked and evaluated by criteria in prioritized sequence. The ultimate purpose of this activity is to select a seller.

Vendor Evaluation Criteria

Key vendor evaluation criteria include, but are not limited to, the following:

- Risk - what is the risk contained in the statement of work and how will the seller mitigate risk?
- Understanding of Need - does the seller's proposal address the procurement statement of work effectively?
- Life-Cycle Cost - this addresses the 'total cost of ownership' aspects of the project. What is the overall cost of the project, based on the purchase price plus all operations and maintenance costs?

- Technical Capability - does the seller have the technical skills to deliver the product of the project?
- Management Approach - does the seller's management approach make sense to the buyer? Do the organization's culture and process assets contribute to the delivery of a successful project?
- Technical Approach - will the seller's proposed methods, procedures, techniques, solutions, and services meet the requirements of the procurement?

Bidder Conferences

This is a key tool and technique in conducting procurements. A bidder's conference invites all bidders to a Q&A session in which bidders can ask clarifying questions regarding the buyer's RFP. This is done to ensure that all bidders have a clear understanding of the business and technical requirements of the project. It also ensures that all bidder questions are funneled through the buyer's single point of contact, so that it will be clear that no bidder is receiving preferential treatment. Not asking questions through the buyer's single point of contact is usually grounds for disqualification from responding to the buyer's RFP.

The bidder conference process allows the other bidders to hear questions from all other bidders and the buyer's response to each of those questions. Because some sellers feel that asking questions in front of potential competitors may reveal their technical approach to a problem, bidders are usually very careful to ask questions in a manner that does not reveal their technical approach to the RFP.

Qualified Sellers Lists

Maintaining a list of qualified sellers, or approved vendors, has distinct benefits for the buyer:

- Familiarity with the seller's management structure
- Understanding of the seller's technical capabilities
- Clear understanding of methods, procedures and standards utilized by the seller
- Quality of deliverables is well known and understood
- May serve as a yardstick by which to measure other potential vendors
- Set up of a 'master services agreement' establishes an administrative foundation for managing procurement activities with specified vendors. Once set up, the basic 'rules of engagement' for all procurements with the vendor are already defined.

Review Seller Proposals

There are a number of tools that are used to evaluate seller proposals. Outside of the look and feel of the proposal, quantitative methods are used to calculate specific metrics that measure the seller's ability to satisfy the proposal criteria. Some of these tools include:

- **Weighting Systems** - essentially a grid listing all the proposal criteria and assigning a numeric weight each of the criteria. Each seller is then scored on a scale of 1-10 against each of the

proposal criteria. The criteria, multiplied times the seller score, equals the seller's total score for that criterion. Total scores for all the criteria are added up for each seller, and highest score wins.

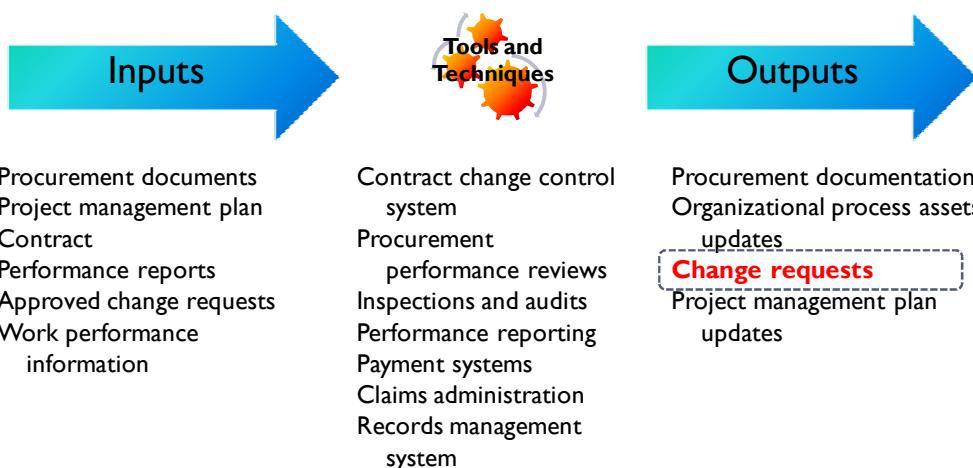
- **Independent Estimates** - the buyer hires an external auditor to evaluate seller estimates.
- **Screening Systems** - usually a prequalification tool that is used to screen out nonqualified vendors. This can include a list of 'showstopper' criteria the seller must achieve to be considered for the contract.
- **Sellers Ratings Systems** - a repository of past performance evaluations of the seller. This can give the buyer an idea of how the seller may perform on the current proposal, if accepted.
- **Expert Judgment** – the seller's proposal may be evaluated by multidisciplinary teams, such as a cost review team, a technology review team, and a legal review team.

Contract Negotiations and Tactics

When engaged in negotiations with a vendor, there are a number of negotiation tactics that can be employed. You may see reference to any one of these tactics on the exam. Become familiar with the terms and their meanings.

- **Fait Accompli** - Standard contract terms that are nonnegotiable. (In reality, *anything* in the contract is negotiable although your adversary will never admit it).
- **Deadline** – A set deadline by which the other person has to decide or act. Make it clear that this is the time by which they must do what you want them to do. As the deadline approaches, increase the emotional pressure, talking more about what will happen if the deadline is missed. This may include threatening actions or vague and disturbing hints.
- **Good guy /bad guy** - One person acts in an aggressive and pushy way, making unreasonable demands and requiring compliance. The other person then acts in a kind and friendly way, asking nicely -- and getting compliance.
- **Missing man** - The person who can actually make the decision is missing from the negotiation. The negotiator can then negotiate for a lower price or more favorable terms which they claim they can agree to.
- **Limited authority** - Refusing to give in on items because you have not been given authority to do what is being requested.
- **Fair and reasonable** - You can engage the other person by asking them 'what is fair'. You can also bring something into the negotiation that is, by definition, fair. You can also reject criteria from the adversary on the grounds that it is not fair.
- **Unreasonable** - Stating that the other side is making unreasonable demands of you in the negotiation.
- **Delay** - Stretching out the negotiation, especially at critical moments.
- **Attack** - A direct attack on your integrity, trustworthiness, competence, or other such bullying bombast designed to force compliance out of you.

Administer Procurements



This process focuses on managing and monitoring the contract, the relationship with the seller, and making changes and/or corrections as necessary. One very important part of the Administer Procurements process is the execution of performance reviews, as well as inspections and audits of delivered product. The project management team must be sensitive to legal implications when administering any aspect of the procurement process.

One of the key tools in the administer procurements process deals with potential disagreements between the buyer and the seller. There may be changes or disputes that need to be addressed in a claims administration process. Claims are documented and monitored throughout the contract life cycle and are executed in accordance with the specifics of the contract. If the parties cannot resolve a claim, it may have to be handled in accordance with an alternative dispute resolution (ADR), facilitated by a third party.

Contract Administration

On the exam some very tricky questions can be asked about contract administration. Make sure you understand the PM's role for managing each type of contract, and the pitfalls of managing each type:

Fixed Price

- Look out for excessive change orders - it may be an indication that the seller's profit is being impacted.
- Audit the sellers work to ensure that scope and quality are not being impacted. The seller may try to cut corners in order to bring in the contract at a fixed price without impacting their profit margin. Bait and switch is a typical tactic here; for example, on a construction project the seller might swap out a stainless steel electrical conduit for PVC without making the buyer aware of it.
- Review the statement of work to ensure that the scope is clearly understood by both parties.

Cost Reimbursable

- All invoices need to be audited - ensure that the work is being performed corresponds to the resources performing the work.
- Look out for additional charges that were not part of the original plan.
- If specific resources with specific skill sets have been contracted, ensure they are not replaced with lower cost, less experienced resources for the same price.
- Ensure that all charges are specifically applicable to your project.
- Ensure deliverables meet their expected milestone dates. Tie payments in the contract to delivered milestones.

Time and Materials

- Ensure that hours are not padded.
- Keep the project to a fixed length.
- Require that deliverables are defined and met by specific milestone dates.

Contract Change Control System

"A contract change control system defines the process by which procurements can be modified."⁴⁵ Change control in a contract is essentially handled in a similar fashion to how it is handled for your project, but there are significant differences. Change control in a procurement environment is more complicated than it is on your project for the following reasons:

- Both the buyer and the seller have different reasons for why they want to or do not want to implement a change. There may be conflict in this area: the seller may submit a change that the buyer sees no reason to implement.
- The buyer usually has less visibility into the seller's internal processes and, therefore, the reason for changes may not be as evident to the buyer.
- Organizational cultures may get in the way and increase complexity between the buyer and the seller when attempting to implement changes.
- If changes are necessary, it must be clearly spelled out in the contract who in your organization has the authority to approve them; it is generally not the project manager.

Change steps:

- Analyze impact of change.
- Follow change procedures specified in contract.
- Any changes to a contract must be formally made.

Know who has authority to make changes to the contract.

⁴⁵ PMBOK® Guide, 4th edition, p. 338

Contract Monitoring

Understand that when you monitor the contract in the administer procurement process, you are using some of the following project processes:

- **Direct and Manage Project Execution** to authorize the seller's work
- **Report Performance** so that you can monitor the cost, schedule, and scope of the contract as well as the sellers technical performance
- **Perform Quality Control** to validate the quality of the seller's deliverables. This requires inspections and audits of the sellers processes
- **Perform Integrated Change Control** to ensure that changes are approved by those authorized to make such approvals, and that the appropriate stakeholders are notified of such changes. This requires the use of a formal change control system
- **Monitor and Control Risks** - so that risks can be mitigated or eliminated

A records management system is also needed so that the project manager can manage the contract and procurement documentation. This record management system is considered part of the project management information system (PMIS), which is considered an Enterprise Environmental Factor.

Ensure payments to the vendor are made according to contracted Terms and Conditions.

The PM is also responsible for ensuring that procurement documentation is updated as a result of monitoring activities.

Buyer-conducted performance reviews:

- Identify performance success and failures
- Identify progress against the contract SOW
- Quantify seller's ability (or not) to perform work

Inspections and audits:

- Identify weaknesses in seller's processes or deliverables

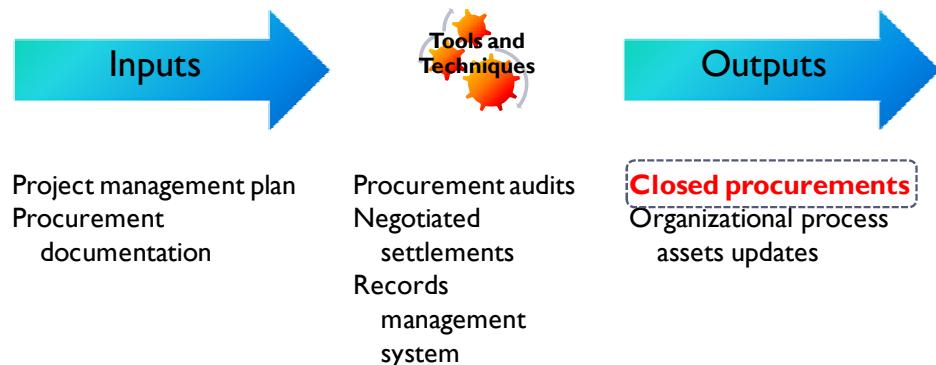
Performance reporting:

- Determine how effectively seller is performing to the contract

Claims administration:

- Settle disputes regarding compensation for changes

Close Procurements



Closing the procurement activity means the work on the contract has been completed, final audits and verification of deliverables have been accepted, that all claims are finalized and closed and all outstanding bills, including retainage, have been paid.

Procurements can be closed one of two ways:

- Completion of the contract
- Termination of the contract

Understand that: ***procurements are always closed prior to administrative closure of the project or project phase.***

On a large project, there can be multiple closures of procurement activities. Whatever phase of your project that you are in, the procurement activity that ends within that phase is closed before administrative closure of the phase.

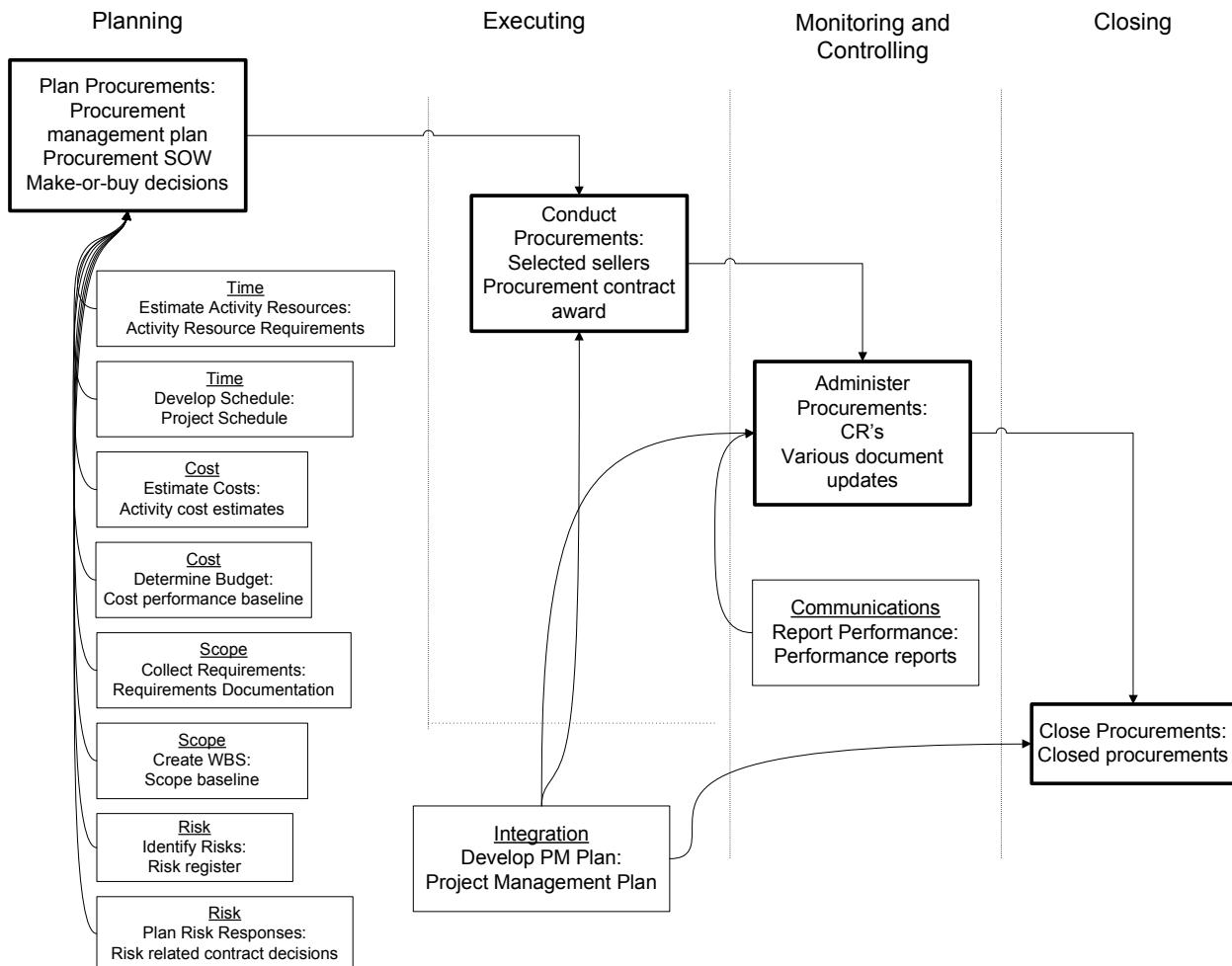
Closure Activities

Closing a procurement in a project includes all of the following:

- Final settlement of all claims and invoices
- Procurement audit
- Final contract performance reporting
- Product verification
- Procurement contract file and updates
- Lessons learned

Project Procurement Management: Key Process Interactions

The key inputs from the other Knowledge Areas to Project Procurement Management processes are shown below. *Know these process interactions for the exam.*



In Summary...

For procurement management, the covered elements included:

- The types of contracts and the risks associated with each
- When each type of procurement document is used
- The difference between single source and sole source
- Bidder conferences
- Good guy/bad guy, deadline, missing man, limited authority, delay, unreasonable, attacks, and other negotiation tactics
- How change control is different in a contracted environment
- Contract closure activities and when they are done

Chapter Twelve Memory Check

1. Several disadvantages of _____ contracting is that the procurement lead may be working on multiple projects, so it may be difficult for the PM to obtain help
2. The five elements of a contract are _____, _____, _____, _____, and _____
3. One of the key tools in the Plan Procurements process that analyzes whether to do the work in house versus having a third party provide the product or service is called a _____ analysis
4. Some advantages of _____ contracting are that the PM has easier access to procurement expertise and that the procurement manager has more loyalty to the project
5. The three fundamental procurement statements of work types are; _____, _____, and _____
6. Two forms of non-competitive procurement are called _____, and _____
7. A non-legally binding document in which the buyer states they intend to hire the seller is called a _____
8. Another term for a teaming agreement is called a _____
9. The three basic forms of contract are _____, _____, and _____
10. The concept of _____ addresses the total cost of ownership of a product or service
11. The key outputs of the Conduct Procurements process is the _____ and _____
12. The prime contractor can use sub-contractors. Since the sub is contracted to the prime and not to the buyer, the buyer has no contractual control over the sub. This is called _____
13. The _____ occurs on fixed price incentive fee contracts in which the seller assumes all additional costs for delivering a product of the project
14. The RFP is best used for a _____ contract, while the IFB or RFB is best used for a _____ contract
15. The key output of the Plan Procurements process is the _____
16. A _____ invites all bidders to a Q&A session in which bidders can ask clarifying questions regarding the buyers RFP
17. A _____ establishes minimum criteria to eliminate non-qualified vendors
18. Fait Accompli, deadline, missing man and limited authority are all examples of _____ tactics
19. A _____ is usually implemented as a grid that lists all the proposal criteria, and assigns a numeric weight to each of the criteria
20. _____ closure always occurs before _____ closure when completing a project or project phase
21. Force majeure, assignment, escrow, time is of the essence, retainage and confidentiality are all contract elements generally grouped in a category called _____
22. A key output of the Administer Procurements process is _____
23. A contract _____ system defines the process by which procurements can be modified
24. Technical Capability, management approach and technical approach are some of the elements that are assessed in _____ criteria

Chapter 12 Test

1. The contract does not specify how overcharges from the vendor should be handled on a Cost Reimbursable contract. The buyer receives an invoice from the vendor that has questionable charges. The buyer should:
 - a. Pay the invoice
 - b. Initiate a claim against the vendor via the claims administration process
 - c. Consult the legal team for remediation options
 - d. Cancel the contract for convenience
2. You have engaged a sole source vendor to procure a critical product for your organization that is needed for your own product line. The vendor submits a contract which is reviewed by your legal team. While most of the provisions are agreeable, there are several questionable provisions that are clearly illegal and unenforceable in the state where the contract will be signed. The vendor has informed you that they will not provide the product or sign the contract without those questionable provisions included. The procurement of this product is critical to the survivability of your business, and time is of the essence. The vendor thinks they have your organization ‘over a barrel’. Aside from the questionable provisions in the contract, everything else in the contract is acceptable. As the buyer, your *best* option moving forward is to:
 - a. Initiate a legal action against the vendor for attempting to break the law
 - b. Point out that the questionable provisions are unenforceable in the state, and offer to sign the contract immediately if the provisions are removed or modified to be legal
 - c. Find a competing vendor that will provide an equivalent product
 - d. Sign the contract – you’ve got them over the barrel if the questionable provisions are legally unenforceable
3. Which of the following are *not* advantages in a centralized contracting environment?
 - a. Access to contracting expertise
 - b. Procurement manager has more loyalty to the project
 - c. Standardized practices
 - d. Defined career path
4. All of the following are required contract elements except:
 - a. Consideration
 - b. An offer
 - c. Capacity
 - d. Alternatives
5. Which of the following occurs in the Conduct Procurement process?
 - a. Contract change control
 - b. Make-or-buy decisions
 - c. Bidder conferences
 - d. Source selection criteria
6. Your organization needs some specialized equipment for the next project. The project is anticipated to last one year. Salvage rate on the equipment is 25 cents on the dollar. When the project is done, you will have no use for the equipment. When performing a rent-or-buy analysis for this piece of equipment, the following facts are established: the equipment price is \$28,000. The rental price is \$3000/month for the first four months followed by \$2000/month thereafter. What is your *best* option?
 - a. Either option is viable – for one year, the rental price equals the purchase price
 - b. If the project ends early, it will be less expensive to rent
 - c. If the project is late, it will less expensive to buy

- d. Unless the project is guaranteed to end 4 months early, buy the equipment
7. The contract specifies that payments are to be made when deliverables are received by the buyer. All of the following regarding the procurement statement of work (SOW) are true *except*:
- a. Changes must be documented as formal written elements
 - b. Non-delivery of any component of the procurement SOW is subject to legal remediation
 - c. The SOW can be developed by both the buyer and the seller
 - d. Payments can be withheld in the event that the customer is not satisfied with the deliverable
8. Withholding a portion of a vendor's payment in order to guarantee delivery of the final product is called:
- a. Withholding
 - b. Retainage
 - c. Escrow
 - d. Assignment
9. You are managing a contract in which you will not have much time to audit invoices. What is the best form of contract to choose under these conditions?
- a. Time and Materials (T&M)
 - b. Fixed Price
 - c. Cost Plus Incentive Fee (CPIF)
 - d. Best Efforts
10. You are negotiating specific contract terms with a purchaser of your organization's flagship product. As the negotiations progress, a number of terms have already been hammered out, and the negotiation session looks to be proceeding well. Your final price comes to \$1.25 million for the product and associated services. The customer's negotiator then says the following; "I am only allowed to spend up to \$1 million on this product. If you're willing to offer it at that price, we can move forward, otherwise we will have to reconvene this session in two weeks". The negotiation tactic being employed at this point is described as:
- a. Missing Man
 - b. Delay
 - c. Limited authority
 - d. Deadline
11. When do contract negotiations occur on a project?
- a. Administer Procurements
 - b. Plan Procurements
 - c. Conduct Procurements
 - d. SOW evaluation
12. The buyer has established a CPFF vehicle for the current procurement activity. What is the buyer *most* concerned about?
- a. Risk
 - b. Cost
 - c. Specifications
 - d. Vendor expertise
13. What is the seller's *biggest* benefit for arranging a T&M contract with a potential buyer?
- a. The seller's profit is unknown to the buyer
 - b. Profit is built into every hour of work
 - c. Project scope is usually small and easy to manage
 - d. The TM vehicle can usually become a cost reimbursable contract

14. You have set up a cost reimbursable contract with your vendor on your organization's newest project.

The most appropriate procurement document for a cost plus contract is:

- a. IFB
- b. RFQ
- c. RFB
- d. RFP

15. Your company makes a product that a potential buyer is very interested in. After several discussions, the potential buyer issues a letter of intent to purchase the product within the next two months. Your company president takes this letter of intent (LOI) to the local commercial bank in the hopes of obtaining a short-term loan to purchase the necessary equipment to deliver on this potentially lucrative contract.

The bank turns him down flat, even though the seller's finances are in good order. Why do you think this is the case?

- a. Issues with the buyer's reputation
- b. The LOI is not a legal document
- c. The LOI does not contain enough money to cover the loan
- d. The seller has not reached the minimum funding limits for loans of this type

16. What is a tool and technique of Close procurements?

- a. Negotiated settlements
- b. Payment systems
- c. Performance Reporting
- d. Claims administration

17. You are negotiating contract terms with a potential buyer of your services. While one of the members of the negotiating team on the buyer's side has been very helpful in establishing reasonable terms, the buyer's negotiating partner has challenged every point put forth in the meeting by your team, stating you are 'brain damaged'. At one point, this partner even verbally abuses the other negotiator on his team!

This negotiation tactic is *best* known as:

- a. Direct attack
- b. Good guy/bad guy
- c. Unreasonable
- d. Escalating demand

18. The RFP is:

- a. A tool and technique of the Conduct Procurements process
- b. An output of the Plan Procurements process
- c. An input to Administer Procurements process
- d. A tool and technique of the Plan Procurements process

19. An output of Administer Procurements is:

- a. Terms and conditions validation
- b. Change requests
- c. Resource calendars
- d. Make-or-buy decisions

20. The project manager can perform all the following functions in a procurement *except*:

- a. Be the lead negotiator in a procurement
- b. Have authority to authorize changes to the procurement
- c. Help to clarify and finalize the contract terms and conditions
- d. Take a lead role in auditing the seller's work product

21. The structured review of the procurement process from Plan Procurements through Administer Procurements is known as a:
- Structure procurement review
 - Records review
 - Procurement audit
 - Procurement verification and validation
22. Your company is the sole source provider of a specific product in the pharmaceutical industry. You currently enjoy a virtual monopoly in this product space. What would be your *best* strategy for maintaining your virtual monopoly in this area?
- Charge the highest price the market will endure to guarantee a high ROI before the competition catches up
 - Provide the better than average customer service than most available
 - Create the largest distribution network possible for the product
 - Charge the lowest reasonable price so that it will be too expensive for competitors to enter the market
23. The PM has been authorized by the contract administrator in your organization to handle specific, low impact changes in the contract should the need arise. The vendor on this particular procurement has indicated a need for a major change in the current specification. You discuss the change with the vendor, verbally agree to it, and implement the change via the standard internal change control process. At an invoice audit several months later, the purchasing organization refuses to pay for the work that was entered in the change system. What has the project manager *forgotten* to do in this instance?
- Consult the technical team prior to implementing the change
 - Implement a formal written change to the contract
 - Verify that the change was within the project manager's responsibility from the contract administrator
 - Update the configuration documents on the project
24. What costs are the *most important* costs that need to be considered when making a purchase decision for a product or service?
- All development costs
 - The purchase price
 - The life-cycle costs
 - The purchase price + failure costs
25. You are thinking of purchasing a software product from a relatively young organization - they have been in business less than two years. This is a cutting edge financial product that would put you at least 18 months ahead of all competitors in your market space. However, your concern is that if you purchase software from them, there is a possibility that they may go out of business and you would lose the investment in the software. You ask the company to outright purchase the software code, but the company has rejected this as an option. What is your *best* option moving forward if the company's survivability is an issue?
- Contract it as a work made for hire
 - Set up a code escrow arrangement
 - Offer to buy the company
 - Look for viable alternatives

Chapter 12 Test – Answers

1. A – Read this question carefully. It does not state that there was an overcharge, only that some of the charges were ‘questionable’. In the absence of specific contract language about overcharges, the invoice must be paid
2. B – This is a somewhat tricky question and it must be read carefully. Answer A does not help you if time is of the essence - litigations and additional negotiations can take quite a long time. Answer C may or may not be possible and will also take considerable additional time. Answer D would probably work, legally, but may not support the idea of ‘protecting the relationship with the seller’. However, it might become your ‘fallback’ option if B does not work. The best option, Answer B, is to point out the legal problems with the contract and appeal to the vendor’s reason. Point out that if it comes down to legal wrangling or a court case, the illegality of the specific contract provisions will be exposed and deemed unenforceable in a court of law. (Most contracts will contain a phrase that states that if any provision of the contract is deemed unenforceable in a court of law, the remaining provisions are still in force.)
3. B – The Procurement manager is not loyal to your specific project but may be administering many procurements
4. D – Alternatives are not a required contract element
5. C – The bidder conference is a tool and technique of Conduct Procurements. *PMBOK® Guide*, 4th edition, p.331
6. D – Did you forget the salvage costs of the equipment? That brings the cost of the purchase down to \$21,000. Four months @ \$3K = \$12,000. Eight months @ \$2K = 16,000. Total = \$28,000, minus salvage of 25 cents on the dollar or \$7,000 to sell the equipment. \$28,000 - \$7,000 = \$21,000. If the project goes 8 months your rental costs are \$20,000 – in this case it is cheaper to rent. At nine months, the rental costs are \$22,000 – in this case it is cheaper to buy the equipment
7. D – The contract terms do not specify customer satisfaction as a contract term
8. B – This is known as retainage
9. B – This is one of the buyer advantages in a firm fixed-price contract
10. C – This is an example of the limited authority ploy
11. C – Procurement negotiations occur in the Conduct Procurements process. *PMBOK® Guide*, 4th edition, p. 332
12. A – For a cost plus contract vehicle, the biggest concern is Risk from the buyer’s perspective
13. B – the vendor’s profit is built into every hour of work delivered
14. D – For a CR or cost plus contract, the most appropriate procurement document is the RFP
15. B – The letter of intent is not a legal document and does not obligate the buyer to follow through
16. A – Negotiated Settlements. *PMBOK® Guide*, 4th edition, p. 343
17. B – This is a good guy/bad guy technique
18. B – It is one of the Procurement Documents which is an output of the Plan Procurements process. *PMBOK® Guide*, 4th edition, p. 326
19. B – Change requests is the only output listed in the answer set for Administer Procurements. *PMBOK® Guide*, 4th edition, p. 341
20. A – The PM cannot be the lead negotiator in procurements. *PMBOK® Guide*, 4th edition, p. 333
21. C – This is the definition of a procurement audit. *PMBOK® Guide*, 4th edition, p. 343
22. D – This question may qualify as one of those questions that you’ve never seen before when taking the exam. In this case, it is simply best to reason out the answers by carefully reading the question. The question asks what you would do to *maintain* your virtual monopoly. Keeping your price low or as reasonable as possible would discourage competitors in getting into the market to begin with - it would take them too long to recoup their investments.
23. C – The contract is the final arbiter of what gets paid, not your internal change control system. Only a formal written change to the contract, specifying who has the authority to make the change, is legally binding.
24. C – Life-cycle costs are the inclusive costs that include purchase price, maintenance and support and warranty costs. This is your ultimate cost for the product or service

25. B – A code escrow arrangement will protect the seller and the buyer. If the seller goes out of business, the buyer will have access to the code for continuing support of the product. Otherwise the code stays in escrow

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Chapter 13 : Professional and Social Responsibility

Section Topics:

- ▶ Overview of Professional and Social Responsibility
- ▶ The Meaning of Professional and Social Responsibility
- ▶ Recurring Themes

The PMI Code of Ethics and Professional Conduct

If you are an applicant to become a PMP®, or you already have become a PMP®, you are required to adhere to the PMI Code of Ethics and Professional Conduct.

A complete version of the PMI Code of Ethics and Professional Conduct can be found in the Project Management Professional (PMP®) Credential Handbook. We will review the high-level requirements over the next several pages.

The Code of Ethics – Four Areas

The code is basically broken down into four distinct areas:

1. Responsibility
2. Respect
3. Fairness
4. Honesty

You will be expected to answer between 17-25 questions regarding Professional and Social Responsibility for the exam (or between 8 -12 % of the test).

NOTE: The PMI Code of Ethics and Professional Conduct are not contained in the PMBOK® Guide, 4th edition®. While there is not a separate category for the PMI Code of Ethics and Professional Conduct on the PMP exam, there may be test questions addressing ethics.

The following attribution applies to pages 13-4 through 13-7 of this manual:

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Responsibility

Aspirational Standards

- 2.2.1 - We make decisions and take actions based on the best interests of society, public safety, and the environment.
- 2.2.2 - We accept only those assignments that are consistent with our background, experience, skills, and qualifications.
- 2.2.3 - We fulfill the commitments that we undertake – we do what we say we will do.
- 2.2.4 - When we make errors or omissions, we take ownership and make corrections promptly.
When we discover errors or omissions caused by others, we communicate them to the appropriate body as soon they are discovered. We accept accountability for any issues resulting from our errors or omissions and any resulting consequences.
- 2.2.5 - We protect proprietary or confidential information that has been entrusted to us.
- 2.2.6 - We uphold this Code and hold each other accountable to it.

Mandatory Standards

- 2.3.1 - We inform ourselves and uphold the policies, rules, regulations and laws that govern our work, professional, and volunteer activities.
- 2.3.2 - We report unethical or illegal conduct to appropriate management and, if necessary, to those affected by the conduct.
- 2.3.3 - We bring violations of this Code to the attention of the appropriate body for resolution.
- 2.3.4 - We only file ethics complaints when they are substantiated by facts.
- 2.3.5 - We pursue disciplinary action against an individual who retaliates against a person raising ethics concerns.

In summary:

Aspirational Standards

- Decisions and actions based on best interests of society, public safety and the environment
- Accept assignments consistent with our background, experience, skills and qualifications

Mandatory Standards

- Uphold rules, regulations and laws
- Report illegal activity or unethical conduct
- Report code violations to the appropriate body
- File ethics complaints only when substantiated by fact

Respect

Aspirational Standards

- 3.2.1 We inform ourselves about the norms and customs of others and avoid engaging in behaviors they might consider disrespectful.
- 3.2.2 We listen to others' points of view, seeking to understand them.
- 3.2.3 We approach directly those persons with whom we have a conflict or disagreement.
- 3.2.4 We conduct ourselves in a professional manner, even when it is not reciprocated.

Mandatory Standards

- 3.3.1 We negotiate in good faith.
- 3.3.2 We do not exercise the power of our expertise or position to influence the decisions or actions of others in order to benefit personally at their expense.
- 3.3.3 We do not act in an abusive manner toward others.
- 3.3.4 We respect the property rights of others.

In summary:

Aspirational Standards

- Be informed of norms and customs of others
- Listen to others points of view
- Directly engage those with whom we disagree or have conflict
- Conduct ourselves in a professional manner

Mandatory Standards

- Negotiate in good faith
- We do not influence others for personal benefit
- We do not act in an abusive manner to others
- We respect the property rights of others

Fairness

Aspirational Standards

- 4.2.1 We demonstrate transparency in our decision-making process.
- 4.2.2 We constantly reexamine our impartiality and objectivity, taking corrective action as appropriate.
- 4.2.3 We provide equal access to information to those who are authorized to have that information.
- 4.2.4 We make opportunities equally available to qualified candidates.

Mandatory Standards

- 4.3.1 We proactively and fully disclose any real or potential conflicts of interest to the appropriate stakeholders.
- 4.3.2 When we realize that we have a real or potential conflict of interest, we refrain from engaging in the decision-making process or otherwise attempting to influence outcomes, unless or until: we have made full disclosure to the affected stakeholders; we have an approved mitigation plan; and we have obtained the consent of the stakeholders to proceed.
- 4.3.3 We do not hire or fire, reward or punish, or award or deny contracts based on personal considerations, including but not limited to, favoritism, nepotism, or bribery.
- 4.3.4 We do not discriminate against others based on, but not limited to, gender, race, age, religion, disability, nationality, or sexual orientation.
- 4.3.5 We apply the rules of the organization (employer, Project Management Institute, or other group) without favoritism or prejudice.

In summary:

Aspirational Standards

- Exhibit transparency in our decision making process
- Constantly re-examine our own impartiality
- Provide equal access to information for those authorized
- Make opportunities equally available to qualified candidates

Mandatory Standards

- Disclose conflicts of interest (CI)

- Recuse oneself from any decision in which there is a CI
- Report code violations to the appropriate body
- We do not hire/fire based on personal considerations
- We do not discriminate based on race, gender, religion, etc
- We apply organizational rules without favoritism or prejudice

Honesty

Aspirational Standards

- 5.2.1 - We earnestly seek to understand the truth.
- 5.2.2 - We are truthful in our communications and in our conduct.
- 5.2.3 - We provide accurate information in a timely manner.
- 5.2.4 - We make commitments and promises, implied or explicit, in good faith.
- 5.2.5 - We strive to create an environment in which others feel safe

Mandatory Standards

- 5.3.1 - We do not engage in or condone behavior that is designed to deceive others, including but not limited to, making misleading or false statements, stating half-truths, providing information out of context or withholding information that, if known, would render our statements as misleading or incomplete.
- 5.3.2 - We do not engage in dishonest behavior with the intention of personal gain or at the expense of another. *

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In summary:

Aspirational Standards

- We seek to understand the truth
- We are truthful in communications and conduct
- We provide accurate information in a timely manner
- We make commitments and promises in good faith
- We create a safe environment so that others feel safe in telling the truth

Mandatory Standards

- We do not engage in deceptive behavior
- We do not engage in dishonest behavior

Contribute to the PM Body of Knowledge

- Sharing lessons learned
- Coaching other project managers
- Educating stakeholders on PM principles
- Becoming an active member of PMI
- Participating in research
- Writing PM articles

Not only is contributing to the Project management body of knowledge a good thing for project management in general, but it will also help you to obtain PDUs necessary to maintain your credential.

Each time you attend a PMI meeting, deliver a keynote speech on project management, do a presentation for your local PMI chapter, teach a course on project management, write an article for a professional journal on project management, or write a book on project management, you will not only be contributing to the knowledge base of project management, but you will also earn PDUs for these activities.

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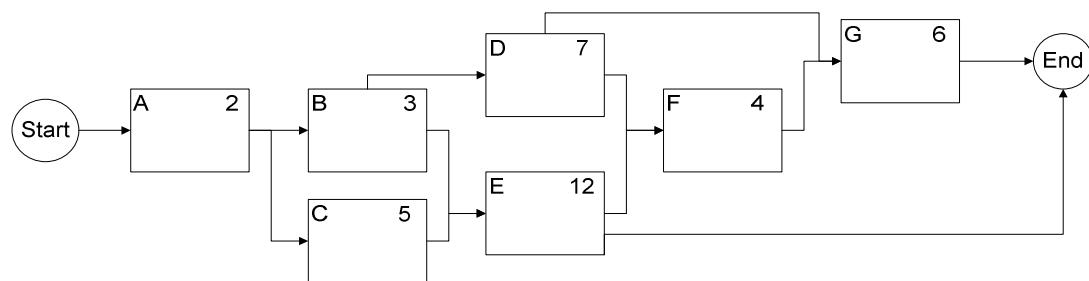
Chapter 14 : Exercise Answers

PDM Exercise Answers

Exercise #1:

Activity	Predecessor	Duration
Start		-
A	Start	2
B	A	3
C	A	5
D	B	7
E	B,C	12
F	D,E	4
G	D,F	6
End	E,G	-

PDM:



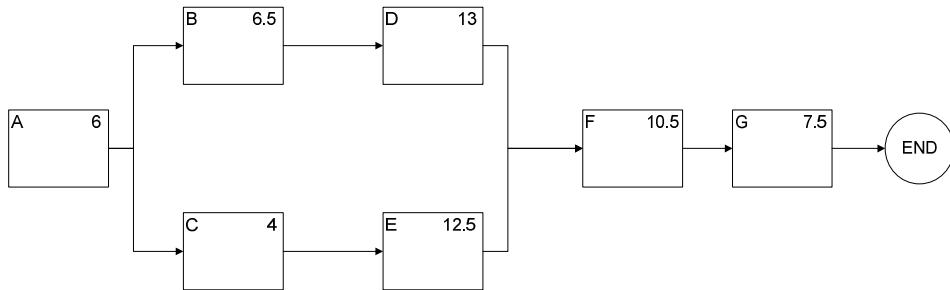
Answers:

1. What is the critical path? **A-C-E-F-G**
2. Where is the float or slack, if any? **Activities B and D have a combined float of 7**
3. The customer needs the schedule brought in seven weeks sooner. You discuss options with the customer and decide to reduce activity 'E' by seven weeks. How does this affect critical path? **You have 2 critical paths: A-B-D-F-G and A-C-E-F-G**
4. Starting with the original schedule, activity 'B' experiences major discovery and, as a result, changes to seven weeks. How does this impact critical path, if at all? **CP increases by 2**

Exercise #2:

Activity	Optimistic	Most Likely	Pessimistic	Predecessor	Computed PERT
A	3	5	13	None	6
B	4	6	11	A	6.5
C	2	4	6	A	4
D	8	12	22	B	13
E	7	12	20	C	12.5
F	6	10	17	D, E	10.5
G	3	6	18	F	7.5
End				G	

Computed PERT for each activity is shown in the grid above.

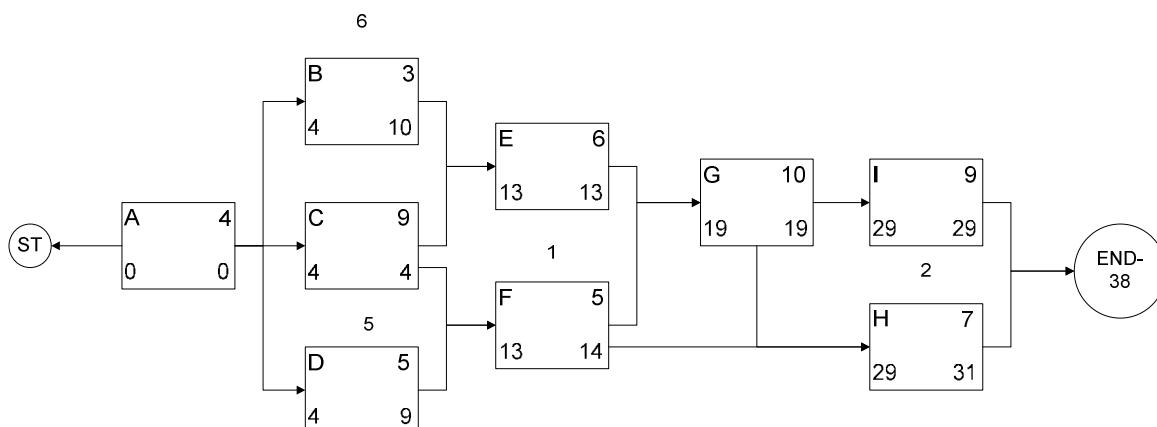


Question answers:

1. Compute the critical path: **A-B-D-F-G = 43.5 WEEKS**
2. Risk on activity E sharply increases 21 weeks due to a major discovery. Which part of the PERT estimate does this impact and what is the impact on the critical path? **It changes the pessimistic estimate from 20 to 41. Recomputed PERT for activity E is now 16. Critical path is now A-C-E-F-G = 44 WEEKS.**

Exercise #3:

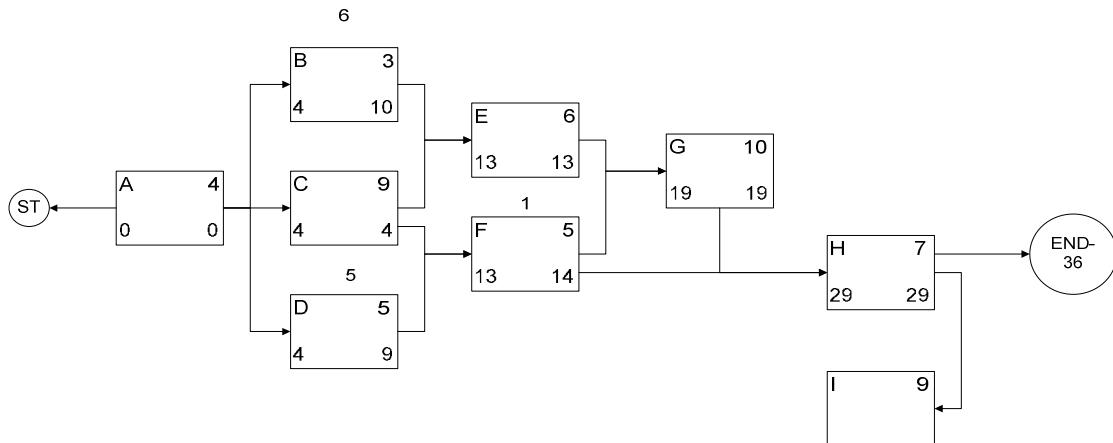
Activity	Predecessor	Duration
Start		-
A	Start	4
B	A	3
C	A	9
D	A	5
E	B,C	6
F	C,D	5
G	E,F	10
H	F,G	7
I	G	9
End	H,I	



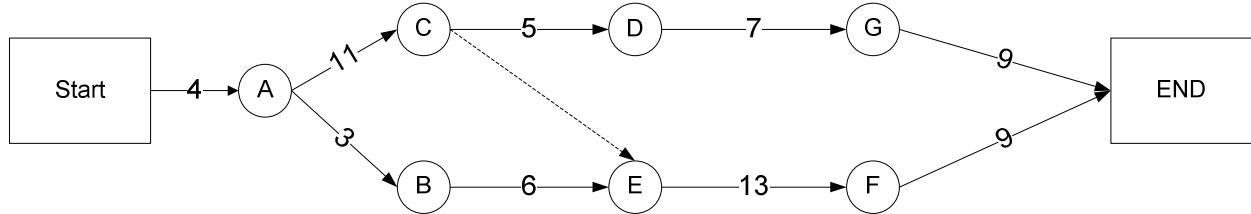
Answers:

1. What is the critical path? **A-C-E-G-I**

2. What is the near-critical path? **A-C-F-G-I and A-C-E-G-H**
3. If the customer wanted to reduce schedule by 4 weeks, what would be the resulting float? **Negative 4 weeks**
4. What would happen if activities 'H' and 'I' change to a finish-to-finish relationship and the predecessor relationship between activity 'I' and 'G' is eliminated? **Activity 'I' is no longer on the critical path and the critical path is now A-C-E-G-H with a duration of 36.**



Exercise #4



Answers:

1. What is the critical path? **Start-A-C-E-F-End**
2. What is the near-critical path? **Start-A-C-D-G-End**
3. If the customer wanted to reduce G-End by 2 weeks, what would the critical path be? **No Change**
4. What would be the simplest way to reduce the schedule by 4 weeks? **Eliminate Activity Start-A**

Earned Value Exercise Answers

Exercise #1:

You are managing a small construction project. The vendor was hired to install an intricate parquet floor in nine sections. Each section is supposed to take one week to complete at a cost of \$750/section. Assume spending continues at the current rate - no BAC variance.

At this point in time, you are 4 weeks into the project and you have the following information:

- Expenditures to date: \$3250
- Sections completed: 4.5

Fill in the following grid with your answers:

Value	Formula/Calculation	Answer	What it Means
PV	$4 * \$750$	\$3000	Planned expenditures by this point in time
EV	$4.5 * \$750$	\$3375	Work accomplished after 4 weeks
AC	Given	\$3250	Expenditures
BAC	$9 * \$750$	\$6750	
CV	EV-AC	+ \$125	We are under budget by \$125
SV	EV – PV	+ \$375	We are ahead of schedule
CPI	EV/AC	1.04	Achieving \$1.04 in value for every dollar spent
SPI	EV/PV	1.125	We are 12.5% ahead of schedule
ETC	EAC - AC	\$3240	Remaining expenditures
EAC	BAC/CPI	\$6490	Forecast of actual budget for the project
VAC	BAC-EAC	+\$260	We finish \$260 under budget
TCPI	$(BAC-EV)/(BAC-AC)$.964	The remaining work divided by the funds available. i.e. we have less work than the funds available to do it

Exercise #2:

Your current project is running with the following indicators:

- CPI = 1.07
- SPI = 1.1
- AC = \$22,500

You are 4 weeks into a 12 week project, and some of the financial data is missing. Variances are atypical of the future.

Given the information above, compute:

- EV = \$24,075
- PV = \$21,886
- BAC = \$65,659
- ETC = \$41,584
- EAC = \$64,084
- VAC = +\$1575
- TCPI for BAC = .963

We need EV to get the remaining answers.

CPI = EV / AC Thus $1.07 = EV / \$22,500$. Solving for EV, we get $EV = 1.07 * \$22,500$ or \$24,075

SPI = EV / PV or $1.1 = \$24,075 / \$21,886$. Solving for PV we get $PV = \$24,075 / 1.1 = \$21,886$

Since we are 4 weeks into a 12 week project, we are 1/3 complete. Thus $BAC = 3 * PV$ or \$65,659

With atypical variances, the EAC formula is $AC + BAC - EV = \$22,500 + \$65,659 - \$24,075 = \$64,084$

$ETC = EAC - AC = \$64,084 - \$22,500 = \$41,584$

$VAC = BAC - EAC = \$65,659 - \$64,084 = +\$1575$

$TCPI = (BAC - EV) / (BAC - AC)$

Exercise #3 - PERT and standard deviation rounded to the nearest dollar:

Deliverable	Optimistic	Most likely	Pessimistic	PERT	Std. Deviation
Component 1	\$5000	\$10000	\$15000	\$10000	\$1667
Component 2	\$3000	\$7000	\$14000	\$7500	\$1833
Component 3	\$20000	\$35000	\$80000	\$40000	\$10000
Component 4	\$15000	\$30000	\$63000	\$33000	\$8000
Totals:	\$43000	\$82000	\$172000	\$91500	

Questions:

1. What is the PERT estimate for the project – rounded to the nearest dollar? **\$91,500**
2. Which component estimate is least precise? **Component 3: highest STD deviation.**
Remember: SD is a measure of precision. The smaller the SD, the greater the precision.
3. What is the budget range to a 95% confidence factor? **\$48.5K to \$134.5K**

Chapter 15 - Memory Check Answers

Chapter 2 Memory Check Answers

1. A project is temporary, unique and delivers a product, process or result
2. Three key constraints on a project are time, cost, and scope as well as quality, resources and risk
3. Three key characteristics of the project manager include; knowledge, performance, and personal effectiveness
4. A program is a group of related projects. A portfolio can be a collection of projects, programs or sub-projects
5. A PMO centralizes and co-ordinates the management of portfolios, programs and projects
6. The project lifecycle deals with the work done to accomplish the goals of the project, while the product lifecycle deals with the lifetime of the deliverable(s)
7. The three categories of multi-phase project types are; sequential, overlapping, and iterative
8. A stakeholder is anyone who is positively or negatively impacted by the project
9. The three basic organizational types are; functional, matrixed, and projectized
10. The term used to describe the process of delivering more accurate estimates for time and budget as the project progresses is called progressive elaboration
11. Clearly defined career paths and much contention for resources is an advantage and a disadvantage of a functional organization
12. Project loyalty and the possibility of not having a job after the project completes describes an advantage and a disadvantage of a projectized organization
13. Increased PM control and multiple bosses describes an advantage and a disadvantage of a matrixed organization
14. A project expeditor has very little decision making authority on a project whereas the project coordinator has some decision making authority
15. The three types of matrixed organizations are referred to as: weak matrix, balanced matrix and strong matrix

Chapter 3 Memory Check Answers

1. The five process groups that comprise the project management lifecycle are: initiating, planning, executing, monitoring and controlling and closing
2. The two primary outputs of the Initiating process are the project charter and identify stakeholders
3. The primary goal of the planning process group is to produce the project management plan.
4. The nine Knowledge Areas of the *PMBOK® Guide*, 4th edition are, in short, Integration, Scope, Time, Cost, Quality, Human Resources, Communications, Risk, and Procurement
5. Almost half of the processes that occur in the nine knowledge areas of the PMBOK® occur in the Planning process group
6. Only the Integration knowledge area has processes in all five of the process groups of the project management lifecycle
7. Two primary goals of the Monitoring and Control process group are to monitor and control project work and to perform integrated change control
8. Early in the project the costs, and the chance of success are low – the risks and stakeholder influence are high
9. PMI defines how a project will tighten its estimates for budget and timeline as more is learned about the project as a progressive elaboration
10. There are 42 processes spread across the nine Knowledge Areas in the *PMBOK® Guide*, 4th edition

Chapter 4 Memory Check Answers

1. Enterprise environmental factors basically describe the organization's culture while organizational process assets describe how the organization does projects
2. The key benefits of the project charter are;
 - a. Formal recognition of the project
 - b. PM is authorized to spend money and commit resources
3. Two project selection methods are known as: benefit measurement methods, and constrained optimization methods
4. The enterprise environmental factor (EEF) that ensures that the correct work gets done in the correct sequence is called a work authorization system, while the EEF that keeps track information storage and distribution in an automated fashion for the project is called a PMIS
5. Templates, historical data, lessons learned, and financial databases are all organizational process assets
6. The tool that is used to eliminate impractical, impossible or unrealistic projects is called a murder board
7. The term that addresses the diminishing value of money over time is called present value
8. The term that addresses the value of an investment at some point in the future is called future value
9. The percentage return on an investment is call the internal rate of return
10. The length of time it will take to recoup the investment in a project is called the payback period
11. The benefit that you give up on one opportunity to pursue another is called the opportunity cost
12. Dynamic, Integer, and multi-objective programming algorithms are all constrained optimization methods
13. Two forms of accelerated depreciation are known as double declining balance and the sum of years digits
14. The costs on a project that have already been expended are called sunk costs
15. The four categories of costs you can experience on a project are: direct, indirect, variable, and fixed
16. The key outputs of Direct and Manage Project Execution are work performance information, change requests and deliverables
17. An action needed to bring future project performance in line with the project management plan is called a corrective action
18. Defect repair is another name for rework
19. One of the critical jobs of the project manager is to prevent unnecessary changes on the project
20. When performing closure on the project or a project phase contract closure occurs before administrative closure
21. The key output of closure is the final product, service or result transition

Chapter 5 Memory Check Answers

1. Adding features to a product that were never requested by the customer is called gold plating
2. Uncontrolled work added to a project by the customer without any adjustment for timeline or budget is called scope creep
3. The scope baseline consists of the scope statement, WBS, and the WBS dictionary
4. The product scope are the requirements relating to the project deliverables, whereas the project scope refers to the work needed to create the deliverables
5. The key output that tracks requirements, the source of the requirement and the requirement completion status is called a requirements traceability matrix
6. What output is used by the team to get their arms around the project, serves as a communication tool for stakeholders and is used by the team to see how their work fits into the project is called a WBS
7. The lowest level in a WBS is called a work package
8. The WBS dictionary shows cross functional dependencies between work packages
9. The key output of the Verify Scope process is accepted deliverables
10. The two processes in the Monitoring and Controlling process group for Scope are: verify scope and control scope
11. The process of breaking down work into manageable work packages is called decomposition
12. Formalizing acceptance of the completed project deliverables is called verify scope
13. The level above a work package is usually called a control account
14. The process of determining what will be and what will not be included in the project is called scope definition
15. The tool used to capture the ‘voice of the customer’ is called QFD
16. The 4 group decision voting methods are called unanimous, majority, plurality, dictatorship
17. The three processes in the Planning process group for scope are: collect requirements, define scope, create WBS

Chapter 6 Memory Check Answers

1. The four possible precedence relationships in an AON network diagram are: finish-to-start, start-to-finish, finish-to-start, and start-to-finish
2. The diagramming method that allows for conditional looping is called GERT
3. The three types of network dependencies are known as: mandatory, discretionary, and external
4. The completion of a key deliverable or of a phase in the project is called a milestone
5. Starting a successor activity before the predecessor is complete is called a lead, while a delay in starting a successor activity is defined as a lag
6. The five processes in the Planning process group for Time Management are: define activities, sequence activities, estimate activity resources, estimate activity durations, and develop schedule
7. Another name for the three point estimate is called PERT
8. The most accurate and time consuming of the estimates is called bottom-up estimating
9. The sigma percentages are 1 Sigma = 68.26%, 2 Sigma = 95.46% and 3 Sigma = 99.73%
10. The time an activity can be delayed without delaying the project end date is called total float
11. The earliest you can begin an activity is called the early start, while the latest time in the network schedule an activity can begin without impacting the late finish (LF) is called the late start
12. Conformance to target values is defined as accuracy, while the precision of the measurement is expressed as standard deviation
13. The critical path in a network diagram is the longest path through the network that produces the shortest possible completion time for the project
14. The time a project can be delayed without delaying the start of a successor project is called project float
15. The two primary schedule compression techniques are called crashing and fast tracking
16. The Monte Carlo analysis is used to build statistical models and perform what-if analysis
17. Stabilizing the number of resources working in each time period to prevent resource over-allocation is known as resource leveling
18. Critical chain project management accounts for limited resources, adds duration buffers, focuses on managing the time buffer and resources
19. Free float describes the time an activity can be delayed before delaying the early start (ES) of a successor activity
20. Higher-level summary activities that occur between milestones in a bar chart are frequently called hammock activities
21. In addition to various updates, a key output of the Control Schedule process is change requests
22. An activity that has no duration is called a milestone
23. Computing the forward pass allows us to ascertain the critical path in the network diagram, while computing the backward pass is used to determine areas of float or slack in the network diagram

Chapter 7 Memory Check Answers

1. The estimate that takes little time to create but is not very accurate is known as an analogous estimate
2. The rough order of magnitude estimate ranges from -50% to +50%
3. The key output of the Estimate Costs process is activity cost estimates
4. A basis of estimate is a detailed analysis on how the cost estimate was derived
5. The tool that addresses the variance between funding limit and the planned expenditures for the project is called the funding limit reconciliation
6. The two types of monetary reserves on a project are identified as contingency reserve and management reserve
7. The main output of the Control Costs process is budget forecasts
8. The cost baseline includes the contingency reserves whereas the cost (total) budget includes the contingency and the management reserves
9. What the work of the project is supposed to have cost by a specific point in the schedule is called the planned value, whereas the total amount that the work should cost for the entire project is called the budget at completion
10. The formula for CPI = EV / AC
11. The formula for SPI = EV / PV
12. A new budget forecast is created to address variances in the project and replaces the BAC. This new forecast is called the estimate at completion
13. The amount of money that remains to be spent on a project that is 1/3 complete is called the estimate to completion
14. The formula for TCPI = BAC – EV / BAC – AC
15. The formula for variance at completion (VAC) = BAC – EAC

Chapter 8 Memory Check Answers

1. The limits that are calculated on a statistical process control chart are the control limits, whereas the limits that are set by the customer are called the specification limits
2. A comparison of project activities against a known standard is called benchmarking
3. Weighing the cost of implementing quality against the benefit it will deliver for the project is called a cost-benefit analysis
4. The tool that is used to test multiple factors simultaneously is called design of experiments
5. Prevention is the lowest cost of quality, while internal is the highest cost of quality
6. The tipping point where benefits or revenues received from improving quality equals the cost to achieve that quality is called a marginal analysis
7. A process that establishes a financial measure of the user dissatisfaction with a product's performance as it deviates from a target value is described in Taguchi's loss function
8. 'Fitness for use' was a concept pioneered by Joseph Juran
9. The five levels of the CMMI are in order; Initial, Managed, Defined, Quantitatively managed, Optimized
10. The amount of inventory carried in a just in time process is typically zero.
11. Six Sigma represents an accuracy of 99.999%
12. Continuous, incremental improvement in a product or process is called kaizen in Japan
13. Deming observed that at least 85% of the cost of quality (or poor quality) is management's responsibility
14. Statistical independence states that the probability of one event occurring does not affect the probability of another event occurring
15. The key output of the Plan Quality process is the Quality Management Plan
16. A product that is not particularly attractive but meets your quality criteria for fitness for use can be described as low grade, but high quality
17. The key output of Perform Quality Assurance is change requests
18. Data that you can perform mathematical computations is called variable or continuous, whereas data that describes a label or a pass/fail scenario is described as attribute or discrete data
19. The quality pioneer that promoted the idea of zero defects was Philip Crosby
20. Kaoru Ishikawa created a diagram used to ferret out root causes of problems that was called the cause and effect diagram
21. The zone test is used to determine if the data in an SPC chart is out of control even though the data points are within the control limits of the chart
22. The pareto chart is used to identify critical issues in descending order of frequency
23. To determine if a change in 'X' corresponds to a change in 'Y' the chart that best displays this correlation is the scatter diagram
24. Mutual exclusivity means that two events cannot occur in a single trial
25. The key output of Perform Quality Control is validated deliverables

Chapter 9 Memory Check Answers

1. The processes in the Project Human Resource Management knowledge area occur in the Planning and Executing process groups of the Project Management Lifecycle
2. The role that accepts the product of the project and provides financial resources for the project is the sponsor whereas the role that sets priorities between projects and the triple constraints is performed by senior management
3. The roles and responsibility grid identifies activities, documents, and other deliverables along with the person accountable for those activities
4. Develop Project Team is in the Executing process group and has the key output of Team Performance Assessment
5. The two forms of project manager authority that PMI states are the most effective are Expert and Reward
6. The four stages of team growth according to the Tuckman Model are, in order, forming, storming, norming, and performing
7. The psychologist who introduced his concept of a hierarchy of needs was Abraham Maslow
8. The management theory that assumes the average person dislikes work, has no ambition, avoids responsibility and is not too intelligent is entitled Theory X
9. Theory Z focused on increasing employee loyalty to the company by providing a job for life with a strong focus on the well-being of the employee
10. A key output of the Manage Project Team process is change requests
11. PMI considers confrontation as the best approach in resolving conflict while it considers forcing the worst approach
12. The leadership model in which the manager of a team applies more direction to managing inexperienced employees, and then moves to a delegating approach as the team members grow in skill and capability is called situational leadership
13. Frederick Herzberg found that the factors causing job satisfaction (and presumably motivation) were different from that causing job dissatisfaction. He called these dissatisfiers hygiene factors
14. Expectancy theory is the belief that increased effort will lead to increased performance i.e. if I work harder, the outcome will be better
15. The top three causes of conflict on a project are: schedule, project priority, and resources
16. Team performance assessment addresses the effectiveness of the team as a whole, while project performance appraisals address the performance of individuals on the team
17. The concept that individuals are motivated by the need for power, achievement and affiliation is known as achievement theory, developed by David McClelland
18. The type of power that a PM can exhibit by offering perks or other benefits is called reward power

Chapter 10 Memory Check Answers

1. Identify Stakeholders is the process of identifying all individuals or organizations that can be positively or negatively impacted by the project
2. Identifying all potential stakeholders, their potential impact on the project and assessing how key stakeholders may respond to specific situations is called stakeholder analysis
3. The stakeholder register includes all information about the stakeholder including their power, impact, and influence level on the project
4. An approach to increase the support for the project and minimize negative stakeholder influence is called a stakeholder management strategy
5. Only 7 % of your message is conveyed in the words themselves, while 38 % of the message is conveyed in vocal tone and inflection and 55 % in body language
6. The formula that determines the complexity of communications is expressed as $[N*(N-1)]/2$
7. The key output of the Plan Communications process is the communications management plan
8. The three fundamental communications methods are known as interactive, push, and pull
9. Distribute Information and Manage Stakeholder Expectations occur in the Executing process of the Project Management Lifecycle
10. The process of attentively responding and verifying what the sender of a message is communicating to you is called active listening
11. The four basic types of communications are known as: formal written, formal verbal, informal written, and informal verbal
12. A status report describes where the project now stands – a progress report describes what has been accomplished – and a variance report compares actuals to the performance baseline
13. A project manager spends 90% of their time on communication activities
14. The three types of forecasting methods are described as: time series methods, causal/econometric methods and judgmental methods
15. The Report Performance process has as a key output, Performance Reports, and occurs in the Monitoring and Controlling process group

Chapter 11 Memory Check Answers

1. The risk categories in a project plan can be graphically represented in a tool called a risk breakdown structure
2. The five Planning steps in Risk Management are, in order: Plan Risk Management, Identify Risks, Qualitative Analysis, Quantitative Analysis, and Risk Response Planning
3. The tool that is used to determine where the organization's strengths and weaknesses play against each other is called a SWOT grid
4. A risk register that measures probability, impact, and detectability is known as a FMEA
5. A decision tool that is best used in which the participants could become contentious is known as the Delphi technique
6. A reactive method of problem detection and solving in which the analysis is performed *after* an event has occurred is called a root cause analysis
7. A repository for all known risks on a project that identifies risk responses and owners is called a risk register
8. Multiplying the Impact of an event in dollars time its probability is called the expected monetary value
9. Three type of responses to negative risks re are known as Mitigation, transfer, and avoidance
10. A decision tool that illuminates a possible path forward based on a decision made by the business and the probability of success of each decision path is called a decision tree analysis
11. The types of responses to positive risks are known as share, exploit, and enhance
12. The risk response plan that is used when the risk has been accepted is called a contingency plan
13. A minor risk that remains after the risk response strategy has been implemented is called a residual risk whereas a risk that occurs as the result of implementing risk response strategy is called a secondary risk
14. A fallback plan is developed when a selected risk strategy is not fully effective or if risk has a high impact
15. Management reserves are used to provide funding for the 'unknown' unknowns of a project – while contingency reserves are used to handle the known unknowns
16. An unplanned response to risk in which no contingency plan exists is called a workaround
17. A risk response the is used for both positive and negative risks is called accept
18. A statistical modeling tool used to create cumulative distributions and what-if scenarios is called a Monte Carlo analysis
19. A risk information gathering technique that collects as many ideas as possible is called brainstorming
20. A document that describes how you will manage and plan your risk responses is called a risk management plan

Chapter 12 Memory Check Answers

1. Several disadvantages of centralized contracting is that the procurement lead may be working on multiple projects so it may be difficult for the PM to obtain help
2. The five elements of a contract are offer, acceptance, capacity, consideration, and legal purpose
3. One of the key tools in the Plan Procurements process that analyzes whether to do the work in house versus having a third party provide the product or service is called a make-or-buy analysis
4. Some advantages of decentralized contracting are that the PM has easier access to procurement expertise and that the procurement manager has more loyalty to the project
5. The three fundamental procurement statements of work types are; performance, functional, and design
6. Two forms of non-competitive procurement are called sole source, and single source
7. A non-legally binding document in which the buyer states they intend to hire the seller is called a letter of intent
8. Another term for a teaming agreement is called a joint venture
9. The three basic forms of contract are fixed price, cost reimbursable, and time and materials
10. The concept of life cycle costing addresses the total cost of ownership of a product or service
11. The key outputs of the Conduct Procurements process is the procurement contract award and selected sellers
12. The prime contractor can use sub-contractors. Since the sub is contracted to the Prime and not to the buyer, the buyer has no contractual control over the sub. This is called privity
13. The point of total assumption occurs on fixed price incentive fee contracts in which the seller assumes all additional costs for delivering a product of the project
14. The RFP is best used for a cost reimbursable contract while the IFB or RFB is best used for a fixed price contract
15. The key output of the Plan Procurements process is the procurement statement of work
16. A bidder's conference invites all bidders to a Q&A session in which bidders can ask clarifying questions regarding the buyers RFP
17. A screening system establishes minimum criteria to eliminate non-qualified vendors
18. Fait Accompli, deadline, missing man and limited authority are all examples of contract negotiation tactics
19. A weighting system is usually implemented as a grid that lists all the proposal criteria and assigns a numeric weight each of the criteria
20. Contract closure always occurs before administrative closure when completing a project or project phase
21. Force majeure, assignment, escrow, time is of the essence, retainage and confidentiality are all contract elements generally grouped in a category called terms and conditions
22. A key output of the Administer Procurements process is change requests
23. A contract change control system defines the process by which procurements can be modified
24. Technical Capability, management approach and technical approach are some of the elements that are assessed in vendor evaluation criteria

