Project Management
- Principles and Practices

Nutek, Inc.
Bloomfield Hills, Michigan 48302, USA.
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Nutek, Inc. (Since 1987)
Quality Engineering Seminar and Software
Bloomfield Hills, MI, USA. 2014

Instructor’s Background

Ranjit K. Roy, Ph.D., P.E., PMP, (Mechanical Engineering, president of NUTEK, INC.), is an internationally known consultant and trainer specializing in quality engineering. Dr. Roy has achieved recognition for his down-to-earth style of teaching of Taguchi’s experimental design and other quality improvement techniques like Quality Operating Systems (QOS), Production Problem Solving, Project Management, etc.

Dr. Roy began his career with The Burroughs Corporation as a senior project engineer following the completion of graduate studies in engineering at the University of Missouri-Rolla in 1972. At General Motors Corp. (1976-1987) Dr. Roy assumed various engineering responsibilities, his last position being that of reliability manager. While at GM, he consulted on a large number of documented quality improvement projects of significant cost savings.

Dr. Roy established his own consulting company, Nutek, Inc. in 1987 and currently offers consulting, training, and application workshops on product and process design improvement. He is the author of the textbooks A Primer On The Taguchi Method, published by the Society of Manufacturing Engineers in Dearborn, Michigan, Design of Experiments Using the Taguchi Approach: 16 Steps to Product and Process Improvement published (January 2001) by John Wiley & Sons, New York, and of Qualitek-4 software for design and analysis of Taguchi experiments. Dr. Roy is a fellow of the American Society for Quality and an adjunct professor at Oakland University, Rochester, Michigan. Dr. Roy is listed in the Marquis Who’s Who in the world.
Project Management - Principles and Practices

Course Outline

In today’s fast-paced business world, organizations that practice sound project management principles secure competitive advantage over those who rely on experience alone. Today, to get products and services to the market faster with a cost advantage, the projects must be time-based as well as cost-based. Project Managers who understand how to use the tools of Project Management are taking leadership roles in the constant drive toward operating improvement.

This comprehensive 4-day seminar is an in-depth and participative course providing project managers with the skills, knowledge and tools needed for project success. Seminar attendees learn the essential steps in setting up project plans, scheduling work, exercising appropriate control and monitoring progress to achieve desired project goals. Through class exercises and realistic simulations, attendees learn how the principles are put into practice. This course conforms to A Guide to the Project Management Body of Knowledge (PMBOK® Guide, 3rd Edition) by Project Management Institute and reviews most materials included in the Project Management Professional (PMP) exam. The topics covered in this session are considered among the best practices in the field. Upon completion of this course, the participants return to their own organizations prepared to meet time, budget and performance objectives of their own projects.

Course discussions during the cover the following PMBOK® areas:


Benefits from the Session:

The participant will learn the skills necessary for planning, scheduling, controlling and assessing risk in projects. Projects planned following the guidelines discussed in this course will reduce the time it takes to get a new team up-to-speed, making your organization realize the benefits of a team’s synergy more quickly, develop better solutions, generate more innovative ideas, and secure greater buy-in. By attending this session, you will develop working knowledge to calculate project duration and express it in terms of confidence intervals using critical path method and PERT.

Who should attend this seminar/workshop?

- Managers and executives responsible for diverse projects
- Anyone seeking a structured project management method
- Project managers currently experiencing difficulty keeping projects on track
- Support function managers and supervisors who want a better understanding of the project management process
- Individuals who want to prepare themselves for a project management exam
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Why?
- Level Problems Optimize products
- Where?
  - Manufacturing
  - Development
  - Design

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PM Overview & Introduction

“Project Management is all about how to successfully lead, conduct and manage a project”

It takes lots of common sense and a few techniques!

- Common sense items are too numerous
- All projects will make use of some of them
- Larger industrial projects make use of many of the techniques we will discuss in this class
- But, industrial projects are too specific and technical for diverse applications
- Simple & small projects are easy to understand by all, but do not usually make use of techniques
- Thus, the most of our examples in the class will be simpler projects that all attendees can relate to
Minimum Planning Activities (Phases as per PMBOK® 3rd Edition)

**Why?**
- Service Problems
- Optimize products

**Where?**
- Manufacturing
- Development
- Design

Minimum Planning Activities (Phases as per PMBOK® 3rd Edition)

- **Initial**
- **Intermediate**
- **Final**

**With a few more activities**

- **Initiating**
- **Planning**
- **Executing (Doing)**
- **Monitoring & Controlling**
- **Closing**

**Time Spent**
- Planning
- Execution

**Phases**

1. Wedding Ceremony & Reception (300 – 500 days of planning, 1 day of ceremony)

**Project: Long Planning – Short Execution**

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<th>Planning</th>
<th>Execution</th>
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2. Powering Powerless Michiganders (Friday Aug. 14, 2003, 4:15PM, 2.2 Million households lost power; Power restored by Sunday night. Planning 2 hours, Execution 70 hours)

**Project: Short Planning – Long Execution**

<table>
<thead>
<tr>
<th>Planning, 2h</th>
<th>Execution, 70 hours</th>
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3. Lunar Exploration Project (Years to plan, years to execute)

**Project: Long Planning – Long Execution**

<table>
<thead>
<tr>
<th>Planning</th>
<th>Execution</th>
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</table>
Initiating the project
- Determine Project Goals
- Determine Deliverable Products and Services
- Determine Project Management Process Outputs
- Document Project Constraints
- Document Assumptions
- Define Project Strategy
- Identify Performance Criteria
- Determine Key Resource Requirements
- Estimate an Appropriate Project Budget
- Create a Comprehensive Document for Final Approval

Executing the project
- Commit Project Resources
- Implement the Project Plan
- Manage Project Progress
- Communicate Project Progress
- Implement Quality Assurance Procedures

Controlling the Project
- Measure Project performance
- Refine Control Limits on Performance
- Take Timely Corrective Action
- Evaluate the Effectiveness of the Corrective Actions
- Ensure Compliance with Change Management
- Reassess Project Control Plan
- Respond to Risk Event Triggers
- Inspect Project Activities Periodically

Prof. Responsibilities
- Maintain Individual Integrity and Professionalism
- Contribute to the Project Management Knowledge Base
- Enhance Individual Competence
- Balance Stakeholders Interest
- Respectfully Interact with Team Members and Stakeholders

Planning the project
- Refine Project Requirements
- Create the Work Breakdown Structure (WBS)
- Develop the Resource Management Plan
- Refine Project Time and Cost Estimate
- Establish Project Control
- Develop a Formal and Comprehensive Project Plan
- Obtain Project Plan Approval

Project Closeout
- Obtain Final Acceptance of Deliverables
- Document Lessons Learned
- Facilitate Administrative and Financial Closure
- Preserve Essential Project Records
- Release Project Resources
Project Management - Principles and Practices

Although people of all ages have managed and accomplished projects for thousands of years, it has been recognized as discipline only a few decades ago. Today the practice is standardized and there are numerous computer aides to support the project success.

Projects of type:
Ancient projects – The Egyptian pyramids, the Trojan horse, the Great Wall, Alexander’s conquest of the east, etc.

Projects of recent pasts – Wright Brother’s flight, construction of railroad, the Statue of Liberty, the Taj Mahal, the Eiffel Tower, and the Empire State Building, etc.

Projects of more recent time – The Moon Landing Mission, The Desert Storm, The Operation Iraqi Freedom, DTE Energy’s ability to bring Power back to Detroit, MI Aug. 14, 2004, 4:15PM), one of the large but short-lived project (72 hours, 2.2 M people out of power), etc.

These projects were all completed by people at different times using their own method of workings at different schedules and cost. Today’s project managers benefit from the best practices of the past and use of standardized techniques allowing project completion with high efficiencies in cost, time and scopes.
A project is plan that needs to get done in a set **timeframe** & within a deadline. Projects come in all sizes and may involve one or more people.

“A project is a temporary endeavor undertaken to provide a unique product and service.”
   – the Guide to the PMBOK

“A project is a problem scheduled for solution.”
   - J. M. Juran

A project is composed of multiple tasks including a plan, proposal, or scheme to meet a designated performance, time, and cost requirement.

A project has specific:
- goals
- time frame
- final outcome or result
- budget
- resources
- plan (what gets done when)
- evaluations (option to be evaluated on their own)

or strategies for completing tasks, & schedules for getting the job done. The end of a project, of course, results in achieving what all wanted and what all team members can be proud to have accomplished.
Project Management: Now that we know what a project is, we can proceed to understand what we mean by project management.

The terms manage and management are defined as follows (- The Tormont Webster’s dictionary):

Manage –
1. To direct or control the use of a tool, machinery, etc.
2. To exert authority to discipline or persuade…..
3. To direct or administer the affairs of (an organization, estate, etc.)
4. To carry on or supervise business affairs …

Management –
The act, manner, or practice of managing, handling, or controlling something. …
**Example Project:**

To see what a project manager needs to do, consider this example.

**Project:** Boost morale and teamwork by arranging for a company picnic

**Budget:** $15 per participating employee

**Time frame:** May 15 – August 30th. (Assume today’s date is April 15)

**Goal:** Organize a picnic for all team members to bolster company morale and raise team spirit

**Results expected:**
Enjoy food, have fun, and get to know your fellow workers on personal level.

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### Kind of Work A Project Manager Needs to Do

A project manager is the conductor of the ‘show’. He/she organizes, runs, and brings the project conclusion by doing the following:

1. Define project goals
2. Determine desired results
3. Ensure work completion within budget
4. Establish schedule
5. Select teams and establish individual role
6. Secure machines & tools
7. Monitor ongoing progress
8. Resolve conflicts and problems
9. Communicate progress to stakeholders
10. Boost team members morale
11. Brings project to completion
12. Close the project by documenting the lessons learned

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**3. Working within budget:** Do not exceed budgeted cost for food, transportation, game/activity equipment, trophies, and other freebees.

**4. Setting up schedule:** Form the planning team eight weeks prior to the event, send out invitations six weeks in advance, order food two weeks before the event, buy other nonperishable goods a week in advance, send reminder for picnic every week for the last three weeks, etc.

**5. Selecting Team:** Select a group of co-workers to form a team. In doing so, you will look for people who have experience and enthusiasm to do special tasks to arrange the picnic. Assign tasks to each individual, that is, decide who will bring chicken, who will bring drinks, who will take care of games, and who will prepare the food.

**6. Securing Machines & Tools:** Make sure that the picnic location is reserved and that grills for barbeque are available.
7. Monitoring Progress: Check with team members to see if they are on schedule with ordering supplies. On the day of the picnic, take notes of how the food was, was there sufficient supplies, etc.

8. Resolving Conflicts and Problems: “Sally can’t bring the supplies to the picnic; she’s in bed with an allergy attack.” Make arrangement for some one else to swing by Sally’s house.

9. Communicating Status: Tell the boss that everything is progressing well and that he can relax.

10. Boosting Team Morale: Meet with team members for a dinner outing to see how everyone is doing.

11. Bringing Project to Completion: Talk with team members the day before the event to check on their status. On the day of the picnic, arrive at the picnic location early. Welcome all and introduce team members with each other when appropriate (This is necessary in today’s business with remote locations).

12. Closing the Project (Asses what went right and what went wrong): People enjoyed the food very much. The picnic location being close to water was a great attraction for many. The charcoal for the grill was not of good quality; we must be selective in buying charcoal next year.

One-Person Projects
Many projects are one-person projects. Individual jobs qualify as projects, as they still definite starting points, target end dates, specific performance requirements, & definite scopes of work and budgets. But, managing these projects may not be classified as project management as there are no coordination activities with other people. For one-person projects, all you need is a to-do list.

Project Management Is Not Just Scheduling
A common misconception is that project management is synonymous with scheduling. If that were true, project management computer programs for project management would make all projects successful. Scheduling work is a tool used in project management. What is more important is the leadership and development of a shared understanding of the project goals and constructing a good Work Breakdown Structure (WBS) to identify all the work to be done.
### Organizational Structure Suited for Project Management

<table>
<thead>
<tr>
<th>Matrix organization</th>
<th>is the most desirable structure for successful. In this type, all employees are organized strictly by skills. In traditional organization, there exists some flexibility in organizing by skills. For example, an engineering analysis group may have a number of employees for specific computer support, while a mechanical test lab may have an electrical engineer. In matrix organization, people of the same skill report to the same functional managers who are responsible for providing the manpower needed by the project manager and take care of the administrative needs of the employees the provide for the project.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Projectized Organization</td>
<td>Project manager with supreme authority</td>
</tr>
<tr>
<td>Fully dedicated personnel</td>
<td></td>
</tr>
<tr>
<td>Difficulty securing special skills for short time</td>
<td></td>
</tr>
<tr>
<td>Personnel reallocation at end of project</td>
<td></td>
</tr>
<tr>
<td>The Traditional Organization</td>
<td>Set up based on people skills</td>
</tr>
<tr>
<td>Specialization is encouraged</td>
<td></td>
</tr>
<tr>
<td>Skill changes are difficult in response to support for project needs</td>
<td></td>
</tr>
<tr>
<td>The Matrix Organization (Weak &amp; Strong)</td>
<td>Introduced in 1970s</td>
</tr>
<tr>
<td>Attempt to combine best of projectized with traditional structure</td>
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</table>

Project managers also have an organization. Specifically, the project manager is responsible for work that is done by the individuals assigned to the project. Since project managers are not responsible for administrative work needed for their employees, they can concentrate their time and effort on forming the right teams to get the job done.

Since people report to project managers and are responsible for their work to both functional managers and project managers, there is a need for BALANCE OF POWER.

**Strong Matrix Organization** – In this set up, project managers are responsible for have more people than the functional manager. This may result in more people assigned to a project than needed. Also, employee skill may be underutilized.

**Weak Matrix Organization** – In this type of organization, the balance of power is tilted toward the functional managers; the organization tends to be similar to a traditional organization with separate project managers. The functional managers assign and monitor work, while the project managers simply expedite the projects.
**Balance Matrix Organization** – In this type of organizational structure, balance of power is adjusted depending on the time spent by each employee. For example, the company could institute a standard rule that if an employee spends more than a month on the project, all work will be done under the direction of the project manager.

**Project Office and Project Management Office** - These terms are often used by companies with larger projects. A project office maintains office supplies and other necessities in a common location to be shared by all projects. A project management office is a separate location for the employees in the project to be housed.

- *In early 70’s General Motors’ five passenger car divisions planned to develop future vehicles working in a common location called Project Center in Warren, MI*

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### The Phases and Project Life Cycle

All projects, large or small, go through similar phases. The project life cycle defines the beginning and end of a project and various milestones within it. Different people have defined the middle phases differently. PMI describes the project life cycle in terms of process groups like: initiating process (concept and definition), planning process, execution process, controlling process, and closing process.

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PMI views projects as a process and describes the project life cycle in terms of six major processes: like *initiation process, planning process, executing, controlling process, and closing process.*

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### Steps in Managing a Project

- **Project Initiation**
  - Define project
  - Develop solution

- **Project Planning**
  - What needs to be done?
  - Who will do it?
  - How will it be done?
  - When must it be done?
  - How much will it cost?
  - What is needed to do it?

- **Project Execution**

- **Project Controlling and Monitoring**
  - Are we on target?
  - What must be done if not?
  - Should the plan be modified?

- **Project Closing**
  - What was done well?
  - What did we learn?
  - How should it be done next time
**PM Phases & Tasks**
Detail the list of tasks that needs to be done in each step of the project’s management. These are the items a project manager has to address. The topics and methods that support accomplishing these areas will be the subject of discussions in the upcoming modules.

You can use the following as a check list while progressing through project phases.

<table>
<thead>
<tr>
<th>Project Initiation Tasks (10 Tasks)</th>
<th>Project Control Tasks (8 Tasks)</th>
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<tbody>
<tr>
<td>1. Determine Project Goals</td>
<td>1. Measure Project Performance</td>
</tr>
<tr>
<td>2. Determine Deliverable Products and Services</td>
<td>2. Refine Control Limits on Performance</td>
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<td>3. Determine Project Management Process Outputs</td>
<td>3. Take Timely Corrective Action</td>
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<td>4. Document Project Constraints</td>
<td>4. Evaluate the Effectiveness of the Corrective Actions</td>
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<tr>
<td>5. Document Assumptions</td>
<td>5. Ensure Compliance with Change Management</td>
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<tr>
<td>7. Identify Performance Criteria</td>
<td>7. Respond to Risk Event Triggers</td>
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<td>8. Determine Key Resource Requirements</td>
<td>8. Inspect Project Activities Periodically</td>
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<tr>
<td>9. Estimate an Appropriate Project Budget</td>
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<td>10. Create a Comprehensive Document for Final Approval</td>
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<table>
<thead>
<tr>
<th>Project Planning Tasks (7 Tasks)</th>
<th>Project Closing Tasks (5 Tasks)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Refine Project Requirements (vision, mission, scopes and objectives)</td>
<td>1. Obtain Final Acceptance of Deliverables</td>
</tr>
<tr>
<td>2. Create the Work Breakdown Structure (WBS)</td>
<td>2. Document Lessons Learned</td>
</tr>
<tr>
<td>4. Refine Project Time and Cost Estimate</td>
<td>4. Preserve Essential Project Records</td>
</tr>
<tr>
<td>5. Establish Project Control (Manage &amp; Control Changes)</td>
<td>5. Release Project Resources</td>
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<tr>
<td>6. Develop a Formal and Comprehensive Project Plan</td>
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<tr>
<td>7. Obtain Project Plan Approval</td>
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<tr>
<th>Project Execution Tasks (5 Tasks)</th>
<th>Professional Responsibilities (5 Tasks)</th>
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<tbody>
<tr>
<td>1. Commit Project Resources</td>
<td>1. Maintain Individual Integrity and Professionalism</td>
</tr>
<tr>
<td>2. Implement the Project Plan</td>
<td>2. Contribute to the Project Management Knowledge Base</td>
</tr>
<tr>
<td>3. Manage Project Progress</td>
<td>3. Enhance Individual Competence</td>
</tr>
<tr>
<td>5. Implement Quality Assurance Procedures</td>
<td>5. Respect and Interaction with Team Members and Stakeholders</td>
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</table>
The Guide to the PMBOK® describes NINE knowledge areas that help you accomplish the tasks necessary (listed below) to manage the projects. Project managers need these collections of knowledge to be successful. Each of these knowledge areas operates as a sub-process in each of the major project processes. For example, the knowledge area of cost management is helpful to estimate the cost of management in the project planning process. Project quality management in the knowledge areas helps you monitor the progress and performance of the project. The nine PMBOK® knowledge areas are summarized below.

1. **Integration Management**
   - Project integration helps you with project planning, execution, and control. It also identifies procedure you need to establish for project change control.

2. **Scope Management**
   - Project scope definition is very important for the success of the project. This area of knowledge helps you develop scope statement, boundaries of project, etc.

3. **Time Management**
   - This helps develop a project schedule that can be met and establish method to ensure that the schedule is met. (It is not to be confused with personal time management)

4. **Cost Management**
   - You will need the information here for estimating cost of resources (people, material, equipment, travel, etc) for the project.

5. **Quality Management**
   - It offers tools for quality planning and assurance. It also describes current practices for evaluation and monitoring of quality requirements.

6. **Human Resource Management**
   - This area helps you with finding people for the project and defines their roles and responsibilities. It also helps you structure the appropriate reporting relationships.

7. **Communication Management**
   - Deals with ways to plan, execute and control gathering and disseminating of all information relevant to the needs of the project stakeholders.

8. **Risk Management**
   - It describes the systematic process by which to identify, analyze, and respond to the project risk. It assures increase probability of project success.

9. **Procurement Management**
   - It helps with methods for procurement of goods, issuance of bids, selection of vendors, administering and closing contracts.
When principles and tools of project management are followed correctly, the project success rate can significantly increase.

Many organizations require that all projects be lead by certified project managers. For many others, projects are completed by people not skilled in project management. In absence of planning, projects are managed by the seat-of-the-pants approach. Often this is the case as all senior management do not understand what project management can do for the project. So, convincing the upper management to adopt formal project management can be a challenge. As you learn more about project management, you will be able to form your own rationale to justify implementing project management in your area of work.

### Project is a Balancing Act

All projects have four common constraints:

- C = Cost or budget
- T = Time to finish
- P = Performance objective
- S = Scope

These constraints bear a relationship like:  $C = f(P,T,S)$, where $f$ represents a function. This is read as “Cost is a function of Performance, Time, and Scope”

Often projects fail because sponsors demand that the project be finished within certain time, within budget, and accomplish certain desired objective (scopes) while achieving specific performance level. This would be like my spouse asking “Can we build three-level deck like our neighbor’s with our $300 savings before our daughter’s graduation party next month?” You can’t have it all. You can only satisfy three of the four constraints in a project.

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**A Standish Group** ([www.standishgroup.com](http://www.standishgroup.com)) report from 1994 shows that:

- 17% of software projects done in the US meet project goals
- 50% require changes to target completion dates
- 33% are cancelled
- $250 Billion are spent on software development projects each year
- $80 Billion is lost on cancelled projects
- The failure rate is similar for product development projects
- An estimated 30% of product development projects require rework

The single common reason for project failure is inadequate PLANNING.
Here is a good example of how the balance of scope, cost, time, and performance compromises may result in severe consequences if not done right.

The Detroit News  
February 27, 2003

NASA culture is culprit in disaster: Overconfidence, safety flaws must be addressed to avoid another tragedy.

In a 248 page report based on the investigation of the shuttle Columbia accident (Feb. 1, 2003, seven crew members died), the Columbia Investigation Board blamed NASA administration for failure to implement independent safety programs that could have prevented the accident.

In response, NASA administration stated: “NASA had conflicting goals of cost, schedule and safety. Unfortunately safety lost out.”

Practice & Learn: Review and solve Exercise Q 0.1 - Q 0.5.
Exercises

Q 0.1 what would you call a temporary endeavor you undertake to create something new or to solve a problem?

a. Development Task  
b. Program  
c. Project  
d. Charter

Q 02. Which project management phase takes the most effort (not time) on the part of the project manager?

a. Execution  
b. Closing  
c. Planning  
d. Approval

Q 0.3 A project scope defines:

a. Total budget of the project.  
b. The magnitude or size of the job.  
c. Project manager’s commitment to the project.  
d. Manpower committed to the project.

Q 0.4 What is PMBOK® ?

a. It’s a special kind of analysis  
b. It is a test administered by Project management Institute (PMI)  
c. It is the body of knowledge available for project management  
d. Project management book of rules

Q 0.5 What is a common problem that a working project manager will face?

a. Run short of time all the time.  
b. You won’t know what priorities to set  
c. Your management may think you are not putting full effort.  
d. Your work is likely to take precedence, and managing will suffer.
Module 1
Project Initiation
Module - 1

Project Initiation

This is the phase where the project is born. Here you will determine the project goals, products and services deliverable, document project constraints and assumptions. You will also identify performance requirements and determine key resource requirements to produce what the stakeholders want. At end of this phase, you will prepare a document complete with all information the management will need to approve time and budget for the project and authorize you to proceed with complete project planning activities.

<table>
<thead>
<tr>
<th>Project Initiation Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tasks Performed</strong> (10 Tasks)</td>
</tr>
<tr>
<td>1. Determine Project Goals</td>
</tr>
<tr>
<td>2. Determine Deliverable Products and Services</td>
</tr>
<tr>
<td>3. Determine Project Management Process Outputs</td>
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<td>4. Document Project Constraints</td>
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<tr>
<td>5. Document Assumptions</td>
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<tr>
<td>6. Define Project Strategy by Evaluating Alternative Approaches</td>
</tr>
<tr>
<td>7. Identify Performance Criteria</td>
</tr>
<tr>
<td>8. Determine Key Resource Requirements</td>
</tr>
<tr>
<td>9. Estimate an Appropriate Project Budget</td>
</tr>
<tr>
<td>10. Create a Comprehensive Document for Final Approval</td>
</tr>
</tbody>
</table>

1.1 Determine Project Goals

In this first step of the project, you will work with the stakeholder to identify and determine the project’s goals. This understanding of what the stakeholders want would help you meet their requirements, expectations and/or specifications.

1.2 Determine Deliverable Products and Services

In this step, you will determine the products and services that you will deliver to the stakeholders at the completion of the project. This is achieved by examining and generating the scope of work, requirements, and specification that will meet the stakeholders’ expectations.

1.3 Determine Project Management Process Outputs

The Guide to the Project Management Body of Knowledge urges one to consider project management process, which like any other process, accepts inputs and processes them; producing outputs. Of course, the project management process comprises of several sub-
processes like the initiation process, the planning process, the execution process, and the closeout process. In initiation process, you will make sure that project management process outputs meet the products and service delivery required by the stakeholders.

1.4 Document Project Constraints
Each project has its own set of time, budget, manpower and availability. Coordinate with stakeholders and review all policies and procedures to ensure that the project complies with all constraints.

1.5 Document Assumptions
The goal is to list all assumptions, identify information that will need validation, & identify situations to be observed or controlled during the project execution. These are items that will have to be reviewed and refined before completing the planning process.

1.6 Define Project Strategy by Evaluating Alternative Approaches
If a project has more than one possible approach, evaluate each alternative that meet the stakeholders’ requirements and specifications for the project.

1.7 Identify Performance Criteria
In this step, you will review the product and service specifications and process standard to determine the performance criteria needed to evaluate the quality assurance effort.

1.8 Determine Key Resource Requirements
The availability and cost of key resources have direct influence on the project’s timing and budget. Here, you will review the deliverable requirements and identify key resources. This step is essential for the planning and decision-making process.

1.9 Estimate an Appropriate Project Budget
You will determine the project budget and schedule by estimating cost of all activities associated with your in the project. AN accurate budget is crucial for the project’s approval.

1.10 Create a Comprehensive Document for Final Approval
This is the document that contains your complete project plan. You will submit this document to stakeholders for their approval.
### How Do Projects Originate?

Projects come in to being in mainly two ways: either you initiate the project, or it is selected for you.

#### Self Initiated Project:
- Personal projects like purchasing a new computer system, planning a trip, remodeling home, etc.
- Business owner’s projects like moving one’s office location, launching a new ad campaign, implementing new database software, etc.

#### Sponsored Project at Work:
These are project selected and approved by your boss/management.
- Building a new facility engine life test
- Launching a new web site for online project management training
- Building a new power plant for Baghdad

#### Other Kinds of Project:
- Community Projects
- Ownership by default

No matter how the project falls into your lap, it will have an expected end result. You will need to identify a **clear goal**. To accomplish the goal you will need a **plan** and set a **schedule**. You will also need to stay within your **budget** and utilize all available **resources**. This will be true for a project like planning your daughter’s graduation party with your wife or working with a team of 75 research scientists to come up with a preventive drug for a new disease named SARS.
Project Charter

- A formal document that initiates the project
- It authorizes project to begin and names the project manager
- Project charter is written by the project manager but is distributed bearing the signature of the person who authorizes it.

Project Charter
As we have seen, there are several ways project could come into existence. It is an important formal document that authorizes formation and work on a project.

Project charter is created by some sort of document issued by the person authorizing the project and one who appoints the project manager. Usually such document will contain a brief description of the justification for the project.

The project charter should be written by the project manager but must be distributed under the signature of the person authorizing the project. By writing the charter, the project manager avails the first opportunity to define the project as she/he sees it.

Things Common to All Projects

- Define clear goal or specific obtainable result
- Plan and schedule
- Stay within budget
- Utilize resources to get desired result

Notes on Project Characteristics:
Generally, projects have **fixed life**. This is not to say that that the goods and services project produces end. For example, a project to build a shopping mall ends when the goals of the construction and making ready for tenants have been achieved. The shopping mall continues to operate, far into the future, even though the project has ended.
For most projects, the goods and services that it provides are unique in nature. Of course, this does not mean that they are totally and completely unique. Many projects build on the results of other projects and commonality with other projects the organization has done before.

Projects are always temporary endeavors, as they are intentionally created to accomplish a specific objective. This allows project managers the ability to form multidiscipline project teams with right people at the right time.

Generally, projects have limited resources; still, some projects have what it seems like unlimited budget and resource. For example, Apollo project of the 1960s and Manhattan Project of the 1940s were long projects with limited constraints by the Congress.

---

**Project and Program**

The difference between program and project is subtle and depends on the activity. Often, projects are part of a program. Also, many projects are subprojects of a larger project.

“A program is a group of projects managed in a coordinated way to obtain benefits not able to be obtained by managing them separately.”

- The guide to the PMBOK®

**Example Programs:**

- Hydrogen Fuel Powered Automobile Development Program (By an auto manufacturer).
- The National Marrow Donor Program
- Mars Exploration by NASA
Who Are Interested In The Project Outcome?

- Customer
- Stockholders
- Executives
- Clients
- Upper Management
- Project Manager
- Project Team

Who Are Key Stakeholders?

- Project Manager (one who is responsible for managing the project)
- Customer (uses projects product/output)
- Performing organization (whose employee performs project work)
- Project Team (who does work for the project)
- Sponsor (individual or group within or external to the performing organization that provides financial resource)

The **client** or **sponsor** is the originator of the project and is the main stakeholder. The client is the person or organization that bears the cost of the project and has the most interest in the success of the project.

Beyond the sponsor (those who requests the project be done) are stakeholders who will have personal or financial interest in the end result. As the leader of the project team, the project manager will need to satisfy the stakeholders. The more the stakeholders in a project, the more you will need to appease a variety of interests.

A **stakeholder** is a person or organization that has something at stake in the outcome of the project. A project will always have at least one; each stakeholder may have different needs and expectations.

Any party interested in or affected by the outcome of the project is a stakeholder. The project team members who perform the work for the project are also stakeholders. Depending on the project, stakeholders may contribute ideas to the project on a regular basis, be intricately involved in the project progress, or not be involved in the actual work of the project at all. For example, stakeholder for development of a state funded prison system may be the community.
Assumptions and Constraints

**Constraints:**
All project constraints may not be included in the project charter. You will need to be aware of constraints that may limit the completion of any project activities.

- Holidays
- Labor unrest & strikes
- Start date
- Project completion date
- Budget restrictions
- Hiring restrictions

**Assumptions:**
While making plan for the project, you will need to make certain assumptions.

- Resources are available
- Vendors are available
- Contract will be signed before project commencement
- Start date will be agreed upon
- Utility will supply electricity, water, etc.
- Communication and transportation will be normal
Price and Cost Relationship

**Price** is the amount of money that a customer (stakeholder) is willing to pay for the goods and services produced by the project.

- A home buyer pays $250,000 for a new 3 bedroom house from a builder.
- A consulting firm develops a database for an insurance company for $5,500,000.

**Cost** is the monetary value of the manpower, materials, equipment, etc. consumed by the project to produce the deliverables.

- The dollar amount spent by the builder to build the 3 bedroom house ($220,000).
- The expenses incurred by the consulting firm to complete the database creation project ($3,900,000)

\[
\text{PROFIT} = \text{Price} - \text{Cost}
\]
Common Strategies for Pricing

**Price** – should be established based on the customer perceived value of the goods and services.

**Cost** – stay competitive and complete the project with minimum cost.

**Initial Projects**

Higher Price – Lower Cost = High Profit

**Invest extra profit** to be cost efficient in future projects.

<table>
<thead>
<tr>
<th>Common Strategies for Pricing and Maximizing Profit</th>
</tr>
</thead>
<tbody>
<tr>
<td>The selling price is determined by what the customers are willing to pay. If what the customer or stakeholders are willing to pay is known, then the potential profit from the project can be calculated. Since, profit equals price minus cost, the cost of the project must be estimated.</td>
</tr>
</tbody>
</table>

Global competition will require you to be cost competitive in all areas of the project and accomplish it with minimum cost.

This may seem like a sure recipe for higher profit, but, it will not last long. Excessive profit will attract competition and lower cost, and will offer the same goods and service at a lower price. So the company would be wise to invest its extra profit made from early projects in buying resources that lowers the cost of the future projects. This way, as the price the customer is willing to pay is lowered, a profit margin will be maintained.

Note: Eliyahu Goldratt was first to point out that price should be determined from the “perceived value to the buyer” in his book *It’s Not Luck*.

The strategy is similar to the pricing strategy used by computer manufacturers.

1. In the mid 1970s, mini computer systems for CAD/Cam were sold for $150,000/unit. The systems were more powerful than those available for under $10,000 in 1990’s. This can only be possible by reducing the production cost and increasing the volume of sales so that a satisfactory level of profit is maintained.
2. The first IBM PC was sold for about $4,000 in 1978. More powerful PC’s were in the market selling for under $2,000 in the late 1980’s.

**Overbid and Underbid**

When submitting the project’s bid to stakeholders/customers, you face the risk of being higher (Overbid) or lower (Underbid) than the average. Both scenarios have shortfalls. So, the best practice is to submit a competitive bid with minimum cost. The exact cost of the project, of course, is never known until it is completed.
Underbid – Though it could land you the contract, it may put you in a financial hole, quickly. An underbid may also cause you to loose reputation to the stakeholder temporarily. But, when the project is completed, even with some loss, it could provide valuable lessons for making more accurate estimates in future projects.

Overbid – When a project is not won, one might sight favoritism as a cause, when in reality, it may be that you were too costly. If you do get the job, you can set a comfortable profit margin, supplied with solvent budget, the resources and schedule will be created to utilize it. You will also monitor the progress of the project based on its allocated budget. When the project is completed, the stakeholders will be happy, and all of the team members will be rewarded. Unfortunately, this may not last too long. Sooner or later, the competition will be attracted by the large profit potential as well. Be aware also that for a company accustomed to overbid, it is generally a difficult cultural change from doing things in inefficient ways.

Example: An automotive engine-block machining plant is comfortable with 18% reject rates while many of its competitions produce similar product with only 2% scraps.

Underbid and get the job:
- Not enough money to cover the cost of all deliverables
- Additional funds needed
- Requirements reduced
- Tension, layoffs, other unhappy things may result

Overbid and NOT get the project:
- Guesses follows as to why was the job lost

Overbid and Underbid (Contd.)

Overbid and get the project:
- Set budget high with a comfortable profit margin
- Progress is measured against the allocated budget
- If project is completed in time, the client is happy.
- Soon competition joins the market and takes jobs away. Eventually, the company is priced out of the market.

Overbid is bad for companies in the long run as it perpetuates inefficient practices.
Scope Baseline

The base line is the starting reference requirements for the project. It is analogous to the skeleton or rough draft of the project. Until the scope baseline established, a rough cost or schedule can not be estimated.

What do the stakeholders want? What does the project team think the stakeholders want? Often times the two parties have different understandings.

To sort out the project’s accomplishments and separate any wild expectations from required items, you must come to an understanding with the stakeholder. At this point, the deliverable must be defined concisely & clearly.

**Example:** If part of the project is to supply a user’s manual, it should be clarified as to the level of details needed (5 pages manual to instruct which button to press, or 500 pages document showing all about how to maintain the system after it is delivered).

**Example:** One of our recent home projects was to simply replace the aging front doors in the house. Before too long, after developing better understanding with the stakeholders (spouse), our scope ended up being replacing the main entrance doors consisting of a more expensive version made of mahogany wood with a pair of solid brass locks.

Doors come in all price ranges and materials
- Materials like pressed wood, fiberglass, steel, and solid wood (pine, oak mahogany, etc.)
- Single door with side panels or double door with various styles of clear or designer glass openings
- Costs vary between $400 - $8,000 plus installation.
At the end of project’s initiation, you should have estimated the:
- Scope baseline
- Cost baseline
- Schedule baseline

To determine cost and schedule baseline, a clear understanding of the work involved to produce the deliverables is required.

To plan the project, these deliverables need to be broken into individual pieces of work. This is done by a process known as work breakdown structure (WBS).

Why do you need the cost and schedule?

A project cost & schedule helps determine how much of your budget should be spent on each task, when you need the resources, and for how long you will need them.

The idea of WBS is to divide and conquer. When work to be done is broken down into smaller & individual tasks, you can easily estimate cost & schedule. Adding costs of all such tasks readily gives you the total cost of the project.

Example: Door Replacement Project

Scope: Mahogany exterior double door
- Visit store display and select style (two week nights)
- Find cost of doors and cost of labor
- Order doors (4 weeks delivery)
- Purchase locks (1/2 day)
- Install Doors (1/2 day)
- Operate & test doors with locks (1 hour)
- Remove debris (1/2 day)
To create WBS, breakdown the project in the following order:
- Break project into sub-projects
- Break sub-projects again and again into other sub-projects
- Continue breaking sub-projects until the desired level of detail, called "work package" is reached
- Break work packages into "activities"
- Break activities into "task" (bottom level of project)

Work Package is the smallest task a project manager needs to manage.

The number and layers of sub-projects a project will have depends on the size of the project. Also the project manager’s span of control varies depending on the project. For smaller projects, the project manager may be involved in the minute details of individual activities. For larger project, the work package level may be many levels above the task level.

Task level – it is the bottom level of the project. This is where an individual or a group of individuals accomplish the work rather than managing it.

Regardless of what is called the lowest level (task, activity, or work package), it is important that this level has only one person or one group responsible for satisfying the work component.

Faced with an obsolete airport & increasing demand, executives of Wayne County, MI put together a plan to build a new terminal adjacent to the existing Detroit Metro Airport. The terminal consists of over 120 gates to allow loading and unloading of passenger carriers of all sizes and destinations. The airport involved numerous subprojects including building ticket counters, installing security check points, luggage handling systems, automated transportation system connecting all gates, building parking structures, constructing terminal building, etc. Sub-projects like building transportation system within the project were a large effort. Such sub-projects are themselves projects in their own right and have their own
breakdown structure. The thing to remember is that project management is a powerful methodology that applies to any sized project.

**System Approach to WBS**

All work is a system or process that converts input to output

- **Inputs** – must come from somewhere inside the project or external sources

- **Output** – from a task must go to another task in the project or directly contribute to the delivery of one of the deliverables

In a system approach, sub-projects, work packages, and tasks are all viewed as systems. In this structure, inputs are converted to outputs. Viewed as system, all tasks at the lowest level after WBS must have an input and an output. When look at the whole project as a system, it is a process that convert people’s effort, money, and resources into outputs, the deliverable the stakeholders want.

Input to a task would come from other task or from external sources. When it cannot be found internally or externally, tasks may need to be added to the project. Likewise when output items of a task is not utilized or needed by other tasks in the project, that task becomes a good candidate for elimination (extra work)

All project tasks should be reviewed to ensure that each has an input and an output. This is a good way to uncover the need for additional tasks/sub-projects.

**Example of tasks without output or input:**

**No output** - In a project to clean the house, vacuuming, steam cleaning carpet and removing spots on the carpet are some of the individual tasks. Since steam cleaning of carpet is supposed to remove all spots from the carpet, an effort to remove spots before steam cleaning will be considered extra work.

**No Input** – As part of the same project, cleaning backyard deck with high pressure water was part of the sub-project. In the last moment, the company could not keep their appointment to clean the deck. In this case, borrowing/renting a high pressure spray machine will be a task that needs to be added to the project.
Change Management

Could the stakeholders ask for more/new deliverables?
Who pays for the changes?
What is the process to incorporate changes?

Essential steps:
- Treat it like a miniature project plan
- Evaluate time and effort that the change brings (funded internally or externally)
- Identify who (stakeholder) bears the cost and who authorizes change
- Establish justification for change
- Incorporate change into project plan

Project Justifications

Often, the challenge is not in determining the reason for the project, but to decide which projects should be done or whether a project should be undertaken at all.

Most project costs require up front investment. (Assuming that such funds are available, it could also earn interest if invested in interest bearing account instead of spending on a project. Of course, a large company has large pool of manpower to be engage in project activities.) Lack of project may mean layoffs. So, whether to do a project and not make profit or not do a project, earn interest from money, is a decision must be made based on financial benefit.

Change Management

Change management is formal process that controls the project scope baseline. It must be in place early in the project, definitely before the completion of the scope baseline.

Demand for changes from stakeholders can bog down projects. All changes must be evaluated in terms of their impacts on project costs and schedule. Finally, if the change is justified and funding is authorized by the stakeholder, only then should it be incorporated in to the project plan.

Example: In the door replacement project mentioned earlier, the original plan was to get a double entry door system and so the order was placed with a local supplier. A few days later, one of the stakeholders wondered if the doors could have a different glass panel. A trip to the supplier revealed that such change will cost an additional 50% of the cost of the door already ordered.
An Example Project Justification

The US Federal Government, through its national Institutes of Health (NIH) grants close to a billion dollars in research funding each year. In 2005 its 800 million dollar funding supported over 1000 research project. Grantors of the money, in this case the stakeholders of the project require that the competing researchers justify their application for grant in the following six areas. Such requirements change with time and focus of the direction of the intended growth of research and societal needs.

1. Significance: Merit of Project
   - Does the study address an important problem?
   - If the aims are achieved how will scientific knowledge or clinical practice (in case of NIH as grantor) be advanced?
   - What will be the effect of these studies on concept, methods, technologies, treatments, services, or preventing interventions that drive this field?

2. Significance: Commercial Value
   - How strong is the commercial potential of the project in terms of leading to a marketable product or process?
   - What may the product or process be worth?
   - Will the technology have a competitive advantage over existing or alternative technologies in meeting the market needs?

3. Quality of Approach
   - Are the conceptual or clinical framework, design, methods, and analyses adequately developed, well integrated, well reasoned, and appropriate to the aim of the project?
   - Does the applicants knowledge potential problem areas and consider alternative tactics?

4. Innovation in Research
   - Is the project original and innovative?
   - Does the project challenge existing paradigm or clinical practice; address an innovative hypothesis or critical barrier to progress in the field?
   - Does the project develop or employ novel concepts, approaches, methodologies, tools, or technologies for this area?

5. Investigators Qualifications
   - Are the investigators appropriately trained and are well suited to carry out this work?
   - Is the work proposed appropriate to the experience level of the principal investigator or other researchers?
   - Does the investigating team bring complimentary and integrated expertise to the project?

6. Environment of Research
   - Does the scientific environment in which the work will be done contribute to the probability of success?
   - Do the proposed studies benefit from the unique feature of the scientific environment, or subjects populations, or employ useful collaborative arrangements?
   - Is there evidence or institutional support?
More common is the need to decide which project will be more financially rewarding. Cash flow analysis compares the financial benefits of various projects. The idea is to compare projects based on which one brings in more money than others. With this analysis, one can compare: (1) two options of a project, (2) the cost of project A vs. project B, & (3) the pros and cons of taking on a new project.

### Method of Cost Justification

**Cash Flow Analysis** – A measure of cash flowing into and out of the organization over a period of time.

Which project should be undertaken? Which one will bring more return?

Cash Flow Analysis utilizes one or more of these techniques:

- Breakeven Chart
- Average Rate of Return
- Present Value of Money
- Internal Rate of Return

### Break even Chart

A Break Even Chart can be plotted for many expense items & for many alternative projects. Usually, the total cost of project, which is the sum of fixed cost and variable cost, is plotted. When comparing two alternatives, the intersection of the two lines is called the “break even point”. At this pint, the cost or benefit of the two alternatives is equal. Beyond this point, one alternative becomes more attractive than the other.

The time when the break even point occurs is called the “payback period” and is commonly meaningful in case where option/project A is compared with option/project B of not doing the project.
**Example:** A supplier of a plastic part has an old molding machine that produces parts at a cost of $7.0 per unit at a production rate of 5,000 units per month. The machine can be repaired at a cost of $20,000. Alternatively, the same machine could be replaced with a new one for a cost of $90,000 that is expected to produce the same part at a lower cost of $6.0 per part. What should the supplier do if the current product life is expected to be five years?

The cost expressions at constant production cost are:

\[ C_A = 20,000 + 7 \times 5,000 \times T \quad \text{where } T = \text{time in months} \]
\[ C_B = 90,000 + 6 \times 5,000 \times T \]

At break even point, the costs are equal.

Thus \[ C_A = C_B \]

Or \[ 20000 + 7 \times 5000 \times T = 90000 + 6 \times 5000 \times T \]

Or \[ T = 14 \text{ months} \]

When \( T = 20 \text{ months} \)

\[ C_A = $720,000 \quad C_B = $690,000 \]

- Break even point is 14 months.
- Cost of production is lower with the new machine after 14 months.

**Drawbacks of break even chart analysis are:**
- Shortsightedness - Analysis stops at break even point
- Production cost is assumed to be constant

**1.1 Practice & Learn:** While shopping for a family vehicle, you found two automobile of the following description and price:

<table>
<thead>
<tr>
<th>Vehicle A (diesel)</th>
<th>Vehicle B (Gasoline)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchase cost</td>
<td>$24,000</td>
</tr>
<tr>
<td>Annual maintenance cost</td>
<td>$1,200</td>
</tr>
</tbody>
</table>

If you are planning to drive the vehicle for 7 years, which vehicle will be cost effective for you? (You may solve graphically or mathematically)
1.2 Practice & Learn: A homeowner has two options to equip the home with a new furnace. Determine the break even point when the option data are as follows.

Option 1; Cost of furnace $3,500, expected monthly fuel cost $150/month.
Option 2: Cost of furnace $8,500, expected monthly fuel cost $70/month.
(May solve graphically or mathematically)

Average Rate of Return on Investment (ROI)

ROI is generally expressed as the percentage of initial investment.

Suppose that the supplier of the plastic part described in the preceding example decides to replace the existing machine by purchasing of a new one for $90,000. The supplier then sells the parts at varying sales volume shown below.

<table>
<thead>
<tr>
<th>Year</th>
<th>Annual Sales Vol.</th>
<th>Annual Revenue</th>
<th>Capital Inv. War. Cost</th>
<th>Cash Flow</th>
<th>Cum. Revenue</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>$90,000</td>
<td>-$90,000</td>
<td>- $90,000</td>
</tr>
<tr>
<td>1</td>
<td>$350,000</td>
<td>$140,000</td>
<td>$20,000</td>
<td>$120,000</td>
<td>$30,000</td>
</tr>
<tr>
<td>2</td>
<td>350,000</td>
<td>140,000</td>
<td>10,000</td>
<td>130,000</td>
<td>160,000</td>
</tr>
<tr>
<td>3</td>
<td>300,000</td>
<td>120,000</td>
<td>10,000</td>
<td>110,000</td>
<td>270,000</td>
</tr>
<tr>
<td>4</td>
<td>250,000</td>
<td>130,000</td>
<td>15,000</td>
<td>115,000</td>
<td>385,000</td>
</tr>
<tr>
<td>5</td>
<td>200,000</td>
<td>80,000</td>
<td>10,000</td>
<td>70,000</td>
<td>455,000</td>
</tr>
</tbody>
</table>

Average ROI = \[ \frac{455,000}{(90,000 \times 5\text{yr})} \times 100 = 101.1\% \]
1.3 Practice & Learn: Calculate the ROI at the end of the third year for the above example.

Present and Future Value of Money

Present value of a project cost & the expected return (net present value) are important considerations.

- P = Present value of money (principle)
- F = Future value of money
- i = Interest rate,
- n = Number of years

\[
P = \frac{F}{(1 + i)^n} \quad \text{(2)}
\]

\[
i = \left(\frac{F}{P}\right)^{1/n} - 1 \quad \text{(3)}
\]

Present value of money (principle) = \$100
Future value of money = \$106
Interest rate = 6%
Number of years = 1

\[
F = P(1 + i)^n = \$106 + 106 \times 0.06 = \$112.36 \text{ the year after.}
\]

Example: What is the future value of $5000 in 4 years at 8% interest?

Ans: Using relationship (1)
\[P = 5000, \ i = 0.08, \ n = 4 \quad F = 5000 \times (1 + 0.08)^4 = \$6,802.44\]

Example: What is the present value of $12,000 expected 5 years later if the interest rate remains fixed at 7%?

Ans: Using relationship (2)
\[n = 5, \ i = 0.07, \ F = 12,000, \quad P = 12,000 / (1 + 0.07)^5 = \$8,555.83\]

Example: What is the interest rate at which $100,000 will double in 10 years?

Ans: Using relationship (3)
\[n = 10, \ P = 100,000, \ F = 200,000, \quad i = \left(2^{1/10}\right) - 1 = 7.17\%\]
1.4 Practice & Learn: The local hospital wishes to set aside $350,000 for the down payment necessary on the lease of new MRI (Magnetic Resonance Imaging) machine that they will receive in 3 years. If the interest rate is 5.5%, how much should they invest now? (Hint: use equation 2 above to calculate P)

1.5 Practice & Learn: In the example above, if the hospital wishes to buy a similar MRI machine that costs $450,000 from another vendor who is willing to accept the entire payment (delayed payment) with interest after 4 years. If the interest rate is 7.5%, what will be the total payment amount after 4 years?

1.6 Practice & Learn: What should be the rate of return (interest rate) for an investment if you wish to double your amount in 6 years? (Hint: use equation 3 above to calculate P)
Present Value – Project A

This project requires an initial investment of $200,000. The expected return is $120,000 for a period of 5 years.

Present value cash flow at interest rate of 9% (all amounts in thousands, add 000)

<table>
<thead>
<tr>
<th>Year</th>
<th>Outflow</th>
<th>Inflow</th>
<th>PV</th>
<th>NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-200</td>
<td>0</td>
<td>0</td>
<td>-200</td>
</tr>
<tr>
<td>1</td>
<td>120</td>
<td>110.09</td>
<td>-89.90</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>120</td>
<td>101.00</td>
<td>11.10</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>120</td>
<td>92.66</td>
<td>103.76</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>120</td>
<td>85.01</td>
<td>188.77</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>120</td>
<td>77.99</td>
<td>266.76</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>600</td>
<td>466.76</td>
<td>266.76</td>
<td></td>
</tr>
</tbody>
</table>

Note: Both projects will have the same Net Present Value (NPV) if the interest rate were zero.

Present Value – Project B

Sample calculations:

Year, n =1, I =.09, F =200

\[ P = \frac{200}{(1 + .09)^1} = 183.48 \]

Year, n =2, I =.09, F =150

\[ P = \frac{150}{(1 + .09)^2} = 126.25 \]

Year, n =3, I =.09, F = 100

\[ P = \frac{100}{(1 + .09)^3} = 77.21 \]

Present Value – Project A

Sample calculations:

Year, n =1, I =.09, F =120

\[ P = \frac{120}{(1 + .09)^1} = 110.09 \]

Year, n =2, I =.09, F =120

\[ P = \frac{120}{(1 + .09)^2} = 101.00 \]

Year, n =3, I =.09, F =120

\[ P = \frac{120}{(1 + .09)^3} = 92.66 \]

etc.

Present Value – Project B

This project also requires an initial investment of $200,000. However, the expected return is in varying amount over the 5 year period.

Present value cash flow at interest rate of 9% (all amounts in thousands, add 000)

<table>
<thead>
<tr>
<th>Year</th>
<th>Outflow</th>
<th>Inflow</th>
<th>PV</th>
<th>NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-200</td>
<td>0</td>
<td>0</td>
<td>-200</td>
</tr>
<tr>
<td>1</td>
<td>200</td>
<td>183.48</td>
<td>-16.52</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>150</td>
<td>126.25</td>
<td>109.73</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>100</td>
<td>77.21</td>
<td>186.94</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>75</td>
<td>53.13</td>
<td>240.07</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>75</td>
<td>48.74</td>
<td>288.81</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>600</td>
<td>488.81</td>
<td>288.81</td>
<td></td>
</tr>
</tbody>
</table>
**Internal Rate of Return (IRR)**

This method calculates a single number that is highest for the most favorable project, regardless of its size.

This method is more complicated than ROI & may be studied further beyond the conclusion of this seminar.

---

1.7 Practice & Learn: Determine the Net Present Value (NPV) after 5 year for a project that requires an initial investment of $450,000, assuming that the interest rate is 6.6%.

<table>
<thead>
<tr>
<th>Year</th>
<th>Cash Outflow</th>
<th>Cash Inflow</th>
<th>PV</th>
<th>NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-450,000</td>
<td>0</td>
<td>0</td>
<td>-450,000</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>400,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>300,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>250,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>200,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>175,000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1.8 Practice & Learn: Review and solve Exercise Q 1.1 - Q 1.9
**Key Concepts Review - Module 1**

**R1.1 Project Integration Management** - This process ensures that various project elements are properly coordinated. It involves making tradeoffs among competing objectives and alternatives. The integration management includes: *project plan development, project plan execution, and overall change control.*

**R1.2 Opportunity for influence** - The project sponsors and stakeholders have the greatest influence on the project scope, quality, and cost *during the concept stage* of the project.

**R1.3 Ideal means of Communication** - The project manager has the option to adopt one of several communication strategies. The ideal method of communication between the project manager and the project team members is *written and verbal communication* (Other forms of communications: daily status report, through approved document/form, or through formal chain of commands).

**R1.4 Project Payback Period** - A project payback period ends when the *cumulative revenue* (cash flow in) *equals cumulative costs* (cash flow out). It is the time that it takes to generate enough revenue from the project to cover expenses.
Exercises

Q 1.1 Who are project stakeholders?

Q 1.2 What do you call a group of related projects that are managed in a coordinated way?

Q 1.3 When does the project payback period end?

Q 1.4 A project typically goes through concept phase, development phase, execution phase, and close-down phase. During which phase do the project sponsors have the most influence on scope, quality, time and cost?

Q 1.5 Early in a project’s life cycle a project manager must complete a cost justification study for the project. At this stage, very little information is available about the project. All estimates are to be considered rough estimates. Cash flow estimates are shown in the table below.

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Cash Flow In</th>
<th>Cash Flow Out</th>
<th>Cum. Revenue</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>700,000</td>
<td>- 700,000</td>
</tr>
<tr>
<td>2</td>
<td>450,000</td>
<td>150,000</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>625,000</td>
<td>175,000</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>300,000</td>
<td>275,000</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>125,000</td>
<td>65,000</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>100,000</td>
<td>50,000</td>
<td></td>
</tr>
</tbody>
</table>

(a) What is the payback period for this project?

(b) What is the cumulative (net) cash flow at the end of 6 years?

(c) If the interest is assumed to be 10% for the period of the project, what will be the present value of the cumulative cash flow at end year 6?

Q 1.6 What can a project manager do to verify the project scope? Explain by use of example.

Q 1.7 What document officially initiates the project and authorizes use of an organization’s resources?
Q 1.8 A project manager budgeted $950,000 for the original baseline of the project. After the work on the project begun, several changes were authorized and approved. The cost of these changes has been estimated at $60,000 and the cost of investigation of the changes prior to approval was $5,000. What should the current budget for the project be?

Q 1.9 A project manager in charge of a software development project determines that a new computer has the potential to save the firm money in the long run. The investment for the new computer system including installation and delivery will require $75,000. Once installed and functional, the new computer system is expected to produce $130,000 in savings at the end of one year. Assuming that the interest rate is 10%, what is the net present value of the savings?

Q 1.10 What is a statement of work and what is a project plan?
Module 2
Project Planning
**Module -2**  
**Project Planning**

In the project planning phase you refine project requirements, create work breakdown structures, and develop resource management plans. You will also finalize your cost estimate and establish project controls that will tell you how well the project is progressing. At end of planning, you will have a comprehensive document to receive management’s approval to proceed with the project.

<table>
<thead>
<tr>
<th>Project Planning Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tasks Performed</strong> (7 Tasks)</td>
</tr>
</tbody>
</table>
| 1. Refine Project Requirements  
   (define problem to be solved: vision, mission, scopes and objectives) |
| 2. Create a Work Breakdown Structure (WBS) |
| 3. Develop a Resource management Plan |
| 4. Refine Project Time and Cost Estimate |
| 5. Establish Project Controls  
   (manage & control changes) |
| 6. Develop a Formal and Comprehensive Project Plan |
| 7. Obtain Project Plan Approval |
Planning Purpose and Ingredients

Why Plan?

A major function of management is making sure the desired project objectives are met. To do this, you need to have **CONTROL** over your resources.

- Knowing where you are and where you want to be
- Power and domination over the project not a desirable thing

**No plan, no control!**

"Predicting the future is easy. It’s knowing what’s going on now that’s hard."
- Fritz R. S. Dressler

Why Plan?

Managing a project requires full control of project activities at all time. To have control is to know at all time where you are and where you want to be. You can only make such assessment of progress only if you have a plan which tells you where you should be at any point in time.

Another meaning of CONTROL is to exercise power or authority to instill fear and intimidation among employees to get the job done. This method works in some situation when people have not much choice about employment. But, it is not a desirable option to follow.

Planning is hard work, but it is not an option. It must be done. Without a plan, you will have no control over the project.

Planning Pain

Author J. Lewis in his *Fundamental of Project Management*, described pain suffered by people participating in planning and estimating. He recognized that most people find the planning process painful and resists the pain it causes.

The two pain curves shown are typical. The curve (1) is for reluctant participants who suffer more towards the end of a project.

Those who plan well, suffer pain early (2), but face less hardship towards the end of the project.
What is Project Planning?

Project planning is simply answering questions like:

- **WHO**
- **WHAT**
- **WHEN**
- **WHY**
- **HOW MUCH**
- **HOW LONG**

What is Project Planning?

Planning determines details about how and when activities are accomplished (the task or activity is the lowest level of WBS).

- **WHO** will do the task? Who else will be in the group or help the person accomplish it?
- **WHAT** needs to be done?
- **HOW** should it be done? What tools and equipment will be needed?
- **WHEN** must it be completed? What other tasks will depend on activity’s completion?
- **HOW** much will it cost?
- **What** quality level is needed for the final product?

Project Plan Ingredients

All projects plan must have the following components.

- Problem statement
- Mission statement
- Project objectives
- Work requirement & deliverables
- Exit criteria
- End-item specifications
- Work Breakdown Structure (WBS)
- Work Schedules
- Resource requirements (people, equipment, materials, etc)
- Control systems
- Major contributors
- Risk areas with contingencies

Project Plan Ingredients

Project plan ingredients are not planning steps, but components that all plans must address.

- **Problem statement** is an expression of what the project is going to eliminate.
- **Mission statement** describes what is being done to satisfy the vision (what we want to be).
- **Project Objectives** specifically defines results that must be achieved to accomplish the overall mission.
- **Work requirements & deliverables** list all items including reports, hardware,
software, service manual, & maintenance instructions. It is recommended that all project milestones have deliverables identified such that the progress can be monitored.

**Exit criterion** at each milestone is used to determine whether the preceding phase of work has been finished or not. Exit criteria are particularly essential when a deliverable is not associated with a milestone.

**End-item specification** refers to the engineering specifications, government requirements, building codes, etc. that must be met.

**Work Breakdown Structure (WBS)** identifies all project tasks.

**Schedules** identify sequences and timing for all project tasks.

**Resource requirements** include all people, equipment, machine, materials and facilities required to accomplish a project.

**Control system** defines the methods for project control that assures where a project is and where it should be.

**Major contributors** are project contributors listed on the linear responsibility chart with actual responsibility of tasks.

### Project Plan Sign-Off

A completed plan is submitted to stakeholders for approval, & allows work to begin.

- Stakeholder sign-off assumes that they agree with the scope and accept specifications as valid.
- Contributor sign-off does not guarantee performance, but a commitment.
- All plan sign-off on the plan should occur in a review meeting.

**Project Plan Sign-Off**

Project plan sign-off is formal approval step at the end of the project initiation phases.

Project plan approval means that stakeholders agree with the scope and accept all specifications.

The project contributors do not always have control over everything that is needed. Thus their signature is a verification of their commitment, and should not be interpreted as a guarantee.

The project plan review meeting is the preferred venue for approval and sign-off of a project plan. In this meeting, all participants should be encouraged to review & critique the plan (“shoot hole in the plan”). This is important in identifying any last minute corrections or deletions.
Project Planning Steps

The seven project planning steps will be discussed in greater detail in the rest of this module.

2.1 Refine Project Requirements
(Define problem to be solved by the project: vision, mission, scopes and objectives)

Many view projects as activities to solve some kind of problem. Thus, describing the project is often to define the problem it solves. In fact, the way the problem is defined usually reveals how it will be solved; it becomes important that a proper project definition be developed. (Vision, mission and problem statements that help describe the project will be described later in this course.)

Consideration for Effective Planning

Planning is a key task in managing any project. As project manager, you should expect to spend a good amount of time. This includes planning for your team & ensuring they feel ownership in the project process & outcome. Planning meeting should be held with all contributors to discuss information needs including timeliness and estimate of task.

Problem statement, WBS, and risk analysis will be discussed in more details later in this seminar.
**Problem Statement**

“A problem is a gap between where you are and where you want to be, with obstacles existing that prevent easy movement to close the gap.”

- J. P. Lewis

**Where I am:** I do not have a garden for fresh vegetables.

**Where I want to be:** I would have vegetable garden in my backyard.

**The Gap** or problem: I have no vegetable garden. (Same as where I am)

---

**Examples:**

**Problem statement#1** (Home Project): *The front entry door to our house has some weather damage and does not allow enough light in the foyer. A new, modern door is expected to solve these problems.*

**Where we want to be:** We would have a new front door installed.

**Where we are now:** We have a damaged entry door.

**Problem statement#2** (Website): *We have no website for customers to register on-line for our seminar.*

**Where we want to be:** We would have a website where attendees could register for our seminars.

**Where we are now:** We have no website.

**Problem statement#3** (Home project): *Our basement lacks insulation and sufficient ventilation. It also could benefit from some aesthetic appeal.*

**Where we want to be:** We would have a remodeled basement with proper heating and air conditioning.

**Where we are now:** We have a cold and stuffy basement.

**Problem statement#4** (Database): *Our admission and registration system currently does not keep track of students withdrawing from the class. Lack of such admission history makes financial planning very difficult.*

**Where we want to be:**

---

**Consideration for Effective Planning**

- Arrange a formal planning meeting with a clear agenda and goals.

- Invite people who would implement the plan. Secure contributors’ buy-in and commitment.

- Be prepared allow room for changes in plan as unexpected things may crop up.

- Consider what could go wrong through risk analysis.

- Develop a problem statement that incorporates the purpose of the project.

- Utilize WBS to divide work into smaller tasks.
Where we want to be: We would have a database that will keep record of students dropping out of the class after the start of the semester.

Where we are now: We have a database that does not present a true picture of attendance.

Problem statement#5 (Restaurant): Lack of timely training before menu changes, makes service staff unprepared to serve the guests. Recent indications are that it has resulted in loss of customer satisfaction.

Where we want to be: We will have all staff prepared and knowledgeable on menu-items before serving patrons.

Where we are now: We have no formal training of the waiter and waitresses.

Problem statement#6 (Fund for Charity): We do not have funds to employ staff that can solicit donations from international organizations. Additional staff in this area can provide the needed financial stability.

Where we want to be: We will have volunteers soliciting donations from organizations around the world.

Where we are now: We have nobody to market and solicit donation from organizations outside the USA.

---

**Mission Statement**

**Problem:** We have a damaged door

**Vision:**
- Double doors
- Darker color
- Wood Base
- Glass openings

- Mahogany wood
- 100% Wood
- Solid brass locks

- Matching design
- Silver beaded
- Weather resistant stain

**Mission:** To find a door that meets all the MUSTs and as many of the others.

---

**Mission Statement**

**Mission** tends to satisfy the vision to the greatest extent possible.

**Vision** describes all the things that can be done that make the problem go away.

**Writing a mission statement:**
Write vision items in the order (MUST have, WISH to have, and NICE to have). These are items that will solve the problem or satisfy stakeholder & customer expectations. Then select as many as possible for mission statement.

**Mission:** The mission of the door replacement project is to install a double door system made of Mahogany
wood. The door system will be equipped with a pair of solid brass locks and have wide opening with decorative glass.

**Mission statement answers:** What are we going to do & for whom we are going to do it?

### Project Objectives

Project objectives are statements that define how the mission can be accomplished in measurable terms. It has the following characteristics:

(SMART)

- **Specific**
- **Measurable**
- **Attainable**
- **Realistic**
- **Time-limited**


### Project Objectives

Objective clearly describes two issues:

- What is our desired outcome?
- How will we know when we have achieved it?

Examples of objectives:

- Our objective is to replace the entry door before my daughter’s graduation party on July 19th, 2003.
- My objective is to finish developing the project management training proposal before the end of the month.
- My wife’s objective is to lose 10 pounds in next three weeks on Atkins’ diet.
- Our objective is to raise $5000 in charitable donations for

### Strategy and Logistics

Setting up the project’s game plan is a very important part of planning.

Examples:

- Buying an old house and relocating it to a new plot of land, instead of constructing a house from ground up.
- In the U.S. war against the Taliban in Afghanistan, the strategy was to launch air attacks rather than using ground forces.
- In 1940, Avondale Shipyard was first build ships upside down, allowing the keel to be welded from outside resulting in a faster built boat.

---

**2.2 Create the Work Breakdown Structure (WBS)**

WBS is the key to accurately determining cost, time and resource requirements. It is not always easy to estimate a task’s completion time, even when the parameters of the task are fully known. Typically, in engineering, software, or hardware development projects, time estimates will be erroneous. Still, a complete WBS can result in the most accurate estimate.

WBS only shows tasks that are to be performed, not the sequence in which they need to be done. Task sequence and duration are determined and represented in the project schedule. However, the schedule can only be determined once the WBS is completed.
WBS Guidelines and Uses

- Create WBS prior to staring a schedule
- Do not try to identify the sequence of activities when creating a WBS
- Continue breaking down each task until the time can be accurately estimated (usually lowest level)
- All paths in WBS need not have the same number of levels.
- Utilize WBS to define scopes and assign responsibilities.

Example: (WBS to determine scope)
Project Title: Backyard Landscaping and Beautification
Scopes: Must include DECK, BRICK PATHWAYS, FOUNTAIN, and FLOWER GARDEN
WBS sub-projects:

**DECK**
- Design
- Materials and cost
- Get Carpenter
- Order lumber
- Build deck

**FOUNTAIN**
- Determine water source and connection
- Purchase fountain

**BRICK PATHWAYS**
- Design path layout
- Estimate bricks needed
- Dig pathways

**FLOWER GARDEN**
- Determine size & layout
- Estimate power needs
- Purchase soil

Here are a few examples of common projects.

<table>
<thead>
<tr>
<th>Example Project: Put up the Outdoor Christmas Lights</th>
<th>Example Project: Get ready for Work</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Put on outdoor clothing</td>
<td>A: Get out of bed</td>
</tr>
<tr>
<td>B. Get lights and ladder out</td>
<td>B: Start coffee machine</td>
</tr>
<tr>
<td>C. Connect power line</td>
<td>C: Brush teeth, shave, and shower</td>
</tr>
<tr>
<td>D. Check lights</td>
<td>D: Get dressed</td>
</tr>
<tr>
<td>E. Put lights on tree</td>
<td>E: Drink coffee</td>
</tr>
<tr>
<td>F. Test to see if lights work</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Example Project: Change Engine Oil</th>
<th>Example Project: Bake Pound Cake for Competition</th>
</tr>
</thead>
<tbody>
<tr>
<td>A: Hoist Car</td>
<td>A: Get recipe</td>
</tr>
<tr>
<td>B: Remove nut and drain oil out</td>
<td>B: Gather ingredients</td>
</tr>
<tr>
<td>C: Replace filter</td>
<td>C: Mix batter</td>
</tr>
<tr>
<td>D: Replace drain nut</td>
<td>D: Bake cake</td>
</tr>
<tr>
<td>E: Add oil</td>
<td>E: Prepare and apply icing</td>
</tr>
<tr>
<td>F: Run engine</td>
<td>F: Inform judge if ready</td>
</tr>
<tr>
<td>G: Check oil</td>
<td>G: Display cake for testing</td>
</tr>
<tr>
<td></td>
<td>H: Receive cake score</td>
</tr>
</tbody>
</table>
2.1 Practice & Learn: Discuss among your group and select a project that you already are thinking about doing, or already have done. After you agree on a project that all group members can understand and appreciate, define it in terms of the following project descriptions.

Before finalizing project elements, brainstorm to identify: Who are the stakeholders? What is it expected to do for your customer? What is the reasoning for undertaking the project? What are the project’s deliverables? Who will actually use the deliverables? How are these deliverables different from those already available to the customer? Write a problem statement for the project (gap between where you want to be and where you are now). What obstacles prevent easy movement to close the gap? Etc.

Discuss among your team and document any information along the line of above items, then prepare the following minimum items for your group project.

a. PROJECT TITLE
b. PROBLEM STATEMENT
c. OBJECTIVES (Vision, Mission, Strategy, and Logistics are optional descriptions)
d. WBS (8 - 12 tasks for the class project. You may exceed this number if it’s a real project)

(Wait for further instruction before showing project activities in graphical form)
The bar graph shown below (known as Gantt chart) was prepared for one of the examples.

**Bar Graph (Gantt Chart)**

**Project: Getting ready for Work**
- A: Get out of bed (5 min)
- B: Make coffee (15 min)
- C: Brush teeth, shave, and shower (25 min, starts 5 minutes after coffee start)
- D: Get dressed (5 min)
- E: Drink coffee (15 min)

Gantt chart Characteristics:
1. X-axis represents time in unit suitable for your project (minute, hour, day, week, years, etc)
2. Y-axis show the task/activity
3. The length of the bar is proportional to the duration of task
4. The height of the bar is arbitrary
5. The gap between the two bars is arbitrary

Information conveyed by the chart:
- a. Numbers of tasks
- b. Task start & finish times

Information not conveyed by the chart:
- a. Which task is dependent on another
- b. Which tasks are more important than others
2.3 Develop the Resource management Plan

**Human Resource Planning**

- Identify, assign and document project roles and responsibilities (who does what?)
- Establish reporting relationships
- Acquire the right people and assign them to the project
- Develop your team by enhancing individual and group skills to maximize project performance

In this task, you will identify human resources and other machines and materials that must be procured to complete the project. After the requirements are identified, you will need to secure commitments from all internal and external sources.

[Refer to Human Resource, Contract and Procurement Management in PMBOK® for activities you will need in this task]

**Procurement Planning**

- Determine what to procure and when to procure them
- Review product requirements and identify sources from which you will solicit quotes
- Obtain quotation by soliciting bids, offers or proposals, as appropriate
- Elect sources from potential suppliers.
- Sign contracts and issue purchase orders for suppliers
- Finalize the contract after settlement and resolution of any open items

2.4 Refine Project Time and Cost Estimate

By this stage in the project, you should have completed a WBS. You can now examine all WBS tasks to refine project times and cost estimates using estimating tools and techniques. This exercise will produce the project baseline schedule and budget.

(To be discussed later under task 2.5 Project Control)
To complete a project schedule, you need to know:

- **Activity Duration** – How long will the activity take to complete?

- **Activity Sequence** – What are the activities are before and after this activity? On which activities does this one depend? What other activities depend on this one?

- **Schedule of Activity** – When should an activity start? How long does the entire project take? How can the activities be arranged to accomplish the project in minimum time.

### 2.4.1 Estimating Activity Duration

Once the work is broken down into tasks, you can proceed to estimate how long each task will take through:

- Expert judgment
- Analogous estimating
- Quantitatively based duration
- Reserve time (contingency)

Time Management has tools to help determine:

**Expert judgment** – Estimates are obtained from people with special skills, knowledge or training in the subject, or expert judgment guided by historical knowledge.

**Analogous estimating** – Also known as top-down estimating, where actual times used in previous similar activities are used as the basis for estimating future activity. It is frequently used to estimate project duration when a limited amount of detailed information is available (e.g., in the project’s early phases). An analogous estimate may be considered a form of expert judgment.
Quantitatively based duration – In this method, the amount/quantity to be performed for each specific work category is defined by its engineering/design effort, and is multiplied by the productivity unit rate. For example, time in hours required to produce certain number of drawings, tons of concrete in an hour, cost incurred for unit length of cable, etc. can be used to estimate the cost of tasks utilizing such items.

Reserve time (contingency) – Using this approach, a project team will incorporate additional time called the reserve, contingency, or buffer, the activity duration as an estimate into risk. The reserve time can be a percentage of the estimated duration, or a fixed number of work periods, and can later be reduced or eliminated. As more precise information about the project becomes available such reserve time should be documented along with other data and assumptions.

2.4.2 Activity Sequencing

There are four common techniques used for Activity Sequencing.

- Precedence Diagramming Method (PDM)
- Arrow Diagramming Method (ADM)
- Conditional Diagramming Method
- Network templates

Precedence Diagramming Method (PDM)

In this method, the project network diagram is constructed using boxes or rectangles (nodes) that represent activities and connect them with arrows to show dependencies. This technique is also known as activity on-node (AON) and is commonly utilized in project management software packages. The PDM uses four types of dependencies or precedence relationships:

- **Finish-to-Start (FS)**: The initiation of the work of the successor depends upon the completion of the work of the predecessor. FS is the most commonly use dependency symbol used in project management. For example, in a cake baking process, baking must be completed before frosting can be applied.

- **Finish-to-Finish (FF)**: The completion of the successor depends upon the completion of the predecessor’s work. For example, in the cake baking process, the master chef cannot supervise cake decoration until the frosting process is finished.
• **Start-to-Start (SS):** The initiation of the work of the successor depends upon the initiation of the work of the predecessor. For example, the baker cannot start decorating the cake until the master chef is present.

• **Start-to-Finish (SF):** The completion of successor’s depends upon the initiation of the predecessor’s work. For example, in the same cake baking process, the baker is to finish frosting the cake only after the master chef is present. (The frosting may, however, begin before the chef is present.)

Finish-to-start is the most commonly used type of logical relationship in PDM. Start-to-Finish is seldom used relationship.

Leads and lags are imposed delays in relationship between independent and dependent activities:

**Lag** – In a pair of activities, a lag causes a designated number of time periods to be added to the start or finish of the dependent activity. For example, in the cake example described earlier, the baking of the cake is to be completed before frosting it. If the baker decides that one hour is necessary for the cake to cool, the relationship between baking & frosting will change from FS to (FS + 1).

**Lead** – causes the dependent activity of the pair of activities in the relationship to have designated number of time periods subtracted to its start or finish. For example, in the frosting of the cake, if frosting were to start a unit period ahead of the presence of the master chef, then the relationship will be designated as (SS – 1).

![Figure 2.3 Precedence Relationships](image)

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>FS + 2</td>
<td>C must start before D starts</td>
</tr>
<tr>
<td>E must finish before F can finish</td>
<td></td>
</tr>
<tr>
<td>G must start before H can finish</td>
<td></td>
</tr>
</tbody>
</table>

A must finish before B starts + 2 Hours
Example of Precedence Relationships

**FS Relationship:**
The independent activity (A) must *finish* before the dependent activity (B) can *start.*

This is most common kind of precedence relationship. All tasks that are placed sequentially in the schedule fall into this category. If there is no mention of the type of precedence relation, it is assumed that the relationship is FS.

**SS Relationship:**
The independent activity (C) must *start* before the dependent activity (B) can *start.*

*Project: Wedding ceremony, C: Play bridal march, D: Walk the bride down aisle*

**FF Relationship:**
The independent activity (E) must *finish* before the dependent activity (F) can *finish.*

*Project: Deck Building, E: Building deck  F: Cleaning debris*

**SF Relationship:**
The independent activity (G) must *start* before the dependent activity (H) can *finish.*

*Project: Dinner Party,  G: Hostess to inspect kitchen  H: Cleaning kitchen,*

**Lag Relationship:** B must start 3 hours after A finishes.

*Project: Cake baking, A: Bake cake  B: Frost cake*

**Lead Relationship:** B must start 1 hour before A finishes.

*Project: Fill prescription drugs, A: Visit drug store  B: Call pharmacist*

Tasks in Parallel (A, C)
Tasks in Series (G, A, B)
The precedence diagram for the example “Getting Ready for work” project is shown below.

**Example:** In a project to replace our home’s exterior and interior doors, the following were major activities:

2. Approval (Securing wife’s agreement), 5 days, 6/30 – 7/6.
3. Order & Deliver Interior Doors, 3 days (in stock item), 7/7 – 7/9
   3.1 Install, 1 day (but can only begin after the exterior doors are delivered as both types of doors will be installed together by the same carpenters), 8/4 – 8/4
   3.2 Finish, 10 days, 8/6 – 8/19 (only after exterior door is installed and the carpenter is out of the way)
4. Order & Deliver Exterior Doors, 20 days (special order item), 7/7 – 8/1
   4.1 Install, 1 day, (Done only after finishing interior door installation) 8/5 – 8/5
   4.2 Finish, 15 days, 8/6 – 8/26
5. Reinstall Security & Doorbell Systems, Approval & Close. 1 day, (can only be done after all doors are installed and finished) Wednesday 8/27/2003 9/9/2003

Use the calendar for June – August, 2003 shown below to indicate the time frame for the above example. Unless otherwise stated, weekends (Saturday and Sunday) are excluded from project working days.
**Figure 2.4** Precedence Diagram (Door Replacement Project)

- **Required Information:**
  - List of activities
  - Duration of each activity
  - Predecessor for each activity

### June 2003
<table>
<thead>
<tr>
<th>S</th>
<th>M</th>
<th>T</th>
<th>W</th>
<th>Th</th>
<th>F</th>
<th>Sat</th>
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<td>30</td>
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</tr>
</tbody>
</table>

---

**Develop Project Plan** (Year 2003)
- 1: 15 days
- M 6/9: F6/27

**Plan Approval**
- 2: 5 days
- M 6/30: F 7/4

**Install (Interior Doors)**
- 3.1: 1 day
- M 8/4: M 8/4

**Order & Deliver (Interior Doors)**
- 3: 3 days
- M 7/7: W 7/9

**Install (Exterior Doors)**
- 4.1: 1 day
- T 8/5: T 8/5

**Order & Deliver (Exterior Doors)**
- 4: 20 days
- M 7/7: F 8/1

**Finish (Exterior Doors)**
- 4.2: 15 days
- W 8/6: T 8/26

**Finish (Interior Doors)**
- 3.2: 10 days
- W 8/6: T 8/19

**Security System, Doorbell, Close.**
- 5: 1 day
- W 8/27: W8/27

---

**Install (Exterior Doors)**
- M 7/7: F 8/1

---

**Develop Project Plan** (Year 2003)
- 1: 15 days
- M 6/9: F6/27

---

**Plan Approval**
- 2: 5 days
- M 6/30: F 7/4

---

**Install (Interior Doors)**
- 3.1: 1 day
- M 8/4: M 8/4

---

**Order & Deliver (Interior Doors)**
- 3: 3 days
- M 7/7: W 7/9

---

**Install (Exterior Doors)**
- 4.1: 1 day
- T 8/5: T 8/5

---

**Order & Deliver (Exterior Doors)**
- 4: 20 days
- M 7/7: F 8/1

---

**Finish (Exterior Doors)**
- 4.2: 15 days
- W 8/6: T 8/26

---

**Finish (Interior Doors)**
- 3.2: 10 days
- W 8/6: T 8/19

---

**Security System, Doorbell, Close.**
- 5: 1 day
- W 8/27: W8/27
Arrow Diagramming Method (ADM)
This method represents network diagram for projects using arrows that represent activities and show their dependencies by connecting them at nodes. This method is also known as activity-on-arrow (AOA). It is not as popular as PDM, but is available in many software programs. ADM only uses finish-to-start dependencies, and may require the use of the dummy activities to define all logical relationships correctly. Three things associated with each activity are: the activity description, a starting event of the activity, and the ending event.

Figure 2.5 Arrow Diagramming Method

Conditional Diagramming Method
Two techniques known as Graphical Evaluation and Review Technique (GERT) and System Dynamics models allows loops (for tests that need to be repeated multiple times) and conditional branches (e.g., design updates hat are required only if the inspection detects errors) absent in both PDM and ADM. Discussion of this technique is beyond the scope of this seminar.
Network templates
Sometimes standardized network diagram can suit a project activity well. They may be used for an entire project or for just a portion of the project (referred as subnets or fragnets). Subnets prove valuable when the project includes several identical or nearly identical features, such as floors on a high-rise office or apartment building, clinical trials on a pharmaceutical research project, program modules on a software development project, or the start-up procedure of a development project.

2.4.3 Schedule Development

When developing schedule, the start and finish dates for project activities are identified. It is important to set realistic start & finish dates so that the project deadline can be met.

Before developing a schedule, you will need to complete a project network diagram, project activity duration, and project resource requirements.

History of Scheduling
Prior to the 1960’s, bar charts were the only tools used for scheduling. Henry Gantt furthered the effectiveness of bar charts when he developed a complete notational system for displaying project progress. Known as Gantt charts, these bar charts are simple to construct and interpret and effectively communicate task goals and deadlines.

Figure 2.7 Bar Chart (Gantt chart, Door Replacement Project)

Benefits: Easy to construct and communicate information
Drawbacks: No interdependencies; difficult to determine the impact of one task on the rest of the project
### 2.2 Practice & Learn: Continue with your group exercise (2.1 Practice and Learn)

- Review with your group and refine WBS (8 -12).
- Establish and assign duration (2 or more units of time: sec, hour, days, etc) of each task elements
- Identify all applicable precedence requirements (Create at least 1 dependency requirements in your class project.)
- Show tasks in graphical form (Draw Gantt Chart)
- Create the Precedence Diagram for your project using calendar days starting on first Monday of next month (Ignore this step if your time is in min, or hour)
- Create the Precedence Diagram for your project using the project activity days.

## Schedule Development

A number of tools and techniques are used to develop schedules.

### Mathematical Analysis
- Critical Path Method (CPM)
- Program Evaluation and Review Technique (PERT)
- Graphical Evaluation and Review Technique (GERT)

### Duration Compression
- Crashing (cost and schedule tradeoffs analysis)
- Fast Tracking (doing activities in parallel that would normally be done in sequence)

### Simulation
(calculates multiple project durations with different sets of activity assumptions – Monte Carlo Simulation)

### Resource Leveling Heuristics
(allocation of resources to critical path activities first.)

### Project Management Software
(automates calculation mathematical analysis and resource leveling together)

### Coding Structure
(allows extraction/sorting based on different activity attributes)

To overcome the lack of interdependencies in the Gantt chart, the two arrow diagramming methods of scheduling were developed in the late early 1960’s. These techniques capture the sequential and parallel relationships among project activities.

Critical Path Method (CPM) – developed by Du Pont.

Program Evaluation and Review Technique (PERT) - developed by the U.S. Navy and the Booze, Allen, and Hamilton Consulting Group.

Although, all arrow diagrams (PDM and AON diagrams introduced earlier) are generally referred to as PERT networks, strictly speaking, PERT methods use statistical probability techniques, while CPM does not. In other words, PERT makes it is possible to calculate the probability for an activity to finish to finish by a certain time. CPM can not calculate this probability.
**Critical Path Method (CPM)**

Using the critical path, project managers use the notion of a float (or slack) to direct effort where it’s most needed. This way, activities with more float can be less intensely managed than other activities, optimizing a PM’s resources.

Remember that the purpose for scheduling is to identify the start and finish dates for each project activity. In CPM, you start with the network diagram (PDM) which utilizes the WBS following these steps.

<table>
<thead>
<tr>
<th>Sequence of Activities for Schedule Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Create a list of activities to be scheduled</td>
</tr>
<tr>
<td>• Assign each activity’s duration</td>
</tr>
<tr>
<td>• Determine the predecessor for each activity</td>
</tr>
<tr>
<td>• Calculate the forward pass, or the <strong>early schedule</strong> for each activity</td>
</tr>
<tr>
<td>• Calculate the backward pass, or the <strong>late schedule</strong> for each activity.</td>
</tr>
<tr>
<td>• Calculate the <strong>float</strong> for each activity</td>
</tr>
<tr>
<td>• Determine the <strong>critical path</strong></td>
</tr>
<tr>
<td>• Determine if the project completion date is earlier than the promised deliver date</td>
</tr>
<tr>
<td>• Adjust schedule or re-establish new completion date</td>
</tr>
<tr>
<td>• Apply resources and determine resource constraints</td>
</tr>
<tr>
<td>• Adjust schedule to allow for resource constraints</td>
</tr>
<tr>
<td>• Determine if the predicted project completion date is earlier than the promise date</td>
</tr>
<tr>
<td>• Adjust the schedule or promise date</td>
</tr>
<tr>
<td>• Get approval on schedule</td>
</tr>
</tbody>
</table>

In the door replacement project, the first three steps as outlined above were previously in Figure 2.4. To calculate the forward pass (step 4) and backward pass (step 5), we need to work with a precedence diagram (Fig. 2.4).

**Conventions and Notations:**

- The first activity is always scheduled to start on the project’s start date
- Each activity is assumed to start at the beginning of its period and finish at the end of the period identified. For an activity of one day duration, the start and the end day is the same.
**Early Start date (ES)** = Earliest date of the beginning of an activity  
**Early Finish date (EF)** = Early start date + duration of the activity – 1  
**Late Start date (LS)** = Latest date of the beginning of an activity  
**Late Finish date (LF)** = Latest start date + duration of the activity – 1

**Float or Slack** = Late start date – early start date

**Free Float** is the amount of time that an activity can be delayed without delaying the *early start* of any immediately following activities.

**Forward pass** is the process used to calculate early start and early finish dates for the uncompleted portions of network activities. By reviewing the precedence diagram (Fig. 2.4), we can identify the early start and finish dates shown below. The numbers under ES & EF in Table 2.1 represent the number of days in a sequence.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Description</th>
<th>Duration</th>
<th>Predecessor</th>
<th>ES</th>
<th>EF</th>
<th>LS</th>
<th>LF</th>
<th>Float</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Develop Project Plan</td>
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<td>-</td>
<td>1</td>
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<td>20</td>
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<tr>
<td>3.</td>
<td>Order Interior Doors</td>
<td>3</td>
<td>2</td>
<td>21</td>
<td>23</td>
<td></td>
<td></td>
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<tr>
<td>3.1</td>
<td>Install</td>
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<td>3, 4</td>
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<td>41</td>
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<td></td>
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<td>4.</td>
<td>Order Exterior Doors</td>
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<td>2</td>
<td>21</td>
<td>40</td>
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<tr>
<td>4.1</td>
<td>Install Doors</td>
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<td>4, 3.1</td>
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<td></td>
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<tr>
<td>4.2</td>
<td>Finish Doors</td>
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<td>4.1</td>
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<td>5.</td>
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<td>3.2, 4.2</td>
<td>58</td>
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</tbody>
</table>

Notations: ES – Early Start, EF – Early Finish, LS – Late Start, LF – Late Finish

- The entire project takes 58 days to complete (sum of the durations of activities 1, 2, 4, 4.1, 4.2, and 5).  
- Activity 1 is completed during day 1 and day 15  
- Activity 2 is completed during day 16 and day 20  
- Activities 3 and 4 both start on day 21st, but finishes on day 23 and day 40 respectively.  
- Activity 3.1 can only start after activity 4 is completed (same carpenter installs all doors)  
- Activity 3.2 can start on day 43 after 3.1 and 4.1 are done and finish on day 52 (43 + 10 – 1)  
- Activity 4.1 can only start after 3.1 and 4 are done on day 42 and finish on day 42  
- Activity 4.2 can start on day 43 and finish 15 days later on day 57  
- The closing activity takes place on day 58 and ends on day 58
**Backward pass** is the process used to calculate late finish and late start dates for the uncompleted portions of network activities by working backward through the network logic starting with the project’s end date. The calculated LS, LF, and Float are shown in Table 2.2.

- The end activity has the LF date same as EF day
- Activity 3.2 has late finish date of day 57 and a late start date of day 48
- Activity 4.2 can finish as late as day 57 and have a late start date as day 43, and 0 float
- Activity 4.1 has the same LS and LF days as day 42 and 0 float
- Activity 3.1 can have LF day (41) as one day before LS day for Activity 4.1 (42) due dependency between activities 3.1 and 4.1
- Activity 4 can have LF (40, calculated LS is 21) day as one day before LS day for activity 3.1 (41)
- Activity 3 can have a LF day on day 40 (day before LS of Activity 4) and LS day as 38 with a float of 17 days
- Activity 4 will have LF day as day 40 (day before LS of Activity 3.1) and LS day as day 21, and 0 float.
- The LF day for Activity 2 is 20 (day before LS of Activity 4) and LS for
- The LS and LF days for activities 1 remain same as the ES &EF

### Table 2.2 Precedence with Floats (Door Replacement Project)

<table>
<thead>
<tr>
<th>Activity</th>
<th>#</th>
<th>Description</th>
<th>Duration</th>
<th>Predecessor</th>
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<th>EF</th>
<th>LS</th>
<th>LF</th>
<th>Float</th>
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<td>1</td>
<td>15</td>
<td>1</td>
<td>15</td>
<td>0</td>
</tr>
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<td>Approval</td>
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<td>20</td>
<td>0</td>
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<td>3. Order</td>
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<td>Interior Doors</td>
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<td>57</td>
<td>5</td>
</tr>
<tr>
<td>4. Order</td>
<td>4</td>
<td>Exterior Doors</td>
<td>20</td>
<td>2</td>
<td>21</td>
<td>40</td>
<td>21</td>
<td>40</td>
<td>0</td>
</tr>
<tr>
<td>4.1 Install</td>
<td>1</td>
<td>Doors</td>
<td>1</td>
<td>4, 3.1</td>
<td>42</td>
<td>42</td>
<td>42</td>
<td>42</td>
<td>0</td>
</tr>
<tr>
<td>4.2 Finish</td>
<td>15</td>
<td>Doors</td>
<td></td>
<td>4.1</td>
<td>43</td>
<td>57</td>
<td>43</td>
<td>57</td>
<td>0</td>
</tr>
<tr>
<td>5 Close</td>
<td>5</td>
<td>Project</td>
<td>1</td>
<td>3.2, 4.2</td>
<td>58</td>
<td>58</td>
<td>58</td>
<td>58</td>
<td>0</td>
</tr>
</tbody>
</table>

**Critical path** is the group of activities with zero float. In the Door replacement project (Table 2.2), the critical path is comprised of activities 1, 2, 3.1, 4, 4.1, 4.2, and 5. These activities cannot be delayed without delaying the entire project completion date.

Total Project Duration = Sum of durations of all activities in CRITICAL PATH (15+5+1+20+1+15+1 = 58)

Notations:  ES – Early Start,  EF – Early Finish,  LS – Late Start,  LF – Late Finish
Other items in **schedule development** are discussed briefly.

Once your schedule is complete, you should check to see if the **project completion date** is earlier than the date committed to the stakeholders. Warning flags should be raised, if this is not the case.

If the scheduled completion date is different from the promised date, you will need to either **adjust the schedule** or change the promised date.

If the predicted date of the schedule is later than the promised date, **crashing or fast tracking** should be implemented. **Crashing** a schedule reduces the scopes or adds additional resources to the project. For example, in the Door Replacement project, crashing would reduce time delay by ordering exterior door from alternate source, using multiple carpenters for installation, etc.

**Fast tracking** is another option for **schedule compression** where activities originally scheduled in sequence are rearranged to overlap instead. The use of leads in the logical relationships between activities may be used for this purpose. For example, when staining wooden doors, one crew completes the job in 30 hours as shown in Figure 2.8a. When a second crew is used to start pre-staining 4 hour after the first crew started sanding, the total project time can be reduced to 22 hours as shown in Figure 2.8b. Notice that the work content (30 man hours) and the effort remain the same.

![Figure 2.8a Wood Door Finishing](image)

Although crashing and fast tracking schedules are useful in reassigning project timeliness, it may increase costs and risks. In the example, the overall cost has not increased & the total hours remain the same. However, in big projects, the real cost of the project is likely to go up. For more people on the job, the cost of tool will increase, and the transportation and other overhead cost of employee hiring will have gone up.
The risk of the project is also likely to go up. This is because; human error with more people will be greater.

**Figure 2.8b  Wood Door Finishing** (Fast tracking)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand surfaces</td>
<td>12 hours</td>
</tr>
<tr>
<td>Apply pre-stain wood conditioner</td>
<td>8 hours</td>
</tr>
<tr>
<td>Total Project Duration</td>
<td>22 hours</td>
</tr>
</tbody>
</table>

In this Fast Tracking approach, the pre-stain application is done in parallel with the sanding task, which results in a reduction of the total project completion time.

**Buffering the Schedule**

A much more pleasant problem is when the scheduled project completion date is much earlier than the promised date. This problem is solved by adding float to a selected activity. The schedule should be buffered only after allowing for reserve schedule time, normal fluctuations in activity durations, and resource limitations. An example of a schedule with a completion date before the promised date is shown in Figure 2.9a.

**Figure 2.9a Schedule (completion date before promise date)**

A project schedule should not be adjusted by increasing the duration of activities (Figure 2.9b). If this is done, individuals will be given extra allowances and could indeed set a negative precedence for future projects. The schedule should also not left as is.
A better choice is **buffering the schedule** as shown in Figure 2.9c. One way to buffer is to **add a lag** in the relationship. Suppose that the gap between activity A and B is 20 days. Then, the relationship between A and B will be changed from normal FS to FS + 20 which adds 20 days of float to the activity and also shift the project completion date to ten days later.

Yet another way to buffer a schedule with an early completion date is to add in a dummy activity for each activity that is to be buffered as shown in Figure 2.9d. The dummy activity is created between the independent and the dependent activities. If there was originally a FS relationship between A and B, the new relationship will show FS between A and A’ (dummy activities).

**How does one determine which activities should be buffered?**

The amount of buffer time that is applied to activities can be proportional to the risk of the activity, the dependencies that it follows, or other reasons deemed appropriate by the project manager.
Resource availability is important consideration for project completion. There are times when one person or machine is needed for several activities. In such a case, the schedule may have to be adjusted to make resources available for all activities. The amount of resources and duration for which it is required may also have an impact on the schedule.

Unexpected resource constraints may also require a schedule change. When managing a set number of employees on a project, the project manager’s goal is to avoid underutilization or over-utilization of resources. While underutilized resources may be reallocated to other project tasks, over utilization (extra hours of work, overtime pay) may prove costly and demoralizing to project members.

To adjust a schedule to accommodate resource constraints, resource-leveling task may be performed. A common way to graphical display resource allocation is through a combined plot activity chart or resource histogram, as shown in Figure 2.10a. Notice that during week 1 and week 2, the resource (Programmer 1) is underutilized, but is over utilized during weeks 5 and 6 when the higher combined time allocation is 60 hours/weeks.
This problem is easily resolved by allowing Activity B (6 weeks duration) to be interrupted for two weeks, reducing this resource’s workload & eliminating overtime, as shown in Figure 2.10b.

![Figure 2.10b Over-allocation of Resource Resolved (Resource Histogram), Programmer 1](image)

After adjusting for resource constraints, the schedule should be checked to ensure that the scheduled date meets the promise date. If it does not match, continue to readjust the schedule until they are equal. Of course, before a plan can be finalized, it is important that the schedule base be approved through a formal sign-off by the stakeholders.

Once all time constraints are rectified, a final critical path method is used to display the schedule as shown in Figure 2.11.
Figure 2.11a  Critical Path Method (Door Replacement Project, Project Days)

1. Develop Project Plan, 15 days
   1  15
   1  15

2. Plan Approval, 5 days
   16  20
   16  20

3. Order & Deliver (Int. Doors), 3 days
   21  23
   38  40

4. Order & Deliver (Ext. Doors), 20 days
   21  40
   21  40

4.1 Install (Ext. Doors), 1 day
   42  42
   42  42

4.2 Finish (Ext. Doors), 15 days
   43  57
   43  57

3.1 Install (Int. Doors), 1 day
   41  41
   41  41

3.2 Finish (Int. Doors), 10 days
   43  52
   48  57

5. Sec. System, Close, 1 day
   58  58
   58  58

Note:
4.1 Install (Ext. Doors), 1 day
4.2 Finish (Ext. Doors), 15 days

Source & Related Information:
- Figure 2.4 Precedence Diagram
- Table 2.2 ES, EF, LS, LF data
**Summary of CPM**

What does Critical Path Method (CPM) do? By using CPM, you can:

- Establish early and late start and finish times and float for each activity.
- Tell whether it is possible to meet important project milestones.
- Determine exactly when various tasks must be finished in order to meet that deadline.
- Identify which tasks have some leeway and which do not.
- Allows prioritization of activities by float.
- Determine **critical path** (also in PERT), which is defined as the longest path through a project, showing the shortest amount of time in which the project can be completed with no slack or float. Many task relationship types are possible on the critical path, and there may be many that are done in parallel.
2.3a Practice & Learn: Critical Path method (CPM)

a. Review Family Vehicle Purchase Project (Pages A.70 – A.73)
b. For certain *Home Building Project*, the Precedence diagram is as shown below.

- Make copies of the PRECEDENCE DIAGRAM and perform FORWARD PASS with calendar dates (Assume that the project starts on January 4, 2010)

- Perform FORWARD PASS with project days (*Early* start & *Early* finish dates)

- Perform BACKWARD PASS with project days (Be sure to confirm that the *Late* start times match for the starting activity)

- Complete the Precedence Table and calculate the FLOATS.

Answer these questions:

a. Which activities are in CRITICAL PATH and what is their total duration?

b. If activity D2 is delayed by 2 days, would it affect the project outcome?

c. What would be the project completion time if the activity B1 delayed by 4 days?

**Useful Relations**

\[
\text{Finish Day} = \text{Start Day} + \text{Duration} - 1 \\
\text{Start Day} = \text{Finish Day} - \text{Duration} + 1
\]

Take care of LEAD and LAG intuitively.

(Use start day of successor to subtract or add numbers)
Exercise: Home Building Project

**Precedence Data with Floats - Home Building Project**

<table>
<thead>
<tr>
<th>Activity # &amp; Description</th>
<th>Duration (days)</th>
<th>Predecessors</th>
<th>ES</th>
<th>EF</th>
<th>LS</th>
<th>LF</th>
<th>Float</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B1</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B2</td>
<td>14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B3</td>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C2</td>
<td>19</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D1</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D2</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A2</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: ES = Early Start, EF = early Finish, LS = Late Start, LF = Late Finish, Float = (Late Start – Early Start)
Program Evaluation and Review Technique (PERT)

Like CPM, the PERT method also utilizes the critical path from the activity network diagram (PDM) to establish the project’s completion time. However, with PERT, the probability for an activity to be completed by a certain time may be calculated. Furthermore, PERT can estimate the duration and probability of completing the project by adding the individual durations and variances of the activities in the critical path. Most people use CPM instead of PERT today.

To estimate activity duration, PERT uses the distribution mean to estimate a weighted average of duration. In this method, the expected value, or EV, replaces the estimate used in CPM.

A normal probability distribution relates an event to the probability that it will occur. The duration and cost of a project activity comes close to matching a normal distribution. Like a normal curve (bell-shaped curve), the beta distribution fits the project time and cost better. However, the normal curve is close enough for practical purposes.

![Figure 2.12 PERT Duration Calculation for a Single Activity](image)

**Figure 2.12 PERT Duration Calculation for a Single Activity**

Expected Value, \( EV = \frac{[Optimistic + 4 \times Most\ likely + Pessimistic]}{6} \)

Note: Most likely, Optimistic and Pessimistic values are estimated by project team members.

In a normal distribution, 99.7% of occurrences will fall between the optimistic and pessimistic estimates which are assumed to be the two extreme values at +/- 3 x standard
deviation from the mean (See Figure 2.13). Thus, using the estimates of the pessimistic and optimistic values, the standard deviation can be calculated as:

**Standard deviation, SD = (Pessimistic – Optimistic) / 6**

Also

**Variance = SD^2 or SD = (Variance)^{1/2}**

### Figure 2.13 Area Under Normal Distribution Curve

![Figure 2.13 Area Under Normal Distribution Curve](image)

Where do the optimistic, pessimistic, and most likely values come from?

You will need these values to compute EV and SD. A good approximation of these values can be obtained by asking the activity estimator to estimate three values instead of just one. Ask the estimator to estimate:

- Optimistic value – what will happen if things go well?
- Most likely – what is most likely to happen?
- Pessimistic – what will happen if things do not go well?

**Example:** Suppose that for a particular programming (coding) activity, the estimates are:

- Most likely = 30 days
- Pessimistic = 36 days
Optimistic = 27 days

Then, Expected value, \[ EV = \frac{36 + 27 + 4 \times 30}{6} = 30.5 \text{ days} \]

\[ SD = \frac{36 - 27}{6} = 1.50 \text{ and Variance} = 2.25 \]

You could now make a statement that this activity:
- has a 95 percent probability that it will be finished in 27.5 to 33.5 days (\( EV \pm 2 \times SD \)), or
- has over a 99 % probability that the activity will be finished in 26 to 35 days (\( EV \pm 3 \times SD \)).

Following the above sample calculations, the PERT calculation for the Door Replacement example is (See Table 2.2 for duration values) based on estimated pessimistic and optimistic activity duration values as shown in Table 2.3 below.

### Table 2.3  PERT Statistics (Door Replacement Project)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Description</th>
<th>ML</th>
<th>Opt.</th>
<th>Pess.</th>
<th>EV</th>
<th>SD</th>
<th>Var</th>
<th>(Critical Path Activities)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Develop Project Plan</td>
<td>15</td>
<td>14</td>
<td>19</td>
<td>15.5</td>
<td>0.833</td>
<td>0.69</td>
<td>15.5 0.69</td>
</tr>
<tr>
<td>2.</td>
<td>Plan Approval</td>
<td>5</td>
<td>4</td>
<td>7</td>
<td>5.17</td>
<td>0.5</td>
<td>0.25</td>
<td>5.17 0.25</td>
</tr>
<tr>
<td>3.</td>
<td>Order Interior Doors</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>0.333</td>
<td>0.11</td>
<td></td>
</tr>
<tr>
<td>3.1</td>
<td>Install</td>
<td>1</td>
<td>0.5</td>
<td>2</td>
<td>1.08</td>
<td>0.25</td>
<td>0.063</td>
<td>1.08 0.063</td>
</tr>
<tr>
<td>3.2</td>
<td>Finish Doors</td>
<td>10</td>
<td>8</td>
<td>12</td>
<td>10</td>
<td>0.67</td>
<td>0.44</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Order Exterior Doors</td>
<td>20</td>
<td>18</td>
<td>25</td>
<td>20.5</td>
<td>1.17</td>
<td>1.36</td>
<td>20.5 1.36</td>
</tr>
<tr>
<td>4.1</td>
<td>Install Doors</td>
<td>1</td>
<td>0.5</td>
<td>2</td>
<td>1.08</td>
<td>0.25</td>
<td>0.063</td>
<td>1.08 0.063</td>
</tr>
<tr>
<td>4.2</td>
<td>Finish Doors</td>
<td>15</td>
<td>12</td>
<td>20</td>
<td>15.33</td>
<td>1.33</td>
<td>1.78</td>
<td>15.33 1.78</td>
</tr>
<tr>
<td>5.</td>
<td>Close Project</td>
<td>1</td>
<td>0.5</td>
<td>3</td>
<td>1.25</td>
<td>0.42</td>
<td>0.17</td>
<td>1.25 0.17</td>
</tr>
</tbody>
</table>

\[ \text{(Critical Path) Total} = 59.91 4.376 \]

\[ SD = (4.376)^{1/2} = 2.09 \]

Notations: ML – Most Likely; Pess. – Pessimistic, Opt – Optimistic (estimated duration in days)
EV – Expected Value; SD – Standard Deviation; Var – Variance (calculated from estimates)

For Activity 1, EV, SD, and Variance are calculated as

\[ EV = \frac{19 + 14 + 4 \times 15}{6} = 15.5 \]

\[ SD = (4.31)^{1/2} = (19 – 14)/6 = 0.833, \text{ and Variance} = (SD)^2 = 0.69 \]

Likewise EV, SD, etc. for all other activities are calculated in Table 2.3.
From the above PERT calculations, the project completion time (sum of all critical path activities) is 59 (58.83) days and the standard deviation of the total project time is approximately 2. Thus, it can be said that this project has over a 95% probability that it will be completed in 55 to 63 days.

**Steps for estimating project completion time expressed with confidence level (Using PERT)**

- **List all tasks** and associated durations (most likely, optimistic, and pessimistic values)
- **Draw precedence diagram** showing early, late start, and finish times.
- **Prepare Precedence table** showing tasks with ES, EF, LS, LF, and *float*.
- **Prepare PERT statistics table** showing most likely time, optimistic time, pessimistic time, expected value, standard deviation, and variance.
- Calculate **project completion time** by adding the expected values of all tasks without float. Also, calculate the standard deviation of the entire project by adding the variances of all tasks in the critical path, and then taking the square root of the variance.
- Use standard deviation to express **completion time at a 95% confidence level** (EV +/- 2xSD at 95% CL)

**2.3 Practice & Learn:** Based on the tasks identified in your own group project:

a. Refine and/redraw the PDM (similar to Figure 2.4 using project activity days) for your project allowing room in the activity box for both *forward pass* and *backward pass*.

b. Perform **Forward and Backward Pass** calculations and calculate Precedence Data with FLOATS for your project (Similar to Table 2.2) and determine:

   (i) Activities in the CRITICAL PATH and
   (ii) Time to complete the project.

c. Review your WBS and assume or assign OPTIMISTIC and PESSIMISTIC duration. You may assume the duration you used for Critical Path Method as the MOST LIKELY task duration.

d. Prepare the PERT statistics (Complete Table) and determine the range of project completion time with at (i) 65% and (ii) 95% confidence levels.
**Example: Deck Building Project**

The activities and durations as part of a deck building project identified below are in no particular order.

A. Planning Process (most likely: 5, Pessimistic: 10, Optimistic: 3 days) – commence the project
B. Permit Application (10 days, 15, 8) – follows planning
C. Buy furniture for deck/patio (4 days, 8, 2) – start only after ordering materials
D. Finish detailed deck design and identify material requirements (5 days, 10, 2) – follows planning
E. Ordering Materials & Delivery (5 days, 8, 3) – follows finish design and permit
F. Install Posts (8 days, 15, 5) – follows Material delivery
G. Construct Deck (2 days, 4, 1.5) – follows post install
H. Clean up & close project (2 days, 5, 1) – follows C and G

Complete the following activities assuming that the project begins on June 2, 2003 & using the above activity information and June 2003 calendar:

1. Draw the project’s Precedence Diagram for the project
2. Calculate ES, EF, LS, LF, and float for the project activities
3. Show the project schedule network diagram with ES, EF, LS, LF calendar dates as per the critical path method. (Hint: Assume that the project starts on first working day of June in the current year)
4. Find the expected number of days for project completion?
5. Using PERT calculations, express the dates when the project can be finished with 95% probability.
Solution:
1. Precedence diagram shows dependencies and activity durations in their logical sequence of completion.

To draw this diagram, make activity boxes with room for the activity’s description, number (A, B, etc.), duration, start date, and finish date. Start with activity A on Monday the 2nd of June (see Figure 2.14). Since activity B and D both follow activity A with five day durations, draw FS (Finish-Start) relationships, starting on the sixth day of the project (6/9/03, excluding Saturday and Sunday). Since E can only start after longer of B and C, it must begin 10 days after the start of activity B on 6/23/03. Since C and F can both start after E is finished, they can start on the next available day, i.e., 6/30/03. Likewise G and H can be started and finished in the given logical sequence as shown. Note that, since July 4th being a holiday, it is excluded.

**Figure 2.14** Precedence Diagram (Deck Building Project, Beginning on Monday, June 2, 2003)

Required Information:
- List of activities supplied
- Duration of each activity
- Predecessor for each activities
Note: July 4 is excluded from work days as are Saturdays and Sundays
2. Calculation of precedence values

To calculate early start (ES), early finish (EF), late start (LS), and late finish (LF), it is customary to use the number of days in a project rather than the calendar dates. Float is calculated as the difference between ES and LS. To transform the LS, LF, etc. into a precedence diagram, you will need to use calendar dates. The calendar for the project starting on June 2, 2003, the day of the project is shown in Figure 2.15 below.

![Figure 2.15 Calendars for June – August, 2003](image)

The project starting day is always counted as the first day. Thus, for activity A, the finish day is the end of the 5th day, and may be demonstrated as:

\[
EF = ES + \text{Duration} - 1 \quad \text{or} \quad ES = EF + 1 - \text{Duration}.
\]

The calculation of ES and EF using the above formula and precedence diagram is called the forward pass. Since Activity B starts on the 6th day and requires 10 days to complete (see second line in Table 2.4), its EF is 15 (6 + 10 – 1). Likewise, EF can be calculated with known ES values (Figure 2.14).

The last three columns in the table (Table 2.4), i.e., LS, LF, and Float are calculated by a backward pass in which we start at the last activity (H) that was completed in the early schedule (Figure 2.14). The object here is to determine the latest completion for each activity so that the final project completion date can be maintained.
Since we want the last activity to finish at the project’s finish date, its LS and LF remains the same as it ES and EF (Last line in Table 2.4, 31 and 32). Float for this activity is zero as ES and LS is the same.

Activity G can be finished as late as the day before the start of H (31st day) and can start two days before (LS = 30 - 2 + 1 = 29). The early and late start & finish values for this activity have the same values. Thus, activity G also has 0 float.

For activity C, its late finish can also be the 30th day of the project. However, since it has a duration of 4 days, its late start day is 27 (30 - 4 + 1). The float for this activity is 6 (27 – 21). Similarly, LS, LF, and float for all other activities are calculated as shown in Table 2.4.

### Table 2.4 Precedence with Floats (Deck Building Project)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Description</th>
<th>Duration</th>
<th>Predecessor</th>
<th>ES</th>
<th>EF</th>
<th>LS</th>
<th>LF</th>
<th>Float</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Develop Deck Plan</td>
<td>5 days</td>
<td>-</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>B. Apply for Permit</td>
<td>10</td>
<td>A</td>
<td>6</td>
<td>15</td>
<td>6</td>
<td>15</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>C. Buy Patio Furniture</td>
<td>4</td>
<td>B</td>
<td>21</td>
<td>24</td>
<td>27</td>
<td>30</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>D. Finish Detail Design</td>
<td>5</td>
<td>A</td>
<td>6</td>
<td>10</td>
<td>11</td>
<td>15</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>E. Order Lumber</td>
<td>5</td>
<td>D, B</td>
<td>16</td>
<td>20</td>
<td>16</td>
<td>20</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>F. Install Posts</td>
<td>8</td>
<td>E</td>
<td>21</td>
<td>28</td>
<td>21</td>
<td>28</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>G. Construct Deck</td>
<td>2</td>
<td>G, C</td>
<td>31</td>
<td>32</td>
<td>31</td>
<td>32</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>H. Clean up Close Project</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: ES = Early Start, EF = Early Finish, LS = Late Start, LF = Late Finish, Float = (Late start – Early start)

Observations:
Activities C & D only have floats.
Six activities, A, B, E, F, G, and H are part of the critical path.

3. Project Network Diagram
Using the ES, EF, LS, etc. calculated above, the network with critical path now can be established by simply modifying the previous diagram (Precedence Diagram, Figure 2.14) with early and late start & finish dates shown (Figure 2.16). The activity boxes (Nodes) now contain a title box with Activity #, name, and duration. The lower two lines in the box contain early start-finish and late start-finish dates with day of the week (M for Monday, F for Friday, etc.)

For example, consider the box for activity C (Figure 2.14). The last line in the box is for late start and finish dates. From our earlier calculation, LF is 30th day of the project (Table 2.4). From the calendar (Figure 2.15), the 30th day of the project is July 11th. But since July 4th is a holiday, 30th day is July 14th is the LF and Wednesday July 9th is the late start date for the
activity. In the same manner late start and finish dates for all activities are shown (Figure 2.16)

Observations:
- The project is expected to be completed by July 16
- All activities in the critical path must be completed in their respective time frames (LF)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Early Start</th>
<th>Early Finish</th>
<th>Late Start</th>
<th>Late Finish</th>
</tr>
</thead>
<tbody>
<tr>
<td>B. Apply for Permit 10 days</td>
<td>M 6/9</td>
<td>W 6/20</td>
<td>M 6/9</td>
<td>W 6/20</td>
</tr>
<tr>
<td>C. Buy Patio Furniture, 4 days</td>
<td>M 6/30</td>
<td>Th 7/4</td>
<td>W 7/9</td>
<td>M 7/14</td>
</tr>
<tr>
<td>E. Order Mats/Lumber, 5 days</td>
<td>M 6/23</td>
<td>F 6/27</td>
<td>M 6/23</td>
<td>F 6/27</td>
</tr>
<tr>
<td>F. Install Posts for Deck, 8 days</td>
<td>M 6/30</td>
<td>T 7/10</td>
<td>M 6/30</td>
<td>T 7/10</td>
</tr>
<tr>
<td>G. Construct Deck 2 days</td>
<td>F 7/11</td>
<td>M 7/14</td>
<td>F 7/11</td>
<td>M 7/14</td>
</tr>
<tr>
<td>H. Clean up and Close Project, 2 days</td>
<td>T 7/15</td>
<td>W 7/16</td>
<td>T 7/15</td>
<td>W 7/16</td>
</tr>
</tbody>
</table>

**Figure 2.16** Critical Path Method (Deck Building Project, Monday, June 2, 2003)

4. **Project completion times** by Critical Path Method

5. **PERT** Calculations
Using the PERT method, expected completion dates, activity, and project completion time variances are calculated based on an assumed normal distribution of the probability of occurrences. Two basic quantities for each activity, such as expected value (EV) and standard deviation (SD), are calculated from given the estimates (input values) of most likely, pessimistic, and optimistic values of work duration for each activity. Notice that the estimates
for these values are supplied in this problem and are shown in the 3rd, 4th, and 5th columns of Table 2.5, respectively.

Sample calculations:

For activity A, estimated values are

Most likely = 5 days, Pessimistic = 10, and Optimistic = 3

\[ EV = \frac{(4 \times \text{Most likely} + \text{Pessimistic} + \text{Optimistic})}{6} \]

\[ = \frac{(4 \times 5 + 10 + 3)}{6} \]

Or

\[ EV = 5.5 \text{ days} \]

Also, \( SD = \frac{(\text{Pessimistic} - \text{Optimistic})}{6} \)

\[ = \frac{(10 - 3)}{6} = 1.17 \]

And \( \text{Variance} = SD^2 = (1.17)^2 = 1.37 \)

The last two columns in the table repeat the listing of EV and Variance for only those activities (0 float) that are in the critical path (5.5 and 1.36 for activity A). The EV & SD for all other activities are calculated in a manner similar to Table 2.5.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Description</th>
<th>Likely</th>
<th>Pes.</th>
<th>Opt.</th>
<th>EV</th>
<th>SD</th>
<th>Var</th>
<th>EV</th>
<th>Var</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>Develop Deck Plan</td>
<td>5 days</td>
<td>10</td>
<td>3</td>
<td>5.5</td>
<td>1.17</td>
<td>1.36</td>
<td>5.5</td>
<td>1.36</td>
</tr>
<tr>
<td>B.</td>
<td>Apply for Permit</td>
<td>10</td>
<td>15</td>
<td>8</td>
<td>10.5</td>
<td>1.17</td>
<td>1.36</td>
<td>10.5</td>
<td>1.36</td>
</tr>
<tr>
<td>C.</td>
<td>Buy Patio Furniture</td>
<td>4</td>
<td>8</td>
<td>2</td>
<td>4.33</td>
<td>1.0</td>
<td>1.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D.</td>
<td>Finish Detail Design</td>
<td>5</td>
<td>10</td>
<td>2</td>
<td>5.33</td>
<td>1.33</td>
<td>1.78</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E.</td>
<td>Order Lumber</td>
<td>5</td>
<td>8</td>
<td>3</td>
<td>5.17</td>
<td>0.83</td>
<td>0.69</td>
<td>5.17</td>
<td>0.69</td>
</tr>
<tr>
<td>F.</td>
<td>Install Posts</td>
<td>8</td>
<td>15</td>
<td>5</td>
<td>8.67</td>
<td>1.67</td>
<td>2.78</td>
<td>8.67</td>
<td>2.78</td>
</tr>
<tr>
<td>G.</td>
<td>Construct Deck</td>
<td>2</td>
<td>4</td>
<td>1.5</td>
<td>2.25</td>
<td>0.32</td>
<td>0.17</td>
<td>2.25</td>
<td>0.17</td>
</tr>
<tr>
<td>H.</td>
<td>Clean up Close Project</td>
<td>2</td>
<td>5</td>
<td>1</td>
<td>2.33</td>
<td>0.67</td>
<td>0.44</td>
<td>2.33</td>
<td>0.44</td>
</tr>
<tr>
<td></td>
<td><strong>(Critical Path)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>34.42</td>
<td>6.8</td>
</tr>
</tbody>
</table>

SD = Sq. Rt (6.8 ) = 2.60

By adding the expected values of all activities in the critical path, we get 34.42 days as the project completion time. Also, the total of variances (not standard deviation) for all the critical path activities is 6.8. From variance, the SD is calculated to be 2.60. Using the SD value, the
range of expected completion days for the project can be established. For 95% probability of occurrence, the completion time is EV +/- 2 x SD. The expected project completion time can be calculated as:

\[
\text{Expected Project Completion time} = (34.42 - 2 \times 2.6) \text{ and } (34.42 + 2 \times 2.6)
\]

(Between 29.22 and 39.62 days)

### 2.4 Practice & Learn:
Solve Problem Q2.1 (Page 2.91) & Problem Q2.6 (Page 2.93)

### 2.5 Establish Project Controls (manage & control changes)

In this task, you will establish project controls by identifying the procedures for managing project change, quality, human resources, communication, risk, and procurement. This activity will make you ready for project execution and the control process. It will also ensure that the project complies with applicable industry standards.

#### 2.5.1 Project Change Control:

<table>
<thead>
<tr>
<th>Purpose of Change Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Recognize and agree on scope increases or decreases</td>
</tr>
<tr>
<td>• Acknowledge and approve costs</td>
</tr>
<tr>
<td>• Approve funding for both external and internal sources</td>
</tr>
<tr>
<td>• Investigate the effects of changes on other aspects of the project</td>
</tr>
</tbody>
</table>

Treat change management as a separate sub-project within the project.

Implement a new project plan when all changes in cost, scope and schedule are incorporated.

Project must have a change control process, which is a formal process that maintains the agreed upon project baseline. You will get the necessary help and be aware of standard practices from two areas of PMBOK®: Integration Management and Scope Management. Depending on the size of your project and the organization, you will need to establish procedures for incorporating changes in the project scopes.

The change management process, whether funded externally or internally, must include certain necessary items. The proposed changes must first be evaluated in terms of time, and effort to implement the changes before its impact on other activities can be determined when stakeholders who ask for new items to be incorporated in the project, the activities of the project team may be delayed. Obviously, the stakeholders must authorize the funding to investigate the effects of change first, and then authorize the additional cost of incorporating changes.
2.5.2 Quality Control & Management
Managing the quality of the projects includes ensuring that all project objectives met. PMI views the purpose of project management as a method for meeting stakeholders’ requirements. So far we discussed how the project time and cost are managed. Quality management helps you control the scope.

<table>
<thead>
<tr>
<th>Quality management is accomplished by three distinct processes:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Quality Planning</strong> – In this task you will identify quality standards that are relevant to the project and will determine how to satisfy them</td>
</tr>
<tr>
<td><strong>Quality Assurance</strong> – Here you will evaluate overall project performance on a regular basis to develop confidence that the project will satisfy the relevant quality standards.</td>
</tr>
<tr>
<td><strong>Quality Control</strong> – In this process you will monitor specific project results to determine if they comply with the relevant quality standard and will identify ways to eliminate the causes of unsatisfactory performance.</td>
</tr>
</tbody>
</table>

How is the quality management processes accomplished?
What tools and techniques are available?

Exceeding expectations – not a good idea:
- Can be costly and a waste of time
- Can create precedence unfavorable for future projects

Quality is not to be confused with:
- Low grade is not a bad condition or poor quality
- Inexpensive products may be developed to appeal certain segment of market.

Quality of an item means it is what it is intended to be.
Quality Planning Tools:

**Benefit and Cost Analysis.** The primary benefits of meeting quality requirements are:
- Less work with higher productivity at a lower cost)
- Increased stakeholder satisfaction

The primary cost of meeting quality requirements is the expense associated with project quality management.

It goes without saying that the benefits quality outweighs the costs.

**Example:**
In an assembly & supply of instrument panel for a major auto manufacturer, the quality department is maintained at a cost of $500,000/year. The increased customer satisfaction (amounts to staying in business) is estimated to be worth $250,000/year and the value of the reduced warranty return and scraps is worth $600,000/year.

<table>
<thead>
<tr>
<th>Primary cost of meeting quality requirements:</th>
<th>$500,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary benefit of meeting quality requirements:</td>
<td>$850,000  (600,000+250,000)</td>
</tr>
</tbody>
</table>

**Benchmarking:** Allows comparison of planned project practices to other projects that generate ideas for improvement and help develop standards by which performance can be measured. Other projects may be internal or carried out by other organizations in the same area.

**Example:** In 1972, Burroughs Corporation, the then second largest computer company in the US undertook a project to develop and produce 1500 lpm (lines per minute) printer. In a race to provide faster line printers to the market, benchmarking exercise identified an IBM printer as a faster model to be held as the market standard to meet.

**Flowchart**
A flowchart is any diagram that shows how various elements of a system relates to each other. Two flowcharting techniques are commonly used in the quality

<table>
<thead>
<tr>
<th>Quality Planning</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tools &amp; Techniques:</strong></td>
</tr>
<tr>
<td>- Benefits/cost Analysis</td>
</tr>
<tr>
<td>- Benchmarking</td>
</tr>
<tr>
<td>- Flowcharting</td>
</tr>
<tr>
<td>- Cause-and-effect diagrams</td>
</tr>
<tr>
<td>- Process flow chart</td>
</tr>
<tr>
<td>- Design of Experiments</td>
</tr>
<tr>
<td>- Cost of Quality</td>
</tr>
</tbody>
</table>
management process as shown in Figure 2.17.

- *System or process flow chart* displays how various elements of a system interrelate.

- *Cause-and Effect diagram*, also known as *Ishikawa diagram* or *fishbone diagrams*, graphically shows how various factors might be linked to potential problems or effect (result).

**Figure 2.17 Clutch Plate Fabrications (Process Flow Diagram)**

**Design of Experiments (DOE)**
DOE is an experimental technique to study many factors (variables/input/parameters) at a time using hardware or simulation. In this method, a selected set from all possible experimental conditions are tested. When the experiments are carried out, analysis of the results can identify how each factor influence the results (objectives) and what combination of the factors (levels/values of the factors) produces the most desirable result.

**Example:** A baker can use DOE to perfect the recipe of a cake by determining the proper combination of ingredients like sugar, flour, butter, etc. Using DOE, an automotive engineer can adjust suspension parameters such as spring rate, shock, body structure, seat cushion, etc. that produce the most desirable ride characteristics within a budgeted cost.

A project manager can apply DOE to help evaluate options in project plan. Objective functions such as completion time or project costs can be optimized by taking different factors such as type of employee, experience (junior engineer, senior engineer),
compensation rate, etc. DOE can be applied to a project planning process only when analytical simulations of the objective function(s) are available. If the project involves developing products, the DOE technique should be included in the planned development (design optimization purposes) process.

**Cost of Quality**
The total cost of all efforts to achieve product/service quality, which including the cost of all work to ensure conformance with requirements as well as the cost of all work resulting from nonconformance to requirements. Such costs are incurred in three areas:

- Prevention cost
- Appraisal cost
- Failure cost (internal and external)

### Quality Assurance Tools
**Quality audits** - Quality assurance is accomplished mainly through quality audits. Quality audit is a structured quality management activity. The purpose of the audit is to ensure that all established quality practices are being followed. Quality audits may be scheduled or random, and should be conducted by properly trained in-house auditors (ISO 9000 terms Internal Auditors) or by third parties such as quality system registration auditors.

### Quality Control Methods
For quality control one should monitor specific project performance (Results) to find out if they comply with relevant quality standards and identify ways to eliminate causes of unsatisfactory results. Quality control activity should be performed throughout the project to see that the product results (deliverables) and project management results (cost and schedule) meet the standard. This function is often performed by a Quality Control Department or a similar functioning department within the organization.

Some key quality control terms & definitions that project managers should
Why?

- Solve Problems
- Optimize products

Where?

- Manufacturing
- Development
- Design

Time

UCL

LCL

Figure 2.18 Typical Control Chart

The number next to a point indicates the condition of out-of-control.

Key indicators for a process not “in control” are.

1. A point is beyond the upper or lower control limits
2. Seven points in a row on the same side of the midline (Rule of Seven)
3. Five points in a row headed in the same direction (Rule of Five)
Control Charts
These are graphic displays of process performance (results) over time. The control charts help identify if the process is “in control”, or if causes of variation is random or due to some unusual events. The process should not be adjusted if it is “in control”. A typical control chart and a few key criteria for out of control situation for a manufacturing activity are shown in Figure 2.18 below.

Pareto Diagram
A Pareto diagram is a histogram, ordered by frequency of occurrence, that shows how many results were generated by type or category selected for the study. When a plot is used to show occurrences of problems, the project team should take action to fix problems that are causing the greater number of defects.

Pareto diagram is guided by Pareto’s Law, which states that a relatively small number of causes will typically produce a large majority of problems. This is commonly referred to as the 80/20 principle, where 80% of the problems are caused by 20 percent of the causes.

In 1897, Italian scientist V. Pareto presented his findings that the distribution of income is uneven. Similar observation also was reported by M. C. Lorenz in the U.S. in 1907. Based on the arrangement of the income distribution bars, these scholars pointed out that by far the largest share of wealth is held by a very small number of people. In the field of quality control, in early part of the 20th century, Dr. J. M. Juran used the Pareto principles to isolate the quality problems into vital few and trivial many.

Step 1. Decide the kind of problem you want to investigate.
Example: defects in an automobile, ages of people catching influenza, number of projects done by departments, sales volume by months, etc.

Step 2. Sort data in descending order

Step 3. Calculate percentages and cumulative percentages.

Step 4. Plot frequency of occurrence and the cumulative percentage as shown in Figure 2.19.
**Figure 2.19 Sample Pareto Chart**

*Construction of Pareto diagram:* Sort items (Tasks A, B, C, etc.) in descending order before calculating their percentages and plotting the cumulative values (Y-axis on right).
Flowcharting
Flowcharting (see Figure 2.20) is used in quality control to help analyze how problems occur. Figure 2.20 shows an example.

**Figure 2.20 Sample Flowchart** [registering in Benchmarking (BM) training]

1. **Learn about BM class**
2. **Request registration for ½ day overview**
3. **Get supervisor approval**
4. **Attend ½ day overview session**
5. **Attend 2-day BM class**
6. **Get supervisor approval**
7. **Decide to attend 2-day BM class**
8. **Look for application**
9. **Apply BM to own projects**
10. **Recycle**
11. **Look for new projects**

**Drawing Symbols**
- **Start**
- **Activity**
- **Decision**
**2.5A Practice & Learn:** The sales figures for a retail store are as shown below.

1. Order the months in the list below with higher selling month first, the least selling month last. Complete the last two columns of the table and plot the Pareto Chart with cumulative sales/performances.
2. Determine the three months with higher performances.
3. Identify the months that makes up 85% of the total sales.

<table>
<thead>
<tr>
<th>Month</th>
<th>$Sales (+000)</th>
<th>%</th>
<th>Cum. %</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>120</td>
<td></td>
<td></td>
</tr>
<tr>
<td>February</td>
<td>105</td>
<td></td>
<td></td>
</tr>
<tr>
<td>March</td>
<td>90</td>
<td></td>
<td></td>
</tr>
<tr>
<td>April</td>
<td>85</td>
<td></td>
<td></td>
</tr>
<tr>
<td>May</td>
<td>60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>June</td>
<td>65</td>
<td></td>
<td></td>
</tr>
<tr>
<td>July</td>
<td>70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>August</td>
<td>70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>September</td>
<td>82</td>
<td></td>
<td></td>
</tr>
<tr>
<td>October</td>
<td>118</td>
<td></td>
<td></td>
</tr>
<tr>
<td>November</td>
<td>160</td>
<td></td>
<td></td>
</tr>
<tr>
<td>December</td>
<td>290</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**2.5B Practice & Learn:** In Michigan’s winter months, normal production data for a particular brand of Salsa for Garden Fresh Gourmet Company is as shown below.

<table>
<thead>
<tr>
<th>Volume (Boxes)</th>
<th>Determine:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. 1235</td>
<td>1. Average production volume (Ans. 1385)</td>
</tr>
<tr>
<td>2. 1320</td>
<td>2. Standard Deviation (σ) for the production volume (Ans. 104.33)</td>
</tr>
<tr>
<td>3. 1470</td>
<td>3. Plot a control chart showing average and +/- 1σ, +/- 2σ, +/- 3σ</td>
</tr>
<tr>
<td>4. 1380</td>
<td>4. A routine check in recent time winter month showed the following data: 1230, 1450, 1650, 1445, 1290, 1020, 1360 &amp; 1480. What is your conclusion about the nature of production variation?</td>
</tr>
<tr>
<td>5. 1490</td>
<td></td>
</tr>
<tr>
<td>6. 1530</td>
<td></td>
</tr>
<tr>
<td>7. 1510</td>
<td></td>
</tr>
<tr>
<td>8. 1310</td>
<td></td>
</tr>
<tr>
<td>9. 1420</td>
<td></td>
</tr>
<tr>
<td>10. 1290</td>
<td></td>
</tr>
<tr>
<td>11. 1335</td>
<td></td>
</tr>
<tr>
<td>12. 1355</td>
<td></td>
</tr>
<tr>
<td>13. 1220</td>
<td></td>
</tr>
<tr>
<td>14. 1370</td>
<td></td>
</tr>
<tr>
<td>15. 1540</td>
<td></td>
</tr>
</tbody>
</table>
2.6 Practice & Learn: Draw a Flow chart depicting the steps you will have to take and procedure you will have to follow to register & attend a work related seminar in London, England.

Use the three symbols shown to draw a flow chart of the process. Present and show your chart to the class when asked by the instructor.

- **Show Start or Finish**
- **Show Activity Description**
- **Show Decision Requirements**

---

**Statistical Sampling**

In this approach, a small segment of the sample population of interest is selected for inspection (e.g., selecting one small module of software codes at random from many lines of codes for the entire software). Various methods may be used to select statistically valid samples. One should select a method that best suits the ultimate objective of the study. Often, sampling reduces the cost of inspection.

**Trend Analysis**

Trend analysis uses mathematical techniques to forecast future outcomes based on past or present performances. Project managers use trend analysis to monitor:

- *Technical performance* – how many errors or rejects are found, how many corrective actions remain to be taken, etc?
- *Cost and schedule performance* - how many activities were completed per period of time, how much was the weekly payroll, etc.
2.5.3 Project Human Resource (HR) Management

Making the most effective use of the people involved in your project, including project stakeholder-sponsors, customers, partners, individual contributors and others, is key to project management. The processes involved in HR Management are provided below.

Managing Project Human Resource

How can you make the most effective use of the people involved in your project?

• **Organizational Planning** – identifying and assigning project roles and responsibilities

• **Staff Acquisition** - getting needed human resources

• **Team Development** – developing individual and group skills

Organizational Planning

This task involves identifying, documenting, and assigning project roles and responsibilities, and reporting relationships for individuals or group involved in the project. Such individuals or groups may be part of the organization performing the project or external to it. Four common tools and techniques use for this purpose are:

1. **Templates** – Most projects share many similar characteristics. Organization planning can be made easier by using reporting structures & responsibility definitions from previous projects.

2. **Human Resource Practices** – Many organizations have well established policies and guidelines that can assist the project management team. For example, an organization that views managers as “team leaders or coaches” is likely to have documentation on how the role of “coach” is to be performed.

3. **Organizational Theory** – A substantial body of knowledge is available on how the organization should be organized in general, and how to make it more efficient for the type of project undertaken. The project management team should benefit by being familiar with the subject of organizational theory so as to respond to the needs of the project.

4. **Stakeholder Analysis** – knowing stakeholders and their demands.

Organizational Planning Tools

• **Templates** – benefit from other similar project practices.

• **Human Resource Practices** – Organization’s own policies and guidelines.

• **Organizational Theory** – general management and organizational science.

• **Stakeholder Analysis** – knowing stakeholders and their demands.
4. Stakeholder Analysis – identification of stakeholders specific needs is assessed in Stakeholder analysis is important in managing communications, as discussed later.

At the conclusion of organizational planning, you will have completed project roles and responsibilities descriptions and develop a Responsibility Assignment Matrix, as shown in Figure 2.21. You will document your staffing management plan in a Resource Histogram, as shown in Figure 2.22.

**Figure 2.21 Responsibility Assignment Matrix (RAM)**

<table>
<thead>
<tr>
<th>ACTIVITY PHASE</th>
<th>PR</th>
<th>PM</th>
<th>WM</th>
<th>KR</th>
<th>RR</th>
<th>AG</th>
<th>BG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requirements</td>
<td>S</td>
<td>R</td>
<td>A</td>
<td>P</td>
<td>P</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concept Design</td>
<td>S</td>
<td></td>
<td>A</td>
<td>P</td>
<td>P</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design</td>
<td>S</td>
<td></td>
<td>R</td>
<td>A</td>
<td></td>
<td>P</td>
<td></td>
</tr>
<tr>
<td>Development</td>
<td>R</td>
<td>S</td>
<td>A</td>
<td>I</td>
<td>P</td>
<td>P</td>
<td></td>
</tr>
<tr>
<td>Testing &amp; validation</td>
<td>S</td>
<td></td>
<td>P</td>
<td>I</td>
<td>A</td>
<td>P</td>
<td></td>
</tr>
</tbody>
</table>

P = Participant, A = Accountable, R = Review Required
I = Input Required, S = Sign-off required
Staff Acquisition
During staff acquisition, you will secure needed human resources (individuals or groups) assigned to the project. Often, the best people for the job may not be available, yet the project management team must still make certain that the project’s requirements will be met by the available resources.

Negotiations – Often project management team must negotiate staff assignments with functional managers who are responsible for staff administrative affairs. This becomes increasingly important when there are other competing projects within the organization competing for the same resources. In this situation, the project team’s influencing competency plays an important role in negotiating staff assignments, as do the politics of the organization. For example, if the functional managers are rewarded strictly based on staff utilization, their interest may be to fill available resources regardless of their qualification for the job.

Staff Acquisition Tools
- **Negotiations** – negotiate staff assignment with functional managers.
- **Pre-assignment** – Committed resources prior to project approval.
- **Procurement** – procure outside support when needed.
Pre-assignment – Refers to situations where the project was secured by a competitive bids and specific staff has been committed as part of the proposal. It may also refer to internal projects where staff assignments are already defined as part of the charter of the project’s charter.

Procurement – When the performing organization lacks the in-house staff needed to complete a project, services be obtained or procured from outside sources. You may also need to use procurement when in-house skills are already committed to other projects. Procurement management will be discussed in more details under section 2.5.6.

Team Development
Good project managers will put effort into enhancing stakeholders’ ability to contribute well as individuals while fostering the project team members’ ability to function as a team. Often, the team development process becomes a challenge when team members are made accountable to both the functional manager and the project manager. Effective management of this dual reporting relationship is key to team building and project success.

Team-building Activities – Team building activities are used to improve team performance, and may take a number of forms, including:

- involving management level team members in the planning process;
- establishing ground rules for surfacing and dealing with conflicts;
- holding frequent, but short status meeting;
- Organizing off-site meetings, retreats, and games;
- Facilitating professional skill building seminars to improve interpersonal relationships among key stakeholders.

<table>
<thead>
<tr>
<th>Team Development Techniques</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Team-building Activities – Actions to improve team performance.</td>
</tr>
<tr>
<td>• General Management Skills – a broad range of management skills.</td>
</tr>
<tr>
<td>• Reward and Recognition Systems – action that promote desired behavior.</td>
</tr>
<tr>
<td>• Collocation – putting all active project team members in the same location.</td>
</tr>
</tbody>
</table>
General Management Skills – Project manager should also consider building general skills in areas like finance, accounting, strategic planning, negotiating, problem solving, that often come useful in building teams and running projects.

Reward and Recognition Systems – To promote or reinforce a desired behavior management can institute a formal recognition system. The reward system should only reward actions that directly impact project performance. For example, a project manager who is rewarded for timely project completion should have an appropriate level of control over project planning. At the same time, a person who ends up working overtime as a result of poor planning should not be rewarded.

Collocation – There are benefits to co-locating all active project team members. Though it may not always be possible, co-location is a common practice on larger projects and can be equally effective in smaller projects. The availability of modern communication technologies including conference calls, video conferencing, e-mails, and cell phones has made it convenient to work with remotely located project team members. When team members in large projects are remotely located, one may establish a project center, war room, etc. to provide a balance. Where collocation is not possible, frequent face-to-face meetings may encourage interaction among team members.

[Other Topics for self study]
- Evaluation of Support Personnel
- Employee Motivation
- Supervisory Style and Delegation
- Job and Work Design
- Authority, Power and Leadership Style
- Conflict Resolution
- Effective Meeting Time Management

2.5.4 Project Communication Management

Project communication management involves activities that ensure timely generation, collection, dissemination, storage, retrieval, and ultimate disposition of project information. Project communication provides the vital link between the ideas, information, and people that is necessary for the project success. All involved in the project must be prepared to send and receive information and understand how the flow of information in which they are
involved, affect the project outcome. There are four processes involved in communication management: (1) Communication Planning; (2) Information Distribution; (3) Performance Reporting & (4) Administrative Closure

(1) Communication Planning
In this process, you will determine your stakeholders’ communication needs. In other words, you will find out who needs what information, when they need it, in what format they want it, and who will provide it. On most projects, the majority of communication planning is done in the project’s earlier phases, but it should be revised regularly and changes made as needed.

Stakeholder Analysis – Involves development of a methodical and logical view of stakeholders’ information needs and identification of sources to meet these needs by seeking methods and technologies that meet these information needs in a timely manner. Avoid wasting resources on generating information that is unnecessary or on inappropriate technology.

(2) Information Distribution
Making needed information available to project stakeholders in a timely manner requires that the communication management plan be implemented. The plan should incorporate provisions for unexpected requests of information or reporting on unexpected events.

Communication Skills – Project manager should have proficient communication skills. During an exchange of information, the sender is responsible for communicating clearly and unambiguously, and for making sure the receiver understand it correctly. The receiver, on the other hand, is responsible for making sure the information is received in its entirety and understood correctly. Facets of communication include:
- Written and verbal
- Internal and external
- Formal or informal
- Vertical or horizontal (in the organization)
**Information Retrieval Systems** - Information may be shared among team members and stakeholders through: manual filing systems, electronic database, project management software, engineering drawings, design specs, test plans and results, etc.

**Information Distribution Methods** – Information may be distributed through: meetings, hard copy documents, shared databases, faxes, electronic mail, voice mail, videoconferencing, project intranet, etc.

(3) **Performance Reporting**

In performance reporting, one plans for the collection and dissemination of performance information to provide stakeholders with information on how resources will be used to achieve project objectives.

**Performance Reviews**- regularly scheduled meeting held to review the status and/or progress of the project. Such reviews are usually held in conjunction with one or more of the performance reporting tools described below.

**Variance Analysis**- Variance analysis is performed to see how the actual project performance compares with the planned value. Although cost and schedule are most commonly calculated, variances in scope, resource, quality and risk are also of importance.

**Trend Analysis** – In trend analysis, performance is observed over time. Often, visual observation or mathematical curve fit can indicate the trend of performance indicating whether improvement or deterioration.

**Earned Value Analysis** – the most commonly used method of project’s performance. Earned Value Analysis combines performance in terms of project scope, cost (resources), and schedule to help the project management teams assess a project’s performance. Three key values are calculated as part of this analysis.

\[
\text{Earned Value (EV)} = \text{the value of the work actually completed (Previously called budgeted cost of work performed or BCWP)}
\]

\[
\text{Planned Value (PV)} = \text{the portion of the approved cost estimate that is planned to be spent during given period (Previously called budgeted cost of work scheduled or BCWS)}
\]

---

**Performance Reporting Tools**

- **Performance Reviews** – Meetings to assess project status.
- **Variance Analysis** – Comparing project performance with expected results.
- **Trend Analysis** – Examine project results over time.
- **Earned Value Analysis** – Evaluates project performance in terms of cost and schedule.
- **Information Distribution Tools and Techniques** – How to report.
Actual Cost (AC) = the total cost incurred when accomplishing work on the activity during a given period (Previously called the actual cost of work performed or ACWP)

From the above cost evaluation, several variance statistics are calculated:

\[
\text{Cost variance, } CV = EV - AC \\
\text{Schedule variance, } SV = EV - PV
\]

Also, Cost performance index, \( \text{CPI} = \frac{EV}{AC} \) (used for forecasting cost)

And, Schedule performance index, \( \text{SPI} = \frac{EV}{PV} \) (used for forecasting schedule)

Figure 2.23 below shows time duration and weekly spending for several tasks from which the cumulative spending may be calculated. Figure 2.24 shows the plot of the cumulative values calculated. Since this cumulative value (dollar, hours, etc.) is derived directly from the schedule, it represents planned performance and therefore is called a baseline plan. The baseline curve is used as the basis for comparisons of project’s performance and establishes the status at any point in time. Examples of how such assessments are done follow here.

Based on data collected at the end of 6 weeks when the planned value of the project is $175,000, the actual cost of the project (money paid for resources and materials) to date is $190,000 (AC), and the earned value, which is the value of the work actually completed is $140,000 (EV) as shown in Table 2.6. From PV, AC, and EV, variance values, CV & SV, and cost and schedule performance indices CPI & SPI, are calculated for Tasks 1, 2, and 3 as shown below:

\[
CV = EV - AC = 140 - 190 = -50 \ ($x000) \\
\text{Or } CV \text{ as percent of EV } = -50/140 = -35.7\%
\]

Also, \( SV = EV - PV \) = 140 – 175 = -35

And, \( SV \text{ as percent of PV } = -35/175 = -20\%

BAC (budget at completion = EV of all tasks) and EAC (Estimated project cost at completion) bears relations as

\[
\text{EAC} = \frac{\text{BAC}}{\text{CPI}}
\]
Likewise, performance indices can be calculated as

\[ \text{CPI} = \frac{EV}{AC} = \frac{140}{190} = 0.737 \]

And \[ \text{SPI} = \frac{EV}{PV} = \frac{140}{175} = 0.80 \] (Table 2.6)

<table>
<thead>
<tr>
<th>WBS Element</th>
<th>Planned Budget PV $</th>
<th>Earned Value EV $</th>
<th>Actual Cost AC$</th>
<th>Cost Variance CV= (EV-AC)$</th>
<th>Cost Var. CV/EV %</th>
<th>Schedule Variance SV= (EV-PV)$</th>
<th>Sched. Var. SV/PV %</th>
<th>Cost CPI (EV/AC)</th>
<th>Schedule SPI (EV/PV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task 1, Task 2, and Task 3 Tasks (abc)</td>
<td>175K</td>
<td>140K</td>
<td>190K</td>
<td>- 50</td>
<td>-35.7</td>
<td>- 35</td>
<td>- 20</td>
<td>.737</td>
<td>.80</td>
</tr>
<tr>
<td>Total=&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* $ values shown are in 1000’s (K = x 1000). Other units of measurement are labor hours, tons of steel, cubic yards of concrete, etc.
Although, only one data for each of AC and EV at 5 – 6 weeks is shown (Table 2.6), assuming that such values are available for all other weeks prior to this point, the curves for AC and EV can be drawn along with the PV (Figure 2.4). Depending on where AC and EV are in relation to PV, different conclusions about the project progress and expenditure can be made. Figure 2.25 represents four scenarios of EV, AC, and PV configurations. Their individual assessments are described below.

**Figure 2.25**

**Figure 2.24 Graphic performance Report in Terms of Earned Value**

![Graph](image)

Similar plots can be made with other types of units of measure (labor hours, amount of materials, etc)

**Figure 2.25(a), AC > EV, AC > PV, and EV < PV** indicates that the project is behind schedule and overspent (over budget). Not being able to anticipate delays or complexity of the activities, or otherwise incorrect estimate will cause this situation. Unforeseen accidents and roadblock may also cause such delays and over expenditure.

**Figure 2.25(b), EV > AC, EV > PV, and AC < PV** represents situation where the project is ahead of schedule and under spent or under budget. This may have happened because the original estimate was too conservative & perhaps padded for safety. It may also be the result of a lucky break and everything will fall into place shortly. It may also be that the people work as an efficient team and things got done sooner. The drawbacks on such variance are the tying up of resources. In economic terms, this is called opportunity cost.

**Figure 2.25(c), EV = AC, EV and AC > PV** (EV and AC are almost equal and larger than PV) shows a situation where the project is ahead of schedule, but is spending correctly for the amount of work done. This usually happens when you apply extra resources at the originally anticipated rates. For example, expected weather delays may never have happened and you got things done sooner at the correct cost.
Figure 2.25 (d), $EV = AC$, $EV$ and $AC < PV$ ($EV$ and $AC$ are almost equal and smaller than $PV$) is indicative of performance for a project that is behind schedule, but is spending correctly for the amount of work done. It shows that you have not applied enough resources to the project. This could be because the resources were taken away from you, or there was slow down for some reason (vacation, shut down, etc.). In the end, you end up spending more when you try to catch up later.

**Figure 2.25 Earned Value Analyses** [Schedule: ahead/behind, Cost: under/over budget]

<table>
<thead>
<tr>
<th>Cum. Value</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>EV</td>
<td></td>
</tr>
<tr>
<td>TIME</td>
<td></td>
</tr>
<tr>
<td>AC</td>
<td></td>
</tr>
<tr>
<td>PV</td>
<td></td>
</tr>
<tr>
<td>Data Date</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cum. Value</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>EV</td>
<td></td>
</tr>
<tr>
<td>TIME</td>
<td></td>
</tr>
<tr>
<td>AC</td>
<td></td>
</tr>
<tr>
<td>PV</td>
<td></td>
</tr>
<tr>
<td>Data Date</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cum. Value</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>EV</td>
<td></td>
</tr>
<tr>
<td>TIME</td>
<td></td>
</tr>
<tr>
<td>AC</td>
<td></td>
</tr>
<tr>
<td>PV</td>
<td></td>
</tr>
<tr>
<td>Data Date</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cum. Value</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>EV</td>
<td></td>
</tr>
<tr>
<td>TIME</td>
<td></td>
</tr>
<tr>
<td>AC</td>
<td></td>
</tr>
<tr>
<td>PV</td>
<td></td>
</tr>
<tr>
<td>Data Date</td>
<td></td>
</tr>
</tbody>
</table>
Why?
- Solve Problems
- Optimize products

Where?
- Manufacturing
- Development
- Design

Figure 2.26 Schedule Showing Michigan DOT ad Construction Expenditures

<table>
<thead>
<tr>
<th>Highway</th>
<th>Monthly Spending $K*</th>
<th>Cumulative Spending $K</th>
</tr>
</thead>
<tbody>
<tr>
<td>I-75</td>
<td>15 30 30 40 25 30 20 20</td>
<td>15 45 75 115 140 170 190 210</td>
</tr>
<tr>
<td>I-94</td>
<td>15 30 30 40 25 30 20 20</td>
<td>15 45 75 115 140 170 190 210</td>
</tr>
<tr>
<td>I-275</td>
<td>15 30 30 40 25 30 20 20</td>
<td>15 45 75 115 140 170 190 210</td>
</tr>
<tr>
<td>M-23</td>
<td>15 30 30 40 25 30 20 20</td>
<td>15 45 75 115 140 170 190 210</td>
</tr>
</tbody>
</table>

Data Date: August 31, 2001
- Actual cost (AC) = $130M
- Planned value (PV) = $140M
- Earned value (EV) = $150M (140M + 10M Sept. cost of Hwy I-275)
- Cost variance (CV) = 20 M (150 – 130)
- Schedule variance = 10 M (150 – 140)

Figure 2.27 Earned Value Analyses
(Michigan Hwy Construction Project)
2.7A Practice & Learn: For the building project expenditure shown, 1. Complete table below, 2. Plot graph of planned value, 3. If at end of June, task (a) is completed two months ahead of time. The actual cost of project at that point is $2,500K. What is the status of the project?

### Building A New Production Facility

<table>
<thead>
<tr>
<th>(a) Ground &amp; garden Preparation</th>
<th>$50K per month</th>
</tr>
</thead>
<tbody>
<tr>
<td>(b) Building Structure</td>
<td>$250K per month</td>
</tr>
<tr>
<td>(c) Parking Structure/Lot</td>
<td>$75K per month</td>
</tr>
<tr>
<td>(d) Equipment Purchase &amp; Installations</td>
<td>$300K per month</td>
</tr>
<tr>
<td>(e) Utilities and Facilities</td>
<td>$120K per month</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Monthly Expenditure $K</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cumulative Spending $K</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2.7B Practice & Learn: Earned Value Analysis (page 2.57)
For the example above, the earned value and the actual cost in the month of October are as shown below. What is the cost performance index (CPI) at this point in time?

\[
EV = 185M \quad \text{and} \quad AC = 200M \quad \text{(Ans: CPI = 0.925)}
\]
Common Business and Accounting Terms

Assets = Things a company owns, like cash, plants, & buildings, materials in stock, and machineries.

Liabilities = Items a company owes, such as unpaid bills, short-term and long-term debts, accounts payable, unpaid salaries & bonuses, and unpaid taxes.

Owners Equity = the value of the assets after the liabilities have been subtracted.

The fundamental accounting equation is: \( \text{Assets} = \text{Liabilities} + \text{Owners equity} \)

After a project is completed, the increase in assets is expected to be greater than the liabilities incurred. Bigger the difference, the higher the owner’s equity.

An Income Statement shows where the cash flow into and out of the company comes from. It also shows the net profit after taxes, which is the sum of all money flowing into (+) and all money flowing out (-) of the company.

<table>
<thead>
<tr>
<th>Money-in</th>
<th>Money-out</th>
<th>= Net Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross sales</td>
<td>- (less) Cost of goods sold</td>
<td>= Gross profit</td>
</tr>
<tr>
<td>Gross profit</td>
<td>- Operating expenses</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Salaries &amp; commissions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rent &amp; Royalties</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Depreciation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other operating expense</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Net operating income</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net operating income</td>
<td>- Other expense</td>
</tr>
<tr>
<td>+ Other income</td>
<td>- Interest expense</td>
</tr>
<tr>
<td>+ Interest revenue</td>
<td>= Net income before taxes</td>
</tr>
</tbody>
</table>

Net income before taxes - Income tax = Net income after taxes

A Balance Sheet displays the constituents terms in the fundamental accounting equation (Assets = Liabilities + Owner’s Equity). In a company’s balance sheet, the assets must balance the liabilities, and are shown in dollar amounts.
**Table 2.6 b Sample Balance Sheet**

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
<th>Owner’s Equity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total asset</strong> =</td>
<td><strong>Liabilities</strong> =</td>
<td><strong>Owner’s Equity</strong> =</td>
</tr>
<tr>
<td>Current Assets: [Cash</td>
<td>Current Liabilities: [Accounts payable,</td>
<td>Common stocks</td>
</tr>
<tr>
<td>Accounts receivable,</td>
<td>Unpaid salaries] +</td>
<td>+</td>
</tr>
<tr>
<td>Inventory,</td>
<td>Long-term Liabilities: [Long-term debt]</td>
<td>Preferred stocks +</td>
</tr>
<tr>
<td>Prepaid expenses ]</td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>+ Fixed Assets: [Plants and</td>
<td></td>
<td>Retained earnings</td>
</tr>
<tr>
<td>equipment, Furniture and</td>
<td></td>
<td></td>
</tr>
<tr>
<td>fixtures] -</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accumulated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>depreciation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Return on Sales (ROS):** Return on sale is the ratio between the net profit after taxes or net operating profit after taxes (NOPAT) and the gross sales. Thus, if a project generates $600,000 at completion, and after paying all costs, expenses, and taxes, the income is reduced to $550,000, with a net operating profit of $35,000, ROS can be calculated as:

\[
\text{ROS} = \frac{\text{NOPAT}}{\text{Gross revenue}} = \frac{35,000}{600,000} \times 100 = 5.83\% \quad (\text{Typical American business data is } 5\%) 
\]

**Return on assets (ROA):** ROA is calculated by dividing the net profit after taxes by total assets, and indicates the profit generated for each dollar of investment into the company.

Suppose that to complete the above project, $360,000 worth of company’s assets were used. After sharing all costs and expenses, the net profit was $35,000 (same data shown before). Then,

\[
\text{ROA} = \frac{\text{NOPAT}}{\text{Total asset}} = \frac{35,000}{360,000} \times 100 = 9.7\% \quad (\text{Typical US company data is } 9\%) 
\]

**Economic Value Added (EVA):** EVA tells us whether the net profit generated (NOPAT) is sufficient to cover maintenance cost the assets that it utilizes.
Companies generally maintain assets by borrowing money or when it owes dividends to stockholders who hold stocks in the company. Suppose that 75 dollars out of every $100 of company’s assets are financed by stockholders at 18 percent. This means that $13.5 (18 x 0.75) of every $100 of assets per year is financed by stakeholders. The other 30 dollars of every $100 of company’s assets are financed by lenders at 8.5 percent, or $2.55 (8.5 x 0.30) per year. Thus, the total cost of capital per $100 is 13.5 + 2.55 = $16.05, or 16.05 percent of company’s assets.

Suppose that the capital used by the project is $750,000, and the cost of that capital is 16.05 percent. The weighted average cost of capital (WACC) = $750,000 x 0.1605 = $120,375.

If the net operating profit after tax is $170,000, then

$$EVA = NOPAT - WACC$$

$$= $170,000 - $120,375$$

$$= $49,625$$  (Project economic value added, EVA)

**Depreciation**

Depreciation is the term used to describe the cost of new assets spread out over a period of time. Suppose that you purchase a machine for $70,000. If you account the purchase cost of the machine as an expense in the year it was purchased, your profit in that year will be significantly lowered. Instead, if this expense is spread over the life of the machine, its impact on your profits will be much lower and more realistic.

There are two common methods of depreciation: straight line and accelerated depreciation. Assuming that the machine purchase ($70,000) has a salvage value of $6,000 at the end of 8 years of useful life, the value of the machine that must be depreciated is $64,000 ($70,000 – $6,000).

**Straight line Depreciation** – In this method, the depreciated value of the asset is spread equally throughout the entire life as shown in Table 2.6c.
Accelerated Depreciation – In this method the expenses are depreciated more in the earlier years of the asset’s life. Commonly two schemes are followed.

**Sum of Year’s Digits** – For 8 years, the sum of all the year’s digits is calculated. For example, in an eight year depreciation, $8 + 7 + 6 + 5 + 4 + 3 + 2 + 1$ equals 36. From this number, depreciation for the first year is calculated as $8/36$ of total. There is no specific basis or financial justification for this strategy, as shown in Table 2.6d.

**Table 2.6d Accelerated Depreciation (Sum of the Year’s Digits)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Purchase Price</th>
<th>Salvage Value</th>
<th>Sum Year’s Digit</th>
<th>Depreciation</th>
<th>Current Book Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>70,000</td>
<td>6,000</td>
<td>0</td>
<td>0</td>
<td>64,000</td>
</tr>
<tr>
<td>1</td>
<td>8,000</td>
<td></td>
<td>8/36</td>
<td>14,222</td>
<td>49,778</td>
</tr>
<tr>
<td>2</td>
<td>7/36</td>
<td>12,444</td>
<td></td>
<td>10,667</td>
<td>26,667</td>
</tr>
<tr>
<td>3</td>
<td>6/36</td>
<td>8,889</td>
<td></td>
<td>8,889</td>
<td>17,778</td>
</tr>
<tr>
<td>4</td>
<td>5/36</td>
<td>7,111</td>
<td></td>
<td>5,333</td>
<td>5,334</td>
</tr>
<tr>
<td>5</td>
<td>4/36</td>
<td>5,333</td>
<td></td>
<td>3,556</td>
<td>1,778</td>
</tr>
<tr>
<td>6</td>
<td>3/36</td>
<td>1,778</td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>2/36</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>1/36</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>64,000</td>
</tr>
</tbody>
</table>

Double Declining Balances – In this method, 50% of the total depreciable amount is accounted for in the first year, and same percent of the remaining amount is taken in the
subsequent year as shown in Table 2.6e below. This method is used as a standard accounting practice.

Table 2.6e Accelerated Depreciation (Double Declining Balances)

<table>
<thead>
<tr>
<th>Year</th>
<th>Purchase Price</th>
<th>Salvage Value</th>
<th>Depreciation (at 50%)</th>
<th>Current Book Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>70,000</td>
<td>6,000</td>
<td>0</td>
<td>64,000</td>
</tr>
<tr>
<td>1</td>
<td>32,000</td>
<td>32,000</td>
<td>16,000</td>
<td>16,000</td>
</tr>
<tr>
<td>2</td>
<td>16,000</td>
<td>16,000</td>
<td>8,000</td>
<td>8,000</td>
</tr>
<tr>
<td>3</td>
<td>8,000</td>
<td>8,000</td>
<td>4,000</td>
<td>4,000</td>
</tr>
<tr>
<td>4</td>
<td>4,000</td>
<td>4,000</td>
<td>2,000</td>
<td>2,000</td>
</tr>
<tr>
<td>5</td>
<td>2,000</td>
<td>2,000</td>
<td>1,000</td>
<td>1,000</td>
</tr>
<tr>
<td>6</td>
<td>1,000</td>
<td>1,000</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>7</td>
<td>500</td>
<td>500</td>
<td>250</td>
<td>250</td>
</tr>
<tr>
<td>8</td>
<td>250</td>
<td>250</td>
<td>Total: 64,000</td>
<td></td>
</tr>
</tbody>
</table>

2.8a Practice & Learn: A manufacturer of plastic molded parts purchases a molding machine for $350,000. The salvage value for the machine after 6 years is estimated to be $20,000. Using the sum of all year’s digits method, determine the depreciation and the Book Values for the next 6 years.

2.8b Practice & Learn: A farmer buys equipment for $250,000. Following the double declining depreciation method, prepare the depreciation and Book Value of the equipment for next 8 years. Use $30,000 as the salvage value of the equipment at end of its useful life.
The information gathered and processed as part of the performance reporting are distributed using *Information Distribution Tools and Techniques* discussed in the earlier.

### (4) Administrative Closure

All projects or phase require closure once the objective has been reached, or the activities are terminated. Administrative closure requires documenting project results to formalize stakeholders’ acceptance of the product. It means that you need to collect all project records to make sure that they reflect final specifications, analysis of project successes, effectiveness, and lessons learned, and should store them for future reference.

#### Administrative Closure Tools

- **Performance Reporting Tools**
- **Project Reports**
- **Project Presentations**

These tools have been described earlier as part of the communication management earlier.

### 2.5.5 Risk Management

Risk management is a systematic process of identifying, analyzing, and responding to project risk. The aim in risk management is to increase the probability and consequence of positive events and minimizing the probability and consequence of adverse factors effecting to the project objectives.

**What is project risk?**

Project risk is an uncertain event or condition that has a positive or negative effect on the project’s objective. Each risk has a cause and a consequence. For example, a cause in a software development project could be double checking coding. The risk is that the release date of the project may have to be delayed.

Project risks may be a threat to the project objectives or opportunities to improve those objectives.
Risk Management Planning
You will need to decide how to approach and plan for risk management activities. A common practice to developing a risk management plan is to hold planning meetings with each project team. Participants at such meetings should include project managers, project team leaders, those with responsibility for managing risk planning and execution activities, stakeholders, and others as needed. Risk management templates from other projects may be used to initiate discussion & form a tailored plan for the current project.

Risk Identification
Risk identification involves determining which risk might affect project objectives and the manner in which they may affect the outcome of the project. Each risk must be described in detail such that it will not be confused with any other risks or project tasks. It is customary to assign a number to each risk, and as more information is gathered about the risk’s information can be stored for easy retrieval.

There are several ways to discover and identify risks (See the list at right).

Document Reviews – All project materials that have been generated up to the date of review are examined. The lessons learned from previous projects, contract obligations, project baselines, schedules and budget, resource availabilitys, staffing plan, suppliers, and assumption lists are reviewed.

Information Gathering – There are a number of techniques used in gathering information about risks. A few popular methods are discussed here.

Brainstorming is the most common technique for identifying risk. An idea number of participants for such a meeting is between 8 to 15. Less than 8 participants do not provide necessary interactions, and over 15 make the meeting too large and liable to loosing focus.
Ideas about risks are first identified without scrutiny, and once all ideas are listed, they are slowly examined and descriptions clarified. All risks are then categorized by the type of risks and their definitions sharpened.

**Delphi Technique** is similar to brainstorming. This approach differs in that it involves participants who do not know each other. In fact this type of meeting may be held with participants in remote locations via e-mail, video conferencing, etc. Participants can freely and uninhibitedly by ranks and peer pressure offer ideas, which are then classified and categorized by a facilitator.

In **Nominal Group Technique**, the participants are asked to write their ideas secretly on to pieces of paper. The suggested ideas are listed, then scrutinized and categorized by the facilitator.

In the technique known as **Crawford Slip**, 7 -10 Participants are asked 10 questions one at a time. Participants are not allowed to use the same answer for different question.

**Expert Interviews** method relies on interviewing a few external or internal experts whose experience can be of great help the project team from not encountering the same problem repeatedly.

**Checklists** – In its basic form, checklists are simply predetermined lists of risks that may potentially occur for the given projects. These risks may have occurred in similar past projects. Often, certain customers and stakeholders have particular risks associated with them that can forewarn the new project’s manager.

**Assumption Analysis** – every project is developed based on certain assumptions, hypothesis, or scenarios. In an assumption analysis, the validity of such assumptions is examined. This analysis identifies risk due to inaccurate or inconsistent assumptions.

**Diagramming Technique** - diagrams, cause-and –effect & influence diagrams, etc. for various activities are reviewed to identify risks.

**Qualitative Risk Analysis**
To assess the impact and likelihood of identified risks, risks are prioritized according to potential effects on project objectives. This process helps determine the importance of addressing specific risks and helps develop a risk response.

**Risk Probability and Impact** – Risk probability and consequences are described in this task in qualitative terms like low, moderate, high, very high, etc.
• Risk probability is a number (say 0.25 or 25%) that represents the chance for a particular outcome to occur when the assumed condition allows it to occur. All risk has a probability of occurrence greater than 0 and less than 100 percent. Any risk event that has probability of zero cannot occur and needs not be considered as a risk. On the other hand, a risk event that has probability of 100 percent is not a risk. It has certainty of occurring and must be planned for in the project.

• Risk consequence or impact is the effect on project objectives if the risk event occurs.

Risk probability and risk consequence are two attributes of risk that are applied to specific risk events and not to the overall project. Analysis of risk probability and consequence helps identify those risks that should be managed aggressively.

Probabiliity/Impact Risk Rating Matrix – Risk matrices constructed using risk probability and its impact on the project, can help identify risks that require further analysis and attention. Both risk probability and impact can be assigned ordinal or cardinal scales.

<table>
<thead>
<tr>
<th>Ordinal scale:</th>
<th>Very Low</th>
<th>Low</th>
<th>Moderate</th>
<th>High</th>
<th>Very High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardinal scale:</td>
<td>.05</td>
<td>.10</td>
<td>.20</td>
<td>.40</td>
<td>.80</td>
</tr>
</tbody>
</table>

(Usually non-linear)

Figure 2.7 shows an example of how to evaluate risk impacts by project objective. You can use descriptive impacts (ordinal: very low, low, etc.) or a numeric scale (cardinal: .05, .1 etc.) to assess risk impact. Numeric values make it convenient to combine probability and impact.
The probability-impact matrix illustrates the combined risk impact effect expressed as a risk score (P x I), as shown in Figure 2.8. Using a numerical, non-linear scale for risk and impact, the computed risk score can help separate high risk (red condition), moderate risk (yellow condition), and low risk (green condition) using either an ordinal or cardinal scale.
The risks that are high (shown in the RED based on risk score of 0.18 or higher) must be used to prepare risk response.

---

**Notes** on Probability Theory:
Probability is the likelihood of an event’s occurrence (expressed as a fraction or percentage).

*Mutually Exclusive* – A mutually exclusive event is one where the occurrence of one possibility eliminates the possibility of others (in rolling of dice, all events are mutually exclusive).

*Statistically Independent* – Two events are statistically independent when the occurrence of one event is independent of another (When two dice are rolled, probability of each showing 1, 2, 6 are statistically independent).

Addition Rule for mutually exclusive events A & B

\[
P(A \text{ or } B) = P(A) + P(B)
\]

In a roll of a single dice, the probability of 1, 2, 3, 4, 5, or 6 occurring is 1/6 each. The probability of occurrence of either 1 or 2 is 1/6 + 1/6. Likewise the probability of any of 1, 2, 3, 4, 5, or 6 occurring is 1/6 + 1/6 + 1/6 + 1/6 + 1/6 + 1/6 = 1

Multiplication Rule applies to statistically independent events

\[
P(A \text{ and } B) = P(A) \times P(B)
\]

If two dice are rolled at a time, the probability of getting two 6, is 1/6 x 1/6, or 1/36. Similarly, the probability of rolling 6 on a single dice *three times in a row* is 1/6 x 1/6 x 1/6, or 1/216. These events are statistically independent events.

**Examples:**
A project’s major supplier has a 95% reliability or 5% chance of being late. As an unacceptable situation, the project manager decides to split the order between two different vendors with the hope that one of them will deliver on time. Now the probability that vendor A will be late is .05 and that for vendor B is .05. The probability that both vendors will be late is: .05 x .05 = .0025.

---

**2.9 Practice & Learn:** The following risk impacts were assessed for the project to prepare course materials and conduct the Project Management class for Kellogg Community College in Battle Creek, Michigan. Determine the activities that would require a risk response.

<table>
<thead>
<tr>
<th>Task</th>
<th>Probability (P)</th>
<th>Impact (I)</th>
<th>PxI</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Failing to prepare handout</td>
<td>0.05</td>
<td>0.90</td>
<td>0.045</td>
</tr>
<tr>
<td>B. Failing to ship on time</td>
<td>0.30</td>
<td>0.90</td>
<td>0.27</td>
</tr>
<tr>
<td>C. Forgetting to reserve hotel</td>
<td>0.50</td>
<td>0.30</td>
<td>0.15</td>
</tr>
<tr>
<td>D. Not taking driving direction</td>
<td>0.30</td>
<td>0.10</td>
<td>0.03</td>
</tr>
<tr>
<td>E. Forgetting seminar references</td>
<td>0.20</td>
<td>0.90</td>
<td>0.18</td>
</tr>
<tr>
<td>F. Missing personal clothing</td>
<td>0.30</td>
<td>0.10</td>
<td>0.03</td>
</tr>
<tr>
<td>Etc.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2.10 Practice & Learn: Consider your own group project which you worked on (Practice & Learn: 2.1, 2.2, & 2.3) and determined the schedule & time of completion. Continue with the same project, discuss among your group and answer the following questions in details (For project report preparation next) as they relate to your project.

a. What procedure you would require to be followed for any CHANGE OF SCOPES for the project?
b. Identity methods you would need to follow for QUALITY ASSURANCE and to monitor that performance is on target.
c. What techniques would you recommend be used as a standard practice for QUALITY CONTROL (name a few)?
d. How would you fill the manpower need for the project and what kind of organization structure (REPORTING STRUCTURE) would you follow?
e. After you launch the project, what you undertake as TEAM BUILDING ACTIVITIES?
f. What is your plan for communication project information to all and how would you store and retrieve such information?
g. Show the anticipated expenditure for the project life and prepare a graph showing the PLANNED VALUE.
h. Identify two or more risks and describe how you plan to deal with them (RISK RESPONSE PLAN) should they occur.
i. What machinery or special equipment you will need your project and how do you plan to PROCURE them?
j. What do you need to take care of (return manpower, move equipment, announce to the organization, etc) when the project is completed (CLOSE PROJECT)

Project Assumptions and Testing – identified assumptions are tested against assumption stability and adverse consequences. Assumption stability indicates the assumption’s applicability over time. If there are alternative assumptions are applicable, they need to be reviewed for their impact on the project.

Data Precision Ranking – The use of low precision data, or if the risk is not well understood, may lead to qualitative risk analysis of little or no use to the

Quantitative Risk Analysis Tools

- **Interviewing** – interviewing project stakeholders to quantify risks.
- **Sensitivity Analysis** – examines impact of the uncertainty of project elements to the project objectives.
- **Decision Tree Analysis** – evaluates decisions under considerations and their implications.
- **Simulation** – a simulation model that evaluates uncertainties specified into their potential impact on objectives.
project manager. Data precision ranking is a technique used to evaluate the degree to which the data about risks are useful for risk management, & involves examining:

- Extent of understanding of the risk
- Data availability about the risk
- Quality of the data
- Reliability and integrity of the data

**Quantitative Risk Analysis**
Quantitative risk analysis follows qualitative risk analysis and analyzes numerically the numerical probability of each risk, its consequences on project objectives, and the extent of overall project risks. This process commonly uses Monte Carlos simulation and decision tree analysis techniques which are beyond the scope of this seminar.

*Interviewing* – interviewing project stakeholders to quantify risks.

*Sensitivity Analysis* – examines impact of the uncertainty of project elements to the project objectives.

*Decision Tree Analysis* – evaluates decisions under considerations and their implications.

*Simulation* – a simulation model that evaluates uncertainties specified into potential impacts on objectives.

**Risk Response Planning**
The main purpose of risk planning is to ensure that identified risks are properly addressed by developing options and determining actions for opportunities and reducing threats to project objectives.

*Avoidance* – A project plan should be changed to eliminate risks or to protect project objectives. Typical actions include adding resources, adopting more standard approach, or avoiding unfamiliar contractors.

*Transference* – Transferring the liability of risk to another party is most effective in dealing with financial risk exposure. It always involves risk paying risk premium like in use of insurance, performance bonds, warranties, and guaranties.

*Mitigation* – Changing risk conditions so that the probability of its occurrence is reduced. This may include introducing redundancies into the system to reduce

---

**Risk Response Planning Tools**

- *Avoidance* – changing the project plan to eliminate the risk or protect the project objectives from its impact.
- *Transference* – seeking to shift the consequence of risk to a third party.
- *Mitigation* – seeking to reduce the probability and consequence of an adverse risk event to an acceptable level.
- *Acceptance* – deciding not to change the project plan.
impacts from a failure of the original component.

Acceptance – If risks are accepted, the project team decides to apply a contingency plan to the risks. Risk triggers, such as missing intermediate milestones, should be defined and tracked. A fallback plan is normally developed if the risk has high impact, or if the selected strategy may not be fully effective.

Risk Monitoring and Control

During the final risk management planning step, you plan to keep track of identified risks by monitoring residual risks, identifying new risks, ensuring the execution of risk plans, and by evaluating their effectiveness in reducing risk.

Risk Response Audits – Risk audits are performed throughout the life cycle of the project to control risk. Risk auditors examine and document the effectiveness of risk responses in avoiding and mitigating risk occurrences.

Periodic Risk Reviews - Project risk should be an agenda item in all team meetings and project risk review should be done regularly. If there are changes in risk prioritization during the life cycle, it may require additional qualitative and quantitative analyses.

Earned Value Analysis - Earned value (discussed earlier) is used to monitor overall project performance with respect to a baseline plan. When project deviates significantly from its baseline, updated risk identification and analysis should be performed.

Technical performance Measurement - Evaluation of technical performance during the project and comparison with baseline performance be good source for risk identification. When technical performance deviates significantly, it may imply a risk to achieving project scope.

Additional Risk Response Planning – If a risk emerges that was not anticipated in the risk response plan, or if a risk impact is greater than expected, it may be necessary to perform additional response planning to control the risk.
2.5.6 Procurement Management

In procurement management planning, the project manager establishes procedures required to acquire goods and services to attain project scopes, from outside the performing organization. (Good or services are generally referred as *product*

**Procurement Planning**

To accomplish a project, goods and services produced for stakeholders require resources, tools, machineries, products, etc. In procurement planning you will decide which project needs can be best met by procuring products or services outside the project organization. It involves deciding whether to procure, how to procure, what to procure, how much to procure, and when to procure.

**Procurement Planning Techniques**

- **Make-or-Buy Analysis** – deciding whether to buy or do inside. Done during scope definition process.
- **Expert Judgments** – expert technical judgment to help decide outsourcing issues.
- **Contract Type Selection** – selecting the most suitable contact.
  - Fixed-price
  - Cost – reimbursable
  - Time & Material

When a project obtains products and services (project scope) from outside the performing organization, the processes in procurement management such as solicitation planning to contract closeout would be performed once for each product or service item. When a project does not obtain products or services from outside, these processes will not have to be performed.

*Make-or-Buy Analysis* – This analysis is usually done during the scope definition phase to determine whether a particular product can be cost effectively produced by the performing organization. Such analysis should include both direct and indirect costs of managing purchased products.

*Expert Judgments* – Procurement planning processes often require specialized knowledge from other departments, consultants, professional associations, or other experts.

*Contract Type Selection* – Different types of contracts may

---

<table>
<thead>
<tr>
<th>Procurement Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>How can you acquire goods and service from outside sources?</td>
</tr>
<tr>
<td>- Procurement Planning – determine what to procure</td>
</tr>
<tr>
<td>- Solicitation Planning – find product requirements and who can supply them</td>
</tr>
<tr>
<td>- Solicitation – obtaining quotations.</td>
</tr>
<tr>
<td>- Source Selection – Choosing from potential suppliers</td>
</tr>
<tr>
<td>- Contract Administration – managing relationship with the suppliers</td>
</tr>
<tr>
<td>- Contract Closeout – settling contracts at project completion</td>
</tr>
</tbody>
</table>
suit different products being purchased. The common forms of contracts are:

**Fixed-price or lump-sum contracts** – A total fixed price contracted may be used with well defined products. To the extent that the product is not well defined, both buyer and seller are at risk. A fixed price contract may also include incentives for meeting or exceeding selected project objectives like scheduled targets.

**Cost-reimbursable contract** – When payments are made to the seller for actual cost plus a fee, representing seller’s profit, it is called cost-reimbursable contract. The cost of the product includes direct cost (direct labor and materials for project) and the indirect cost (overhead cost, cost of management such as salaries of corporate executives). Often, indirect cost is a percentage of the direct cost. This type of contract may also include incentives for meeting or exceeding a project’s time scale.

**Time & Material** – This type of contract represents a combination of the above two. They are open ended in terms of cost, but may have fixed rates for various support personnel (i.e., hourly rates for a designer on the job).

### Solicitation Planning

The following materials should be prepared for solicitation purchase materials:

**Standard Forms** – Many corporations have standard forms and procurement documents to identify and describe products to be purchased.

**Expert Judgments** – expert technical judgment may be required to describe the product requirement.

### Solicitation Planning Tools

- *Standard Forms* – standard forms and contracts
- *Expert Judgments* – help identify outsourcing issues

### Solicitation Methods

- *Bidder Conferences* – meetings with prospective sellers before proposal preparation.
- *Advertising* – expanding existing list of potential sellers by advertising.

### Solicitation

Obtaining information from prospective suppliers on how product needs can be met require solicitation. Most of the actual effort in this process is expended by prospective sellers at no cost to the project.
**Bidder Conferences** – Also known as contractor conferences, vendor conferences, and pre-bid conferences are meetings with prospective sellers prior to proposal submission. They are a good way to ensure that all sellers have a common understanding of the procurement needs.

**Advertising** – A good way to expand the existing list of potential sellers is to place advertisements in business and trade magazines. Some government jurisdictions require public advertising of certain types of procurement items.

**Request for Proposal (RFP) – Guidelines for Open Bid Solicitation**

Following is a format suggested by an experienced government supplier:

1. **Scope of Work and Contact information**
   a. This can be bulleted rather than description
   b. Short descriptive paragraph is alright when necessary

2. **Response Requirements**
   a. Describe what specific items you wish the vendor to propose
   b. Indicate if you will accept any additional items or offer vendor may wish to make
   c. Provide forms vendors must complete, sign & submit.
   d. Indicate other materials vendors must read/be aware of and testify to that.
      Enclose signature required forms here.
   e. Describe clearly how you want vendors to propose cost proposal. For comparative purposes, you would benefit by specifying the cost proposal format:
      1. Cost on daily rate, hourly rate etc.
      2. Cost on the basis of total job
      3. Itemized travel cost separately
      4. Itemize material cost
      5. One single cost for all

3. **Policies and Procedures**
   a. Enclose policies and agreement that you want vendors to read and agree, but need not make part of the response.
   b. To ensure that vendor agree to or have read such documents, enclose a form for vendors to sign and return with the proposal.
IV. Submission Requirements
   a. Tell here how you wish to receive the proposals (Original and hard copies, Electronic only, hard copy with electronic version in CD)
   b. Indicate your preference if any (GO GREEN) to reduce papers.
   c. If you must have PAPER copy, reduce size by separating to minimum necessary information from those for instructions only.
   d. If you need multiple copies, indicate whether you wish to have copies of signed FORMS or not.

V. Bid Review & Evaluation
   a. Tell potential suppliers how you wish to evaluate the bid
   b. What you wish to do with the bid materials not selected
   c. Indicate how you will report/post results of evaluation
   d. Indicate TIME of selection

VI. Special Items or Instruction
   a. Indicate here if you have any special areas or items vendor need to address.

Source Selection
Source selection follows the receipt of bids (proposals) from solicitation. An evaluation criterion issued to select a provider, and includes factors aside from cost or price because:

- the lowest price may not be the lowest cost if the seller is unable to deliver on time
- proposals may be separated into technical and commercial categories for evaluation
- multiple sources may be required for critical paths
- single source may be preferred for a single standard contract
- rank ordering of all contracts may be required for negotiating sequence

Source Selection Methods
- **Contract Negotiation** - clarifying mutual agreement before signing.
- **Weighting Systems** - quantifying qualitative data for overall evaluation.
- **Screening System** – based on minimum requirements.
- **Independent Estimates** - verifying cost.

Contract Negotiation – Before signing a contract, mutual agreement on the contract structure and requirements of the contract (include responsibilities and authorities, applicable terms and law, technical and business management approaches, contract financing, and price.) must be clarified.
**Weighting Systems** - Quantifying qualitative data helps minimize the effect of personal prejudices on source selection. The steps for weighting scheme are as follows:

- Assign a numerical weight to each evaluation criteria (say 1 – 5)
- Rate the prospective seller on each criterion (say in a scale of 0 – 10)
- Multiply weight by the rating for each criterion (R x W, weighted ratings)
- Add all weighted rating to compute an overall rating for the seller.

**Screening System** – Here you check to see if a seller meets minimum requirement of performance for one or more of the evaluation criteria. For example, at a construction project to rebuild Iraqi power plant, fluency in Arabic is a needed criterion for field engineers to be hired for the project.

**Independent Estimates** - The procuring organization may prepare its own independent estimates as a check on the proposed price. If a significant difference in estimates appear, it may be an indication that the statement of work (SOW) was not adequate, or that the prospective seller failed to understand or respond to the fully to the SOW.

**Method of Weighted Evaluations**
A single index (number) for evaluating multiple criteria is simpler, and hence, more attractive. A common example is Grade Point Average in academic performance where course scores are generally weighted equally.

\[
GPA = \frac{(\text{grade 1} + \text{grade 2} + \text{grade 3} \ldots \ldots)}{n}
\]

A weighted evaluation for Contract, Vendor, Performance, Items of Study, etc. is shown in the example below.

**Example: Evaluation of Pound Cake**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Range of Evaluation</th>
<th>Weighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taste (T)</td>
<td>0 – 8</td>
<td>55%</td>
</tr>
<tr>
<td>Moistness (M)</td>
<td>0 – 5</td>
<td>33%</td>
</tr>
<tr>
<td>Smoothness (S)</td>
<td>0 – 4</td>
<td>12%</td>
</tr>
</tbody>
</table>

\[
OEC = T \times 55 + M \times 33 + S \times 12
\]

Such evaluation offers a scheme to objectively compare multiple subjects with a group consensus. The weighting above is determined subjectively by the group.

**Contract Administration**
Contract administration is the process used to ensure that the seller’s performance meets the contractual requirements. On projects with multiple service providers, a key role played by contract administration is to manage the interfaces among various providers.
Contract Change Control System – This system defines the process by which a contract may be changed, & includes paperwork, tracking system, dispute resolution procedures, and approval levels necessary for authorizing changes. Contract change control system should be integrated with project change control.

Performance Reporting – Seller performance report provides management with information on how effectively the seller is achieving the contractual objectives, & should be integrated with project performance reporting plan.

Payment System – Payment system defines the procedure for approval and payment to a seller. In most organization, payments are made by the accounts payable department. On larger projects with many or complex procurement requirements, the project may develop its own payment system.

Contract Closeout
Seller closeout is similar to administrative closure described under the communication planning section. It involves both product verification (was all work completed correctly and satisfactorily?) and administrative closeout (updating the records to reflect final results and archiving of such information for future reference). The contract terms may specify closeout procedures. Early termination is a special case of contract closeout.

Procurement Audits – A procurement audit is a formal review of the procurement process spanning procurement planning to contract administration. The purpose of this audit is to identify successes and failures that can be passed on to other procurement items within this or other project.
2.5.7 Project Closeout

In addition to planning for your project’s execution, you must also think about how you will bring the project to an end. It is a good idea to prepare a project-closure checklist of all activities that you and your team must complete before the project can be closed.

<table>
<thead>
<tr>
<th>Project Termination Checklist</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Deliverables – products and services produced</td>
</tr>
<tr>
<td>- Acceptance Tests – performed and test results documented</td>
</tr>
<tr>
<td>- Required Approval - to be secured</td>
</tr>
<tr>
<td>- Final Reports – to be written and distributed</td>
</tr>
<tr>
<td>- Resources – to be re-assigned</td>
</tr>
<tr>
<td>- Administrative Tasks – that need to be taken care of.</td>
</tr>
<tr>
<td>- Announcement – find a novel way to announce the project closure</td>
</tr>
</tbody>
</table>
2.6 Develop a Formal and Comprehensive Project Plan
When all planning tasks discussed in this module are completed, you should prepare a formal and comprehensive project plan that is more detailed than the one prepared during the project initiation phase. The project will document all project deliverables, acceptance criteria, processes, procedures, risks, and tasks that will be executed, controlled completed in subsequent processes.

<table>
<thead>
<tr>
<th>Project Plan Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Items that make up the project plan:</td>
</tr>
<tr>
<td>• <strong>Problem statement, mission statement, and objectives</strong></td>
</tr>
<tr>
<td>• <strong>Project work requirements</strong> - including list of all deliverables (reports, hardware, software, etc)</td>
</tr>
<tr>
<td>• <strong>Acceptance/exit criteria</strong> - milestone with associated completion criteria</td>
</tr>
<tr>
<td>• <strong>End-item specifications</strong> – including engineering specifications, architectural specs, building codes, governmental regulations, etc.</td>
</tr>
<tr>
<td>• <strong>Processes</strong> - WBS, identification of all tasks that must be performed in order to achieve the project objectives</td>
</tr>
<tr>
<td>• <strong>Schedules</strong> – include both milestones and working schedules</td>
</tr>
<tr>
<td>• <strong>Required resources</strong> - people, equipment, materials, and facilities, &amp; project costs</td>
</tr>
<tr>
<td>• <strong>Control systems</strong> - project status and performance evaluation methods, earned value analysis, etc.</td>
</tr>
<tr>
<td>• <strong>Major contributors</strong> - use WBS and linear responsibility charts to identify major tasks and responsibilities.</td>
</tr>
<tr>
<td>• <strong>Risks</strong> - Identify risks with contingencies</td>
</tr>
<tr>
<td>• <strong>Close out</strong> - items that must be done at the close of the project</td>
</tr>
</tbody>
</table>
2.7 **Obtain Project Plan Approval**
Once the project plan is completed, you should review the plan with stakeholders & clients to confirm that the project baseline meets their requirements and secure their approval. You must have the project plan approved before proceeding with the project execution process.

<table>
<thead>
<tr>
<th>Obtain Project Plan Approval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Once the plan has been prepared, it should be reviewed with the stakeholders for their approval.</td>
</tr>
<tr>
<td>• Schedule a Project Plan Review Meeting</td>
</tr>
<tr>
<td>• Review plan</td>
</tr>
<tr>
<td>• Confirm project baseline</td>
</tr>
<tr>
<td>• Sign-off of the plan</td>
</tr>
</tbody>
</table>

The project plan should be signed and approved in a project plan review meeting, not by mail.

Approval and signature on the part of the client or stakeholder means that the individual is committed to his/her contribution, agrees with the scope of work to be done and accepts the scopes of the project. On the other hand, a signature on the part of a contributor (project manager/team) does not mean a guarantee of performance. It simply means that the contributor is committed to the task and promises to do his/her best to fulfill the obligation.

*Project Plan Change*: Any need for project plan changes arising upon its review with the stakeholders, must be done in an orderly manner following the procedures established in the change control plan.

“Any plan is bad which is not susceptible to change.”
- Bartolommono de San Concodio (1475 – 1517)

2.11 **Practice & Learn**: Solve all exercises except Q2.1 and Q2.6.

2.12 **Practice & Learn**: For your own group project, (i) Prepare a report (8 – 12 pages), (ii) make copies for all participants in the class, and (iii) be prepared to present your project to the class.
**Key Concepts Review - Module 2**

**R2.1 Team Development** - Team development includes both enhancing the ability of stakeholders to contribute as individuals as well as enhancing the ability of the team to function as a team. While it is the project manager who should initiate team building activities, team members can be highly constructive by playing roles as encourager, initiator, and gatekeeper (rather than information giver, devil’s advocate, withdrawer, harmonizer, blocker, summarizer, recognition seeker, information seeker, etc.).

**R2.2 Critical Path** - Critical path (CP) activities have fixed start and finish dates. If duration of any of the activities in CP changes, the total duration of the project will also change.

**R2.3 Risk Quantification** - In this method, project risk is numerically quantified by evaluating the probability and impacts.

**R2.4 Project Deliverables** - Deliverables are item that the project will produce to satisfy the stakeholders’ requirements. The precise description of the deliverables is called a **specification**.

**R2.5 Risk Identification** - Risks often repeat themselves from one project to another. To identify potential risks or opportunities a project manager should review **lessons learned from other similar projects**.

**R2.6 Criticality Index** - The Monte Carlo technique is a refinement of PERT. In the PERT analysis, the range of values and the probability of their occurrences are calculated for the project completion date or other specific date within the project. The Monte Carlo technique allows a shift in the critical path in the duration of activities. The criticality index is the percentage of time a particular activity is on the critical path.

**R2.7 Management Reserve** - The management reserve is the time and money used to offset the effect of unknown risks affecting cost and schedule. Usually, these risks are not specifically identified.
Exercises

Q 2.1 A contractor working for the local county road commission submitted the schedule shown in Figure Q2.1 for repairing a highway bridge. Considering the urgency of the job, the contractor agreed to work on a single shift basis continuously for all seven days each week until the job is done. The project was to start on June 1.

![Figure Q2.1 Precedence Diagram Bridge Repair Project](image)

Complete the above diagram with early start (ES), early finish (EF), late start (LS), and late finish (LF) dates for the activities A, B, C,….. and G shown (Fig. Q2.1). From your schedule above, answer the following questions.

(a) Which activities have floats, and for how many days?

(b) What is a free float?

(c) What is the free float for activity F?

(d) What is the free float for activity D?

(e) What day in June will activity D have for its early finish date?
(f) What is critical path and what is the critical path for the project?

(g) How many days will it take for the project to finish as scheduled?

(h) What is the late start date for activity F?

(i) What is the early start date for activity C?

(j) If for some reason activity C starts 5 days late, what will be the effect on the project’s completion date?

(k) What is the early finish date of Activity A?

Q2.2 What does “crashing the schedule” mean?

a. Running project team on overtime
b. Redoing the entire schedule on a of shorter duration
c. Performing activities that were in sequence in parallel
d. Turning over project responsibilities to a new project manager

Q2.3 The original schedule for a project (sub-project, work package, or activity), plus or minus approved changes, is known as:

a. Performance schedule
b. Working schedule
c. Nominal schedule
d. Baseline schedule

Q2.4 What does resource leveling generally mean?

a. Reduce resources to the lowest skill level
b. Reduce the over-utilization of available resources
c. Prolong the time needed to complete the project
d. Cut down the cost of more expensive work packages

Q2.5 Which of the following is considered to be a simulation technique?

a. PERT analysis
b. GERT analysis
c. Monte Carlo analysis
d. Critical path method
Q2.6 In a project to install television cable lines in the city, the installation crews encountered a lot of uncertainty as to how long each task would take. The project manager had decided to use the PERT technique to evaluate the project’s completion date. The project was broken down into seven major activities (A, B, C etc.). The precedence diagram of the activity and their estimates of most likely duration are shown in Figure Q2.6. Along with the most likely duration for each activity, the project team also estimated the pessimistic and optimistic values, as shown in Table Q2.6.

Assuming that the project starts on the first Monday of next month, complete the precedence diagram by showing early and late start and finish dates. Also, identify the critical path activities, calculate the pert statistics, and answer the following questions.
Q2.7 Using the PERT method of scheduling, a project manager determined that the project would take 90 days to complete with the available resources. The variance for the project, based on all activities in the critical path, was found to be 9 days. Determine the range of values of completion duration (days) for 95% probability of success (at least 95% probability that the project will be completed between the high and the low values).

Q2.8 Which of the following use the decomposition process for its construction.

   a. Critical Path Method Diagram
   b. Variance analysis
   c. PERT technique
   d. Work Breakdown Structure

Q2.9 A project is interrupted by a sudden loss of its contracted workforce. A new project team is formed to replace the old team of contracted support. As project manager, what is the first topic to discuss in the kick-off meeting?

   a. Review detailed schedule

---

**Table Q2.6 PERT Data (Cable Installation Project)**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Description</th>
<th>Likely</th>
<th>Pes.</th>
<th>Opt.</th>
<th>EV</th>
<th>SD</th>
<th>Var</th>
<th>EV</th>
<th>Var</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>6 wks</td>
<td>8</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B.</td>
<td>5</td>
<td>6</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C.</td>
<td>12</td>
<td>15</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D.</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E.</td>
<td>6</td>
<td>7</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F.</td>
<td>8</td>
<td>11</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G.</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(Critical Path) Total =

SD = (Var)⁻¹/² =

*Notations: EV = Expected Value, SD = Standard Deviation, Var = Variance*
b. Go over the budget  
c. Identify team roles and responsibilities  
d. Explain the reporting order

Q2.10 Which of the following actions will influence the duration of project completion?

a. The critical path is reduced by elimination of one activity  
b. Project resources are reduced  
c. Contingency is no longer available  
d. Available float time in one activity is reduced

Q2.11 The project you were managing suffered delays due to conflict among team members, but you just resolved the conflict. What should you consider doing to bring the project back on schedule?

a. Perform resource leveling  
b. Crashing the schedule  
c. Put more people on the project  
d. Adjust project scopes

Q 2.12 What is a statement of work and project plan?
Module 3
Project Execution
Module - 3

Project Execution

Starting off your project in the correct manner is the key to your project’s ultimate success. The project plan you prepared and received approval for, describe what you propose to accomplish, the work you will do, how you will do it, when it will be done, and the resources you will need to complete it. To prepare the plan, you relied on information that was available to you, and where there was no information, you made assumptions. Now that the project planning is complete, it is time to check and see if your information and assumptions are still valid. The longer the time between your plan preparation and approval, the more likely it is that these have changed. Before starting the project, you will need to reconfirm and update the information you used in preparing the plan. (Ref. 1, 2 & 4)

Announcing Your Project

By the time you complete your project planning, most of your project audiences (team members, drivers, and drivers) are all aware that the project has been approved and that the project execution is to begin. Still, it is a good idea to formally announce the start of the project and kick off the new effort. The following methods may be used:

- An announcement in your organization’s newsletter
- A flyer prominently displayed in company bulletin boards
- A formal kickoff meeting, particularly if your project is large and you desire to have a broader impact on the organization
- An e-mail message to select individual and department heads

Tasks Performed (5 Tasks)

3.1 Commit Project Resources

You start the project execution by securing and committing resources based on your plan. Appropriate resources assure that all activities will be performed as intended. Here are a few things to do:

Finalize Project Participants – In your project plan, you described anticipated roles and the amount of effort each team member will have to invest. You also identified team members by name, title or position, or by the skills or knowledge
they would need. As you begin your project, confirm the identities of the people who will work to support your project, either by verifying that the specific people included are still able to uphold their promised commitments or by recruiting new people to fill needs.

**Contact Team Members** – Inform team members that the project has been approved, inform them of start date, & reserve the necessary time in their schedules to provide the support they promised.

**Confirm Support** - If there is a long delay between the planning and approval process, the team members’ commitment and workload change. Confirm with each team member that their availability is still valid. If someone is no longer able to provide the planned support, recruit replacements as soon as possible.

**Reconfirm Work Details** – Reconfirm the type of work team members will do and how long it is estimated to take. Clarify with them the nature of their activities and when these activities will be performed. Depending on the size of the project and the appropriate communication mode, this may be done by a quick e-mail or a formal work-order agreement.

**Explain Team Development Plan** – Forming a well function project team is important to your project. You need to share your plan for developing the project team. Tell everyone who will be actively involved in the project team members and who else will be on the team. Tell all what you will do to kick off the project and when you wish to introduce the team members to one another.

A **work-order agreement** is often used to formally confirm the project team’s commitment. It is typically a written document with description of work a person agrees to perform on the project, the dates the person agrees to start and finish, and the number of hours the person agrees to spend on it. Such agreement should be between among you (the project manager), the person involved, and the person’s supervisor. A typical work-order agreement, as shown in Figure 3.1, should have the following minimum information.

**Identifiers:** Include the project name, project number, activity name, and work Breakdown Structure code. The project name and number signify that the project is approved and official. The activity and Work Breakdown Structure number is used to record work progress and accounting information (time and resource).
Work to be performed describes activities involved in the activity and its output.

**Figure 3.1 A Typical work-Order Agreement**

<table>
<thead>
<tr>
<th>Work-Order Agreement</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project Name:</strong></td>
</tr>
<tr>
<td><strong>Activity name:</strong></td>
</tr>
<tr>
<td><strong>Description of work to be done:</strong></td>
</tr>
<tr>
<td><strong>Start date:</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Approval</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project manager:</strong></td>
</tr>
<tr>
<td>Name</td>
</tr>
</tbody>
</table>

Activity Time and Duration contains the start date, end date, and number of hours to be spent on activity. These dates and hours reaffirm:

- The importance of the work on schedule and within the specified time period
- The person’s commitment that the work can be done within these time and resource constraints
- The criteria you will use to assess the person’s performance

Approval signature is the written approval from person doing the work. It is evidence that individual member’s supervisor and the project manager have read and understood the elements of the agreement and commit to support it.

Others in the project are people who will play some role in the success of your project. Such people will generally not charge their time to project and be of the types described below.

Special Audience is your project champion, someone in a high position in the organization and who strongly supports your project. This individual will advocate for your project in disputes, planning meetings, and review sessions; and will take whatever actions necessary to help ensure its successful completion.
Drivers of the project are stakeholders who have some say in defining the results that your project is to achieve.

Supporters of the projects are people who help you perform your project. These are people who either authorize resources or work on your team.

Before start of the execution of the project, contact your project champion, drivers, and supporters who are identified by name in the plan to:

- Inform them about the project’s approval and planned start date
- Reconfirm the project’s objectives
- Reassure the drivers that the project’s planned outcome addresses their needs
- Indicate to the identified supporters exactly the kind of help you need
- Share your specific plans to involve the audiences throughout the project and how you will keep them informed

Team Members Roles and Responsibilities
Typically, your project team will include people from different parts of the organization with different skill levels and operating styles; you may not have worked with all in the team before. Your project goal will be to finish the project in a given time with team members who may not all be 100% dedicated to your project due to other commitments. To assure project success, you will need to quickly establish how you will work with your team and they will work with each other. The following concepts help define and clarify how team members relate to each other.

Authority defines the ability of one to make a binding decision about project schedule and cost. i.e., the ability to sign purchase order not to exceed $2,500, ability to alter schedule date by no more than a week.

Responsibility is a commitment from a member to achieve specific results. i.e., the promise to complete and submit a report by end of the week.

Accountability brings to focus the consequence of people’s performance. It has both positive as well as negative sides. i.e., the boss mentioning your effort to implement a new marketing idea is a positive use of the concept. On the other hand, the boss bringing up your missing an important schedule appointment is an example of negative use of the concept.

Note: Authority and accountability are similar in that they are upfront agreements. But, they are different in that authority focuses on process, while responsibility focuses on outcome.
Both responsibility and accountability focus on results and are similar in this respect. But, they are different in that responsibility is a before-the-fact agreement, and accountability is an after-the-fact process.

Generally, if one is responsible, he/she will be held accountable. If one is not responsible, he/she should not be held accountable.

3.2 Implement the Project Plan
In this early stage of the execution, you will review the project plan and authorize execution of all tasks that produce project deliverables.

Reviewing Project Plan
During project plan preparation, team members have direct input. While reviewing the plan you should ask these members to keep in mind project’s background, purpose, their individual roles, and the work that need to be done. They may also be a good source of information with regard to any changes in circumstances since the plan was prepared and take a second look at the risks identified.

If team members are new to the project, you can encourage them to learn about the project’s background and purpose; learn about their planned roles and assignments. They also might voice concerns about how they will meet the established timeframes, budgets, etc.

Developing Team
As project manager one of your most important roles will be to become a cheerleader for your staff and constantly strive to develop members into a team. A team is just not a group or committee. A team is a collection of people who are committed to common goals and who depend on one another to do their jobs.

A group comprises people who are assigned to a common task and work individually to complete their individual assignments.

A committee is a group of people formed together to review and critique issues, propose changes, etc. and occasionally are responsible for bringing about the recommended changes.
A team requires commitment from each member to reach a common goal; mutually dependent work, and unique contribution from each member. For a team to work well, each member of the team needs to be fully aware of project goals, their own role, the operating process for the team to perform their tasks, and relationships they will maintain with other team members.

Develop team and individual goals – Project team members are more likely to commit to the project if they knew how their work can help the project and how it can help achieve some of their personal goals. As a project manager, you can help your team members develop a shared sense of these goals and help them achieve it.

Develop team and individual goal -
- Discuss the purpose of the project, who is supporting the project, how it will benefit the client, and the impact it will have on the organization
- Explain and emphasize how the results of the project may enhance the organization's growth and stability
- Point out how the success of the project may influence each team member’s job
- Encourage team members to consider how their participation can fulfill personal goals like meeting new people, increased visibility, promotional opportunities, etc.

Be aware of diversity of workforce – Your team members may be composed of different ethnic and cultural background. They may also be located in different countries or different parts of the world. As a project manager, you need to orient your team to such realities and do everything possible to foster an effective and respectful working environment. [Diversity in workplace: gender, racial, cultural, etc.]

Define team member roles – For a team to work well, their individual roles & relationships must be defined. The team will need guidance in defining who will do what portion of the job, who will see that work is progressing as scheduled, who will decide when the job is done, and who will report about the status. If the roles are not clearly defined, even the most qualified team members could be frustrated and disillusioned.
Typical Team Member Roles Include:

- **Primary responsibility**: Person with responsibility to ensure that the job is completed
- **Secondary or supporting responsibility**: Team member with an obligation to complete a part of an activity
- **Approval**: An individual with the responsibility to approve the results of an activity
- **Available for consultation**: A member who can be called upon to provide expert help and actual work support as needed
- **Must receive output**: An individual who either reviews the activities output or reports the results of an activity.

**Defining operating processes** are standard procedures that support day-to-day work. The following are the minimum areas that should be established:

- **Reporting and communication**: The project related information can be shared within the team members in many different forms, like: face-to-face communication, written reports, electronic mail, etc. These procedures might address when e-mail can be issued to share project information, what type of information should be written, when and how to document informal discussions, how report project status, and how to address special issues that arise.
- **Conflict resolution**: Difference in opinion regarding project work is likely to arise among project team members. You will need to establish standard approaches to resolve differences, and also encourage people to develop mutually agreeable solutions. You may also need to establish escalation procedures to resolve issues that cannot be resolved by the parties involved.
- **Decision making**: Establish the procedure for making decisions when faced with alternative options. (Consensus, majority rule, unanimous agreement, decision by technical expert, etc.)
Support team member relationships – As soon as the project starts, you need to begin to help team members get to know each other. Your goal will be to build a high performance team where team members trust each other and have cordial relationships. Building trust and developing effective work practices takes time and concerted effort. Below are some suggested practices.

**Work through conflicts together:** Participate in conflict resolution and try to find a win-win situation among the parties involved.

**Involve teams in challenging problems:** Involve team to brainstorm and solve problems of technical and administrative nature.

**Arrange and take time for informal meetings:** Sponsor informal meetings and group activities (picnic, golfing, lunch, other sport events, etc)

Facilitate sooth team functioning – As team members begin to perform their individual tasks, you should work to help them professionally develop and conform to standard modes of team functions. Key areas for developing understanding are:

**Forming:** Meet individually with team members to discuss the project plan and work assignments. In a meeting with your team, discuss their background and introduce members to each other.

**Storming:** Discuss and resolve any personal conflicts about the project or other team members. Encourage team members to share reservations they may have about working with other team members and about other team members’ abilities to complete their assigned tasks. While doing so, keep the focus of discussions on project performance rather than unproductive personal attacks.

**Norming:** Form and help team members set up their operating standards in regards to meeting discussions (polite, aggressive), format (how long), attendance (on time), and participation (active, passive).

**Performing:** Let members do the work. Share with them the project’s progress and evaluate project performance with regard to established project schedules.
### 3.3 Manage Project Progress

As the work progresses, you should check to see that all activities are being carried out as planned and that the work being done will help achieve project objectives. To know the progress of your project at all times, you will need to set up tracking systems for the following areas.

<table>
<thead>
<tr>
<th>Tracking Systems –</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Schedule</strong>: Evaluates work progress and checks to see how well you are meeting established dates.</td>
</tr>
<tr>
<td><strong>Personnel Resource Usage</strong>: Indicates the level of effort people are spending on each assignment.</td>
</tr>
<tr>
<td><strong>Financial Expenditure</strong>: Tracks cash expenditures made for project resources.</td>
</tr>
</tbody>
</table>

If you are part of a large organization with existing system that track project schedules, you will need to register, obtain official project code numbers, and set up charge codes for labor and financial systems.

#### Project Tracking System Set Up

As the project begins, you will need to establish performance tracking systems for the following areas.

- **Meeting Schedule** – Monitors how well you are meeting established completion dates.
- **Personnel Resource Usage** – Tracks the amount of time that people are spending on their assignments. Sets up charge codes for labor tracking systems.
- **Financial Expenditures** – Tracks other cash expenditures made for project resources such as travel, tools, equipment, etc. Sets up charge codes for financial systems.

### 3.4 Communicate Project Progress

Stakeholders are dependent upon you to keep them apprised of the project progress. You can do so on a regular basis by preparing project reports showing the project’s progress & status. Timely and accurate status information is essential to helping stakeholders make decisions.

#### Establishing Schedules for Reports and Meetings

Early, at the start of the project, you will meet with the appropriate project audiences and team members to develop a schedule for regular project meetings and progress reports. You will need to determine and confirm the following items:
• What meetings will be held, when and for what
• What kind of reports will be produced and when such reports be issued
• Who will attend such meetings and who will receive the reports
• What will be the format and content of the meeting

Preparing Your Project Teams for Post-Project Evaluation
At end of the project, you should have a post-project review to evaluate the experiences gained, recognize team members for their contributions, and document and take corrective actions of any problems that occurred. You will benefit from laying the ground work for the post-project evaluation session soon after the start of your project.

- Make all team members aware that there will be a post-project evaluation at the project’s completion
- Request that team members keep records of problems, ideas, and suggestions throughout the project & clarify the criteria you will use to assess the project success
- If the purpose of the project is to improve a condition (quality, delivery, marketing effort, etc.), establish a way to measure this accomplishment quantitatively so that progress can be tracked
- Encourage all team members to maintain a project log and keep a log yourself. The project log should contain narrative record of project issues and occurrence.

3.5 Implement Quality Assurance Procedures
To ensure that project objectives are met, you should perform the project control activities that you planned as part of your quality assurance tasks.

Implement Quality Assurance Procedures

**Review Plan:** Appraise the project team with the quality management plan

**Identify Activities:** Identify activities responsible for meeting desired quality levels & discuss quality control techniques to be employed

**Identify Responsibilities:** Identify who will determine when each quality level is met and who will sign off on the quality achievement reports.
Key Concepts Review 3

**R3.1 Purchase Commitment** - As a project manager, when you issue a purchase order for a piece of equipment, it represents a *commitment* on your part.

**R3.2 Forecast Project** - CPI (Cost Performance Index) is a measure used to forecast the project’s cost at completion.

**R3.3 Risk Assessment** - The process of determining how delays and other risks will affect the project schedule is called *risk assessment*.

**R3.4 Change Control** - Suppose you assume responsibility of a project in the middle of the execution phase and need to know who has approval authority for revisions in scope, you can consult the *Change control plan* document.

**R3.5 Conflict Avoidance** - Among the many possible conflict resolution options, avoidance is the most undesirable as it will have the least enduring positive results.

**R3.6 Conflict Resolution** - The most effective conflict resolution practices are: smoothing, confronting, forcing, and withdrawing.

**R3.7 Problem Solving to Resolving Conflicts** - Although, compromise, withdrawals, smoothing, and problem solving are used to resolve conflicts, problem solving has most lasting effect. In problem solving more additional facts are gathered until it becomes clear that there is one solution to the problem is found.

**R3.8 Strong Matrix** - When your project is large, complex and involves cross-disciplinary efforts, it is most effectively managed by a *strong matrix organization*.

**R3.9 Stakeholder Management** - An effective stakeholder management plan includes a clear *scope definition*, *scope change control*, and *timely status information*. 
Exercises

Q 3.1 The project manager of a large project is interested in improving team morale and saving cost. He is also particular about informing other project managers about releasing individuals in his team so that they may be assigned to other projects. Which document would be best to address this concern?

a. Project schedule  
b. Staffing plan  
c. Work breakdown structure  
d. Project charter

Q 3.2 Which of the following practice makes one a good listener?

a. Helps the speaker finish his/her sentences  
b. Agrees with the speaker  
c. Is able to repeat some of the things speaker said  
d. Concentrates on taking notes

Q 3.3 A project has a large number of people who needs to work together. To assure that his team will perform as a team, which of the following should the project manager prefer?

a. Matrix management  
b. Staffing plan  
c. Work breakdown structure  
d. Co-location

Q 3.4 A project manager is involved with a project involving manufacture of electronic circuits. An area that is of recent concern is the soldering process which is suspected to be influenced by a number of variables. Attempts to fix the problem by adjusted one or more factors have failed. What technique or method should the project manager employ?

a. Design of experiments  
b. Critical path method  
c. System integration  
d. Output processing
Module 4

Project Monitoring and Controlling
Module - 4

Project Control

The project plan that you laid out and are executing represents a vision of what you believe should work. Unfortunately, a project will not implement itself automatically. Successful projects require continued care and management to ensure that your plans are implemented and produce the expected results. Also, if unexpected events occur, you will want to be in a position to promptly react and keep the project on track. Project control ensures that your project proceeds according to its plan and produces desired results. Project control activities are performed throughout the life of a project.

### Project Control Tasks

<table>
<thead>
<tr>
<th>Tasks Performed (8 Tasks)</th>
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<tbody>
<tr>
<td>1. Measure Project Performance</td>
</tr>
<tr>
<td>2. Refine Control Limits on Performance</td>
</tr>
<tr>
<td>3. Take Timely Corrective Action</td>
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<tr>
<td>4. Evaluate the Effectiveness of the Corrective Actions</td>
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<tr>
<td>5. Ensure Compliance with Change Management</td>
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<tr>
<td>6. Reassess Project Control Plan</td>
</tr>
<tr>
<td>7. Respond to Risk Event Triggers</td>
</tr>
<tr>
<td>8. Inspect Project Activities Periodically</td>
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</tbody>
</table>

#### 4.1 Measure Project Performance

To manage your project, you will need to know exactly where it is, at all times. To determine how far your project has progressed, you will want to measure performance and compare it to the baseline. This allows you to establish the project performance trend and determine how close or how far off it is from your projected path (Variances).

#### 4.2 Refine Control Limits on Performance

As the project work begins, you may find that certain areas require more control than others based on importance to your stakeholders and the organization. In fact, you may have to refine the control limits on certain performance measures by applying established policies that would identify the need for corrective actions.

#### 4.3 Take Timely Corrective Action

When performance trends indicate deviation from the plan, you will take corrective actions on time. To do so, you will investigate and fix the root causes of the problem such that it either eliminates the problem or minimizes adverse impacts.

#### 4.4 Evaluate the Effectiveness of the Corrective Actions

Once a corrective action is in place, you will evaluate (measure) its subsequent performance to learn whether the corrective action has fixed the problem, or if further actions are needed.
4.5 Ensure Compliance with Change Management
When changes to the project are brought by either requirement change defined by stakeholders, or from corrective actions, be sure to verify that these changes comply with your change management plan. You should also monitor the response to change initiative and its impact on your scopes.

4.6 Reassess Project Control Plan
Longer project have a large time gap between planning and execution, and will thus require you to periodically review and reassess your project plan to make sure that it is effective and that all plan items are currently valid.

4.7 Respond to Risk Event Triggers
The risk management part of the plan should have laid out triggers for risk items. This step requires that you respond to risk event triggers as per the plan so that you can manage the project outcome properly.

4.8 Inspect Project Activities Periodically
Periodic inspections to verify that authorized approaches and procedures are being followed, and identify the need for corrective actions.

Other Control Events
- Team Member Self Evaluation
- Project Control Characteristics
- Taking Corrective Action
- Response Timeliness
- Project Review Meetings
- Project Evaluation
- Project Process Review
- Process Review Report

Project Control Using Earned Value Analysis
- Measuring Progress
- Measuring Performance and Quality
- Earned Value Analysis
- Variance Analysis
- Variance Response
Project control is an important phase in the Project Life Cycle Process (shown at right) which includes:

**Initiating Process:** Recognizing that a project phase should begin and committing to do so.

**Planning Process:** Creating and maintaining a workable scheme to satisfy the business needs for which the project was undertaken. It also includes scheduling activities.

**Executing Process:** Carrying out the plan.

**Controlling Process:** Ensuring that the project objectives are achieved by monitoring, evaluating and measuring progress and taking corrective actions when necessary.

**Closing Process:** Formalizing acceptance of the project in order to bring it to an orderly end.

Note that the arrow from Initiating to Planning and planning to Executing goes in one direction. Where as the arrows from executing to controlling go in both directions. This is because, during the Controlling process, you may need to adjust part of your production and go back to execution. Often, you may need to re-plan (shown by arrow from controlling to planning) and then re-execute. Of course, if you re-plan, you must execute first before controlling.

There are some observed facts about the project life cycle processes. It is always much less expensive to plan well and resolve all problems during planning and scheduling processes. The cost to solve the same problem generally is 10 times during the execution phase, and it is 100 times as much to resolve it during mature production. This is known as the 1-10-100 rule.

The 1-10-100 rule has been tested and found to be true across many industries. The rule also represents the way things work in nature. We all are familiar with:

“An ounce of prevention is worth a pound of cure”, “Measure twice, cut once”, etc.

The 1-10-100 rule is similar to common observation on return on investment (ROI) from every $100 invested in quality improvement activities.
Key Concepts Review 4

R4.1 **Earned Value** - A generally accepted method used to confirm the accuracy of a task is earned value calculation.

R4.2 **Quality Control** - Pareto analysis, cause and effect, and flow charts are common tools used in quality control.

R4.3 **Schedule Change** - To effectively change a project schedule, you will need to obtain the appropriate levels of approval, submit the appropriate change requests, and evaluate the impact of the changes to the schedule.

R4.4 **Scope Change Impact** - To best determine the impact of scope changes, baseline, performance measurement, and milestones should be reviewed.

R4.5 **Scope Change Control** - The control processes, including schedule, cost, and quality must take into consideration of scope changes.

R4.6 **Configuration Management** - Configuration management is a technique used for overall change control.

R4.6 **Scope Verification** - The task of reviewing work products to ensure they were completed satisfactorily and formally accepted is part of scope verification.

R4.7 **Cost and Schedule Variances** - A project which was estimated to cost $800,000 and schedule to last 9 months, had an earned value analysis at five months showing the following:

\[
\begin{align*}
BCWP (Budgeted cost of work performed) &= $450,000 \quad \text{(also, EV)} \\
BCWS (Budgeted cost of work scheduled) &= $550,000 \quad \text{(also, PV)} \\
ACWP (Actual cost of work performed) &= $600,000 \quad \text{(also, AC)}
\end{align*}
\]

Then, SV (Schedule Variance) = BCWP – BCWS

= 450,000 – 550,000 = - 100,000

and CV (Cost Variance) = BCWP – ACWP

= 450,000 – 600,000 = - 150,000

[A positive variance is good, and a negative variance is bad.]

Also SPI (Schedule performance index) = BCWP/BCWS

And, CPI (Cost performance index) = BCWP/ACWP
Exercises

Q 4.1 What are the activities performed to bring future project performance into line with the project plan called?

   a. Cost revision
   b. Budget update
   c. Contingency planning
   d. Corrective action

Q4.2 Earned value calculation and reporting considers a project complete when:

   a. The EV (earned value) equals to the AC (actual cost)
   b. The AC becomes equal to the PV
   c. BAC (budget at completion) is equal to the PV (planned value)
   d. The BAC is equal to the EV

Q4.3 Which of the following is life cycle costing?

   a. A government required accounting practice
   b. A method that considers all costs associated with the project over its entire life.
   c. A method used to determine project cost efficiency
   d. A method of evaluating project status

Q4.4 The project manager of a medium sized project used the earned value reporting method to manage her project. The table below shows the planned value of the project for the 10 week life of the project, and the AC and EV data collected for the project’s first five weeks. The figures shown in the table below are all cumulative values in dollars.

<table>
<thead>
<tr>
<th>Week</th>
<th>PV</th>
<th>AC</th>
<th>EV</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10,000</td>
<td>10,000</td>
<td>10,000</td>
</tr>
<tr>
<td>2</td>
<td>30,000</td>
<td>20,000</td>
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<td>9</td>
<td>210,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>215,000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
a. What is the cost performance index at the end of week 3?

b. What is the schedule performance index for week 5?

c. What is the BAC for the project during week 5?

d. What is the EAC (Estimated project cost at completion) for the project at week 5?

Q4.5 The purpose of the contingency budget is to:

   a. Reduce chances of scope changes
   b. Increase probability of changes in cost baseline
   c. Reduce probability of cost overruns
   d. Reduce risk factors

Q4.6 In an office building construction project there is a senior designer on the team dedicated to the project full time for 36 weeks (40 hour/week). The following statistics are available for individuals of this skill level from the human resource department.

Utilization = 70% (amount of time worked on project)
Productivity = 85%
Wage rate = $45 per hour at work (project)
Fringe benefits = 30% of wages
Overhead = 50% of wages + benefits

a. What is the cost of this employee for the project?

b. In one of the design tasks, this individual utilized 60 hours. What is the cost of that task to the project?
Module 5
Project Closing
Module - 5

Project Closeout

Unlike other assignments, a project has a determined beginning and end. Like the start of the project, the project also has a distinct finish, at which time all tasks are completed. Unfortunately, responsibilities associated with other projects or tasks, sometimes the completed projects simply fade away rather than being recognized with a clear announcement of completion. These silent ends are damaging to both the organization and the people who performed the work. If there is no assessment of the project outcome, then there is no way for team members to evaluate whether the project was well planned or well executed. Also, the lack of a formal closure deprives team members of a sense of achievement, or of a job well done.

To close out your project, the following tasks should be implemented.

5.1 Obtain Final Deliverable Approval
As the project nears completion, you will meet with stakeholders to secure their approval that indeed the project has delivered what was expected. This formal approval is required for the project’s closeout.

Create a Detailed Plan for Project Termination – Together with team members, prepare a plan for termination that clarifies your objectives, activities and resources. You would benefit by making a check list of things you and your team must complete before the project can be closed. The checklist may include:

- Products that must be produced
- Acceptance test that must perform
- Approvals that are required
- Final report that you need to prepare
- Resources that you will need to release and/or reassign
- Administrative tasks that you may need to perform
Reestablish Team Identity and Spirit – The following acts may help to reestablish team identity and spirit:

- Meet with team members to reaffirm & recognize their commitment to successfully completing the project
- Be accessible to team members for discussions and updates
- Monitor final activities more closely and give team members frequent feedback on performance

To finish the project smoothly, you would benefit from the inclusion of project closing events in your project plan.

- **Lay the groundwork** for closure when you prepare the project plan and just before the end of the project
- **Include project closing activity in the project plan.** Specify all closing activities in the project plan’s WBS.

### 5.2 Document Lessons Learned

New lessons are learned in each project due to numerous & unexpected events. To learn from these experiences, you should survey project team members and relevant stakeholders to record lessons learned. These lessons learned can be beneficial for future projects.

### 5.3 Facilitate Administrative and Financial Closure

Many administrative, financial, and organizational tasks are needed to closeout projects. In addition, there may be special requirements determined by the stakeholders and the organization that you must take care of.

### 5.4 Preserve Essential Project Records

Every project will generate documents or deliverables such as plans, authorizations, expense records, resources, etc. In addition, most projects require legal documents such as contracts or fee schedules. It is in your benefit to preserve these essential records.

### 5.5 Release Project Resources

Once project is completed, you will no longer need the manpower and resources your organization assigned to this project. So, you should release team members & resources by following your organization’s procedure as soon as the project is over such that they can be utilized in other projects.

### Finishing Tasks

- Finish all uncompleted deliverables
- Hold team meetings to evaluate project
- Meet with stakeholders
- Return equipments
- Reassign team members
- Conduct post-project evaluation
- Determine, “What did we do well?”
- Identify, “What could we do differently next time?
- Record and save information on evaluations

Key Concepts Review 5

R5.1 Formal Acceptance - The project manager should document the formal acceptance process during the contract close-out.

R5.2 Project Termination - If for some reason (cuts in funding), your project is terminated, you should always establish and document the level and extent of completion.

R5.3 Key closing Activity - When closing a project, one of your key activities is should be to disseminate information to formalize project completion.

R5.4 Usefulness of Closing Document – Consider the following example.

You are the project manager of a large project with approved cost over $3,000,000. Your earned value calculations indicate that the project will be completed under budget by about $250,000. Based on this calculation, your personal profit (bonus) will decrease by $5,000.

At end of this project, you will document and archive all of the project’s information. Such information may be used in the future for many tasks like estimating activity duration, administering contracts, and allocating resources.

R5.5 Close-out Communication Management - The project close-out process must be included as part of the communication planning, which includes determining stakeholder information and communication needs. Communication planning helps establish who needs what information, when will they need it, and how it will be given to them. The plan addresses the following three areas:

- Information distribution – making needed information available to project stakeholders in a timely manner.
- Performance reporting – collecting and disseminating performance information like status reporting, progress measurement, and forecasting.
- Administrative closure – generating, and disseminating information to formalize phase or project completion.

INTEGRATION MANAGEMENT
IM00: Project integration management has seven processes: Develop Project Charter, Develop Preliminary Project Scope Statement, Develop Project management Plan, Direct & manage project Execution, Monitor and Control Project Work, Integrated Change Control, and Close Project.

SCOPE MANAGEMENT
SM00: Project scope management has five processes: Scope Planning, Scope Definition, Create WBS, Scope Verification, and Scope Control.

SM01: A coordinated undertaking of interrelated activities directed toward a specific goal that has a finite period of performance is called a Project.

SM02: The document that is proof of upper management's commitment to the project and gives the authority to manage the project to the project manager is called The Project Charter.

SM03: The organization in a company that favors the weakest authority for the project manager is known as Weak Matrix Organization.

SM04: A manager that manages a group of related projects is called the Program Manager.

SM05: The set of procedures developed to ensure that the project design (in terms of form, fit and function) criteria are met is called Configuration Management.

SM06: PScope Definition is the process of decomposing the major deliverables into smaller, more manageable components to provide better control.

SM07: Any numbering system used by a company to monitor project costs by category such as labor, supplies, or materials is called Chart of Accounts.

SM08: Any individual who is involved in or may be affected by the activities or anyone who has something gain or lose by the activity of the project is called a Stakeholder.

SM09: A group of related projects that are managed in a coordinated way that usually include an element of ongoing activity is called a Program.

SM10: A temporary endeavor undertaken to create a new product or service is called a Project.

SM11: The process of establishing clear and achievable objectives, measuring their achievements, and adjusting performance in accordance with the results of the measurement is called Management by Objectives.
SM12: A narrative description of the work that must be done (made by the project manager) for the project is called a **Statement of Work**.

SM13: The document that recognizes the existence of the project is called the **Project Charter**.

SM14: The **WBS** represents all the work that must be completed for the project.

SM15: **Execution** phase of the project is likely to have the greatest amount of its funding spent.

SM16: The lowest level of the breakdown for the project manager (in the breakdown structure) is **Work Package**. (work packages are usually broken down into tasks, and tasks can be further broken down into activities. However, project manager is usually concerned about things down to the work package level)

SM17: As per the PMBOK®, the lowest level of the work breakdown structure (WBS) is the **Task**.

SM18: What distinguishes PERT from CPM is that **PERT** probabilistic and **CPM** is deterministic.

SM19: The WBS, the scope statement, and historical information that supports applicable activity are key inputs to **Activity Definition**.

SM20: The original plan (for a project, a work package, or an activity) plus or minus approved changes is called the **Scope Baseline**.

SM21: **The Change Management Plan** is a document of procedure that is normally included in the **Scope Management Plan**.

SM22: “The first rule of project management is that the people who must do the work should help plan it.” – J. Lewis.

SM23: The project scope defines **the magnitude or size of the job**.

**TIME MANAGEMENT**

TM00: Time management is divided into six processes: **Activity Definition, Activity Sequencing, Activity Resource Estimating, Activity Duration estimating, Schedule Development, and Schedule Control**.

TM01: The original schedule for a project (a work package or an activity) plus or minus approved changes is called the **Baseline Schedule**.
TM02: A tool that project managers use to show the scheduled activities in a way that it is easy to see when ac activity starts and finishes and which activities are taking place at the same time is known as **Gantt Chart**.

TM03: **Crashing** the schedule means making the project shorter by any economical means.

TM04: In **Fast Tracking** several of the activities that were scheduled to be done in sequence are done in parallel to improve the predicted project completion time.

TM05: **Resource Leveling** is used to reduce overutilization of resources.

TM06: Overall duration of project schedule is not influenced by using the Arrow Diagramming method instead of Precedence Diagramming method (**PDM**).

TM07: **PERT differs from CPM** in that PERT uses weighted average of activity durations to calculate project duration.

TM08: According to **PMBOK**®, work package can be divided into **Tasks**.

TM09: A project manager should use **CPM** to manage the project in such a way that she/he will be able to identify specific tasks that should be watched and managed more closely than others.

TM10: To mange project in a manner that allow more accurate prediction of project duration even though the estimates of activity durations have a lot of variability, the project manager should use **PERT**.

TM11: According to the Guide to the **PMBOK**®, the lowest level of the work breakdown structure is the **Work Package**. (Work package is a unit of work that can be assigned to a person or organization. The work package can be broken down into tasks, and tasks can be broken down into activities)

TM12: The problem with being a working project manager is that, in a conflict between working and managing **the work tend to take precedence, and managing suffers**.

**COST MANAGEMENT**

CM00: Cost management has **three** processes: **Cost Estimating, Cost Budgeting, and Cost Control**.

CM01: It is generally accurate to say that **Bottom Up**. Estimate is more accurate than **Top Down** estimate.

CM02: **Corrective Action**. Is the act of doing anything that helps bring the future project performance in line with the project plan.
CM03: In **Earned Value Reporting** a project is considered complete when AC equal to the PV.

CM04: Time phased budget best describes the characteristic of the **Cost Baseline**.

CM05: The time phased cost of the project that reflects the expenditures rather than consumption of resources that will be used to measure and monitor cost performance on a project is the **Spending Plan**.

CM06: The emphasis in **Learning Curve Theory** while producing many goods is that the average unit cost decreases as more units are produced.

CM07: While preparing budget for the project, a project manager uses **Project Schedule, Cost Baseline, and WBS**.

CM08: **Contingency Budget** is created to reduce cost overruns.

**QUALITY MANAGEMENT**
QM00: Project quality management is divided into **three** processes: **Quality Planning, Perform Quality Assurance, and Perform Quality Control**.

QM01: In early 1980’s Edward Deming along with Joseph Juran concluded that **Upper Management** is responsible for most of defects or failure in processes.

QM02: **The Quality Plan** is part of the overall project plan and is an important input to the project plan.

QM03: **The Quality Assurance** is the planned and systematic activities that are implemented within the quality system to develop confidence that the project will satisfy the relevant quality standards.

QM04: **The Quality Plan** is part of the overall project plan and is an important input to the project plan.

QM05: **The Quality Management and Project management** are both very concerned about customer satisfaction.

QM06: **Kaizen** is a Japanese word that means improvement.

QM07: **Modern quality management** believes making small incremental

**HUMAN RESOURCE MANAGEMENT**
HR00: Project human resource management is divided into four processes: Human Resource Planning, Acquire Project Team, Develop Project Team, and Manage Project Team.

HR01: The organization that is formalize structure directed toward the support of the project community within the organization is called Project Office.

HR02: The Advantages of Functional type of organization is that it represents a stable organization structure.

HR03: Matrix Organization. Is suitable for a company that undertake new work that is different from that they have done before, and whose strategic plan calls for much of this kind of work in the future.

HR0: An American company undertook a project to build an automotive assembly plant in Kolkata, India. The project is expected to take several years to build and test. The organization best for managing this project is Pure Project Organization.

HR05: The organization that is a formalized structure where the project teams and the project managers reside is called Project Management Office.

HR06: The beginning and end of the project is defined by the Project Life Cycle.

HR07: One of the characteristics of good listeners is that he or she repeats some of the things said.

HR08: For achieving long lasting solution to project issues involving difficult design problems, Problem Solving is the best approach.

HR09: A key barrier to developing project team is Team Members who are accountable to both functional and project managers.

HR10: According to McGregor’s concept of theory, X and theory Y, the statement “Theory Y managers view their subordinates as creative, imaginative, and agreeable to change”.

HR11: The Functional Manager in a balance matrix organization is responsible for making should be the person responsible for raining the people within his/her organization.

HR12: As person responsible for all that goes on in the project, one of the most important duties the project manager can perform is the function of Integration.

HR13: In a matrix organization, the person most responsible for seeing that proper people are assigned to the projects where they are used most effectively is the Functional Manager.

HR14: To overcome difficulty in communication under matrix organization, a project manager can make communicating with people on his or her project team easier is by publishing a Project Team Directory.
HR15: One of the major attractions of matrix management style of organization is **Pressure of Shared Resources**.

HR16: A formal employee reward system works well when *Relationship between reward and performance is explicit*.

**COMMUNICATION MANAGEMENT**
COM00: Project Communication management has four major processes: *Communication Planning, Information Distribution, Performance Reporting, and Manage Stakeholders*.

COM01: *Effective communication, ability to reconstruct why decisions were made, and historical value* are the three principal interests in maintaining good document control.

COM02: *Language, distance, culture, and knowledge* are filters the receiver uses to filter messages.

COM03: Among the ideas to generate ideas, *Delphi technique* allows participants to be anonymous.

COM04 The project manager is responsible for communicating with the project team.

COM05: *During Administrative Closure*, the project sponsors or client signs off a document expressing their acceptance of project deliverables.

COM06: In a project team of seven (including project manager), there are 21 lines of communications for communicating information to each other \[ 7 \times (7-1)/2 \].

COM07: *Verbal, Written, and Electronic* .type are the main form of communications today.

**RISK MANAGEMENT**
RM00: Project risk management is accomplished by six processes: *Risk Management Planning, Risk Identification, Qualitative Risk Analysis, Quantitative Risk Analysis, Risk Response Planning, and Risk Monitoring & Control*.

RM01: *Risk Avoidance* is the process of eliminating risk from consideration by implementing something that will eliminate it as a possibility.

RM02: *Risk Acceptance* allows the risk to happen and deal with it should it occur. *Risk Tolerance* is the measure of the client to take risks.RM03: *Risk Deflection or Transfer* is the process of transferring the risk to someone other than the project team, such as an insurance company or outside supplier.
RM04: **Risk Mitigation** is the process of reducing risk to an acceptable level due to reduced impact, probability, or both.

RM05: **Management Reserve** is a fund set aside to manage unidentified risks which PMI refers as “unknown unknowns”. It is time and money used to offset the effect of unknown risks affecting cost and schedules.

RM06: When management reserve is in the project, it is used from the management reserve to the cost or schedule baseline.

RM07: **Risk Triggers (also called risk symptoms)** are indications that risk is about to occur.

RM08: **The Monte Carlo Technique.** is a simulation technique that assigns a value to duration for each activity in the schedule. It is also used to refine PERT where range of values and the probability that they can occur are calculated for the project completion date or parts of the project.

RM09: **A Workaround** is the work that was not planned ahead of time to take care of a threat that occurs.

RM10: A project manager should do risk analysis with his/her project team **on a regular basis throughout the project.**

**PROCUREMENT MANAGEMENT**

PM00: Project Procurement managements divided into six major processes: **Plan Purchase and Acquisitions, Plan Contracting, Request Seller Responses, Select Sellers, Contract Administration, Contract Closure.**

PM01: Under blanket order arrangement, payment for all of the materials are made at one time.

PM02: The contracts similar to cost reimbursable contracts are frequently termed as **Cost Plus Contract.**

PM03: Forward buying generally The narrative description made by the project manager to cover the items to be supplied under the contract with the client is called **The Statement of Work.**

PM04: When a project manager discovers that a subcontracted job on a firm fixed price contract contains some risk, he or she should: (a) *(a) expect the supplier to include an allowance for the risk in the contracted price and (b) make sure that the supplier understands the risk before the contract is signed.*
PM05: A formal invitation by a buyer that contains a scope of work that seeks a response describing methodologies and results that will be provided to the buyer is called **Request for Proposal.**

PM06: When subcontracting a work that has a great deal of risk associated with it which also cause difficulty to find contractor willing to take the job, the type of contract offers most incentive to the contractor is **Cost Plus Percentage of cost as an award fee.**

PM07: *A Contract* is an agreement between competent parties, for valid consideration, to accomplish some lawful purpose with clearly established terms.

PM08: *A Solicitation* is an advertised intention by purchasing department expressing intention to let a contract part of the project work.

PM09: Purchase of standard items like nuts, bolts, screws, etc. are example of **Commodity Purchase.**

**PROFESSIONAL RESPONSIBILITY**

PR01: Intellectual property belongs to the author of the property. If you create a presentation based on your own work, you have right to receive credit for it.

PR02: As a project manager you may receive unsupported allegations by a third party which often may be rumors or mistaken facts. It is best to investigate before making any changes.

PR03: Unless an employee has signed nondisclosure agreement with his or her former employer, there is no obligation or him or her not to share knowledge gained while employed with the competitor. As a project manager you can accept such information when offered by the employee.
Module 6
Professional Responsibilities
Module - 6

Professional Responsibilities

This module contains project manager professional skills building suggestions that can benefit you as a project management professional. A project manager is expected to guide and direct the project with highest of professional and ethical standards and to maintain individual integrity. He/she must be familiar with organizational standards & procedures and should be able to contribute to the team’s knowledge base by sharing innovative ideas and best practices.

Responsibilities (5 Areas)

6.1 Maintain Individual Integrity and Professionalism

As a project manager, you must maintain your personal integrity and professionalism while dealing with all aspects of project management. You will be expected to adhere to applicable legal requirements and follow ethical standards that protect your team, the community and the project’s stakeholders.

Example: If the project requires constructing a building, you will need to adhere to city procedures & codes to building plan approved.

Example: If you have a FUND RASING project for a charitable organization, you will need to be aware of city codes regarding solicitation and planning for fund raising accordingly.

6.2 Contribute to the Project Management Knowledge Base

To enrich your project management knowledge base, you should share lessons learned, best practices, research, etc. with professional organization such as PMI. You can also learn a
great deal from other project managers like yourself. The idea is to promote and improve quality of project management practices within your industry and the profession.

Example: In the early 80’s a computer data management system of a large consulting company with resource locations in various parts of the world, the routine project status review took place by telephone conference call coupled with computer slide shows. This form of communication was found so effective that the manager shared the concept with people who maintain a project management knowledge base. Now, use of telephone conferencing & computer slide shows is common practice among many such organizations.

6.3 Enhance Individual Competence
While managing the project, you are to enhance your individual competency by learning and applying advanced knowledge to improve project services.

An ambitious project manager will benefit by undertaking self-assessment periodically and developing plans to reach improvement and professional competence goals.

Example: Even for a small and personal project, WBS, bar chart of work schedules and duration are good tools to use. They give the project a professional & more organized representation and enhance communication with other team members.

6.4 Balance Stakeholders Interest
Often during projects, the P.M. must find a satisfactory balance between the competing needs of stakeholders. You would attempt to do so by finding approaches that seek fair resolution of the conflicting and competing demands from project objectives.

Example: Although, overwhelming data shows that passengers seat airbag in automobiles save lives, accident data reveals high levels of children fatalities from front seat airbag. So, stakeholders may want a vehicle with front seat active airbags for safety, but may also want the option to make it inactive for child passengers. A compromised solution is to include a switch to disconnect the airbag and a sticker notifying the passenger that the option is present.

6.5 Respect and Interaction with Team Members and Stakeholders
Project manager should be professional and cooperative when interacting with the team members and stakeholders. As project manager, you should encourage a collaborative environment by respecting personal, ethnic, and cultural differences among all team members.

Example:
- Find backup support for team member needing to take time off for family emergencies.
• Accommodating the wishes of a group of team members to celebrate special holiday, by not holding important meetings on that day.

**Implementing Project Management in Your Company**

- **Top Management Involvement** – In the early 1950’s, Dr. Deming first insisted that chief executives be involved in projects to assure success. The chief executive must take time to learn about project management, sit on the planning meetings, participate in project review meetings and ask questions about project performances.

- **Key Job Elements in Appraisal System** – Include project performance achievement as part of the key job element and recognize and reward explaining performances.

- **Basic Training for all team members** – Provide training for anyone who needs it. Provide Overview Training for Senior management

- **Initial Projects with High Probability of Success**

- **Change Organization Structure for Project Management**

- **Assign Champions for Sub-Projects**

- **Encourage Team Members to Join Project Management Institute**

- **Top Management Involvement** – In the early 1950’s, Dr. Deming first insisted that chief executives be involved in projects to assure success. The chief executive must take time to learn about project management, sit on the planning meetings, participate in project review meetings and ask questions about project performances.

- **Key Job Elements in Appraisal System** – Include project performance achievement as part of the key job element and recognize and reward explaining performances.
Key Concepts Review 6

R6.1 Culture Shock - The disorientation experienced by people who suddenly find themselves living and working in a different environment is known as culture shock.

R6.2 Multi-national Projects - The most effective way to ensure that cultural and ethical differences do not impede the success of a multi-national project is training.

R6.3 Requirements Definition - A project success is determined by how well you satisfy the stakeholder’s needs. A key activity for satisfying the customers (stakeholders) is to define the requirements in clear terms.

R6.4 Alternative Solutions - During the project performance, when a design error interferes with meeting the technical performance objectives, the preferred course of action should be to develop alternative solutions to the problem.

R6.5 Personal Gain/Loss – The project manager of $3,000,000 project calculates that the project will be completed under budget by about $250,000. Based on this calculation, your personal profit (bonus) will decrease by $5,000.

Given such estimated decrease in your personal benefit, what action should you take? You should definitely communicate the project financial outcome to the project sponsor.

R6.6 Societal Obligations – Suppose that as a project manager, you are building a state government funded sewer treatment facility for the city. Routine test reveals that there is some seepage to the nearing grounds and water sources but they have extremely low risks for causing any harm. What should you communicate to the people? You should inform the public that a detailed examination has been ordered to determine the extent to which the problem exist. (Doing nothing or hiding the situation is not an option.)
Module 7

Appendix & References
Appendix
(Module 7, Reference Materials)

Project Management – Supporting Documents

CONTENT

• Glossary of Terms

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  o Textbooks
  o Information at Web Sites
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• Project Situation Studies

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• Self-Test Your PM Knowledge & Example Project Phases

• PMI & Project Management Professional (PMP) Exam.

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• Project Management Body of Knowledge (PMBOK)

• Worksheets and Reference PDM & PERT Tables

• Course & Instructor Evaluations

• Participant Experience & Expectations

**Activity.** A unit of work performed as part of the project. An activity usually has a duration, a cost, and resource requirements. An activity can be subdivided into tasks.

**Activity definition.** Identifying the specific activities that must be performed in order to produce various project deliverables.

**Activity duration estimating.** Estimating the number of work periods that will be needed to complete individual activities.

**Actual cost (AC or ACWP).** The amount of cost accumulated by doing work on the project; the actual cost that was performed during a given time period. The Guide to the PMBOK® has changed this term from ACWP to AC.

**AD.** Activity Description is a label used in network diagrams. The activity description normally describes the scope of work of the activity.

**ADM.** Arrow Diagramming Method is a network diagramming method in which activities are represented by arrows. The tail represents the start and the arrow head represents the finish of the activity (the lengths DOES NOT represent the duration of the activity). Activities in ADM are connected at points called nodes (small circle) to illustrate sequence.

**AF.** Actual Finish date is the actual date a task or activity was completed.

**AS.** Actual Start date is the point in time that work actually started on an activity.

**BAC.** Budget at Completion is the estimated total cost when the project is completed.

**Backward Pass.** The calculation of late finish dates and late start dates for the uncompleted portion of all network activities is determined by working backward through the network logic from the project’s end date. The end date may be calculated in a forward pass or may be set by the customer or sponsor.

**Bar Chart.** A graphic display of schedule-related information. In the typical bar chart, activities or other projects elements are listed on the left side of the chart, dates are shown across the top, and activity duration are shown as dates–placed horizontal bars. These are also known as Gantt charts.

**Baseline.** The original approved plan (for a project, a work package, or an activity), plus or minus approve scope changes. Usually used with a modifier (e.g., cost baseline, schedule baseline, performance measure baseline).

**Buffer (Reserve).** A provision in the project plan to mitigate cost and or schedule risk. Often used with a modifier (e.g., management reserve, contingency reserve) to provide further details on what types of risk are meant to be mitigated. The specific meaning of the modified term varies by application area.
**Budgeted Cost of Work Performed (BCWP, Earned Value).** This term has been replaced by *earned value*.

**Budgeted Cost Work Scheduled (BCWS, Planned Value).** This term has been replaced by the term *planned value*.

**Calendar Unit.** The smallest unit of time used to schedule a project. Calendar units are generally hours, days, or weeks, but can also be shifts or even minutes. Used primarily in relation to project management software.

**Change Control Board.** A formally constituted group of stakeholders responsible for approving or rejecting changes to the project’s baseline.

**Chart of Accounts.** Any numbering system used to monitor project costs by category (e.g., labor, supplies, materials, and equipment). The project chart of accounts is usually based upon the primary performing organization’s corporate chart of account. (also known as *code of accounts*.)

**Charter (or Project Charter).** A document issued by senior management that formally authorizes the existence of a project provides the project manager with the authority to apply organizational resources to project activities.

**Checklist.** A listing of many possible risks that might occur during a project is used as a tool in the risk identification process. Checklists are comprehensive, listing several types of risk that have been encountered on prior projects.

**Contingency (or Contingency Planning).** Development of a management plan that identifies alternative strategies that ensure a project’s success if a specified risk event occurs.

**Contingency Reserve.** The amount of money or time needed above the estimate to reduce the risk of project overruns.

**Contract.** A mutually binding agreement that obligates the seller to provide the specified products and obligates the buyer to pay for it. Contracts generally fall under the following three broad categories:

- **Fixed-price or lump-sum contracts** – Includes a fixed total price for a well defined product or service may also include additional incentives for meeting or exceeding project objectives such as schedule targets.
- **Cost-reimbursable Contract** – involves payment to the contractor for actual costs incurred.
  - **Direct costs** - wages of team members and materials utilization as cost of doing business, such as salaries of the corporate executives are usually calculated as a percentage of direct cost.
  - **Incentives** – for meeting or exceeding selected project objectives such as project schedule or cost.
- **Time and Material Contracts** – A hybrid contractual arrangement that contain aspects of both cost-reimbursable and fixed-price-type arrangements. It resembles cost-type in that they are open ended, as the full value of the project is not defined at the time of the award. It
can grow in contract value as the cost-type arrangement. Conversely, time and material arrangement resemble fixed-unit arrangements, when, for example, the unit rates are preset by the buyer and seller, like when both parties agree on the rates of a “senior engineer” in the project.

**Control Charts.** A graphic display of the results, over time and against established control limits, of a process. They are used to determine if the process is “in control” or in need of adjustment.

**Corrective Actions.** Changes made to bring expected future performance of the project in line with the plan.

**Cost Budgeting.** Allocating the overall cost estimates to individual work activities.

**Cost Control.** Controlling changes to the project budget.

**Cost Estimating.** Developing an approximate (estimate) of the cost of the resources needed to complete project activities.

**Cost of Quality.** The cost incurred to ensure quality. The cost of quality includes quality planning, quality control, quality assurance, and rework.

**Cost Performance Index (CPI).** The cost efficiency ratio of earned value to actual cost. CPI is often used to predict the magnitude of a possible cost overrun using the following formulas: BAC/CPI = projected cost at completion. CPI = EV/AC. (BAC = Budgeted/estimated cost of project, AC = actual cost of worked performed, EV = earned value)

**Cost Variance (CV).** Any difference between the budgeted cost of any activity and the actual cost of that activity. In earned value, EV – AC = CV

**Crashing.** Taking action to decrease the total project duration after analyzing an alternatives for how to get the maximum duration compression for the least cost.

**Critical Activity.** Any activity on a critical path. Most commonly determined by using the critical path method.

**Critical Path.** The series of activities that determine the project’s duration. In a deterministic model, the critical path is usually defined as those activities with float less than or equal to specified value, often zero. It is the longest path through the project.

**Critical Path Method (CPM).** A network analysis technique used to predict project duration by analyzing which sequence of activities (which path) has the least amount of scheduling flexibility (least amount of float). Early dates are calculated by means of a forward pass, using a specified start date. Late dates are calculated by means of a backward pass, starting from a specified completion date (usually the forward pass calculated project early finish date).

**Decision Tree Analysis.** The decision tree is a diagram that charts out a decision under consideration and the implications of choosing one or another of the available alternatives. It
incorporates probabilities or risk and the cost or rewards of each logical path of events and future decisions.

**Deliverables.** Any measurable, verifiable outcome, tangible, result, or item that must be produced to complete the project or part of a project. Often used more narrowly in reference to an external deliverable subject to approval by project sponsor or customer.

**Dummy Activity.** An activity of zero duration used to show a logical relationship in the arrow diagramming method. Dummy activities are used when logical relationships cannot be completely or correctly described with regular activity arrows. Dummies are shown graphically as a dashed line headed by an arrow.

**Duration (DU).** The number of work periods (not including holidays or other nonworking days) required to complete an activity or other project element usually expressed as workdays or workweeks. Sometimes incorrectly equated with elapsed time.

**Duration Compression.** Shortening the project schedule without reducing the project scope. Duration compression is not always possible and often requires an increase in project cost.

**Early Finish Date (EF).** In the critical path method, the earliest possible point in time in which the uncompleted portion of an activity (or the project) can finish, based on the network logic and any schedule constraints. Early finish dates can change as the project progresses and changes are made to the project plan.

**Early Start Date (ES).** In the critical path method, the earliest possible point in time on which the uncompleted portions of an activity (or the project) can start, based on the network logic and any schedule constraints. Early start dates can change as the project progresses and changes are made to the project plan.

**Earned Value (EV, BCWP).** The physical work accomplished plus the authorized budget for this work. The sum of approved cost estimate (may include overhead allocation) for activities (or a portion of activities) completed during a given period (usually project to date). Previously called budgeted cost of work performed (BCWP).

**Event –on-Node.** A network diagramming technique in which events are represented by boxes (or nodes) connected by arrows to show the sequence in which the events are to occur. Used in the original program evaluation and review technique (PERT).

**Exception Report.** Document that includes only major variations from the plan (rather than all variations)

**Fast Tracking.** Compression of the project schedule by overlapping activities that would normally be done in sequence, such as design and construction.

**Float.** The amount of time that an activity may be delayed from its early start without delaying the project finish date. Float is a mathematical calculation, and can change as the project progresses and changes are made to the project plan. Also called slack, total float, path float, or free float.
**Free Float.** The amount of time that an activity can be delayed without delaying the *early start* of any immediately following activities.

**Functional Manager.** Manager responsible for activities in a specialized department or function (e.g., engineering, manufacturing, marketing)

**Lessons Learned.** The learning gained from the process of performing the project Lessons learned may be identified at any point. Also considered a project record.

**Level of Effort (LOE).** Support-type activity (e.g., vendor or customer liaison) that does not lend itself to measurement of discrete accomplishment. It is generally characterized by a uniform rate of activity over a period of time determined by the activities it supports.

**Life–Cycle Costing.** The concept of including acquisition, operating, and disposal when evaluating various alternatives.

**Logical Relationship.** A dependency between two project activities, or between a project activity and a milestone (Used in *precedence diagram*). The four possible dependency relationships are:
- **Finish-to-start** – the initiation of the work of the successor depends on the completion of work of the predecessor.
- **Finish-to-finish** – the completion of the work of successor cannot finish until the completion of work of the predecessor.
- **Start-to-start** – the initiation of work of the successor depends upon the initiation of the work of the predecessor.
- **Start-to-finish** – the completion of the work of the successor is dependent upon the initiation of work of the predecessor.

**Loop.** A network path that possesses the same node twice. Loops cannot be analyzed using the traditional network analysis technique such as critical path method and program evaluation and review technique (PERT). Loops are allowed in graphical evaluation and review technique.

**Milestone.** A significant event in the project; usually the completion of major deliverables.

**Monte Carlo Analysis.** A technique that performs a project *simulation* many times to calculate a distribution of likely results. A simulation uses a project model that translates the uncertainties specified at a detailed level into their potential impact on objectives that are expressed at the level of the total project.

**Near-Critical Activity.** An activity that has low total float.

**Network Analysis.** The process of identifying early and late start and finish dates for the uncompleted portions of the project activities. (see critical path method, PERT, and graphical evaluation and review technique)

**Network Logic.** A collection of activity dependencies that make up a project network diagram.

**Network Path.** Any continuous series of connected activities in a project network diagram.
Organizational Breakdown Structure (OBS). A depiction of the project organization arranged so as to relate work packages to organizational units.

Organizational Planning. Identifying, documenting, and assigning project roles, responsibilities, and reporting relationships.

Parametric Estimating. An estimating technique that uses statistical relationships between historical data and other variables (e.g., square footage in construction, lines of codes in software development) to calculate an estimate.

Pareto Diagram. A histogram, ordered by frequency of occurrence, that shows how many results were generated by each identified causes.

Planned Value (PV, BCWS). The physical work scheduled, plus the authorized budget to accomplish the scheduled work. Previously this was called as budgeted cost of work scheduled (BCWS)

Precedence Diagramming Method (PDM). A network diagramming technique in which activities are represented by boxes (or nodes). Activities are linked by precedence relationships to show the sequence in which the activities are to be performed.

Product Scope. Features and functions that characterize a product or service.

Program Evaluation and Review Technique (PERT). An event-oriented network analysis technique used to estimate program duration when there is uncertainty in the individual activity duration estimates. PERT applies to the critical path method using durations that are compute by weighted average of optimistic, pessimistic, and most likely duration estimates. PERT computes the standard deviation of the completion date from those of the path’s activity durations. Also known as method Moments Analysis.

Project. A temporary endeavor undertaken to create a unique product, service, or result.

Project Life Cycle. A collection of generally sequential project phases whose name and number are determined by the control needs of the organization or organizations involved in the project.

Project management. The application of knowledge, skills, tools, and technique to project activities to meet the project requirements.

Project management Body of Knowledge (PMBOK®). An inclusive term that describes the sum of knowledge within the profession of project management PMBOK® includes proven, traditional practices that are widely applied, as well as innovative and advanced ones that have seen more limited use.

Project management Professional (PMP). An individual certified by the Project Management Institute (PMI)

Project Phase. A collection of logically related project activities usually culminating in the completion of a major deliverable.
**Project Plan.** A formal, approved document used to guide both execution and project control. The primary uses of the project plan are to document planning assumptions and decisions, facilitate communication among stakeholders, and document approved scope, cost, and schedule baselines. A project plan may be summary or detailed.

**Projectized Organization.** An organizational structure in which the project manager has full authority to assign priorities and to direct the work of individuals assigned to the project.

**Statement of Work (SOW).** An SOW describes the work to be performed and usually includes a timeline and level of effort so that a vendor or contractor can respond to the RFQ with a proposal and cost estimate. SOWs should include the following: work to be performed, location of the work, period of performance and timeline, deliverable schedule, any special requirements (such as security clearances, travel required, special skills or knowledge)

**Team Development.** Developing individual and group competencies to enhance project performance.

**Team Member.** People who directly or indirectly report to the project manager.

**Total Quality Management.** A common approach to implementing a quality improvement program within an organization

**Triggers.** Triggers, sometimes called the risk symptoms, or warning signs, are indications that a risk has occurred or is about to happen. Triggers may be discovered in the risk identification process and watched in the risk monitoring and control process.

**Value Engineering.** It is a creative approach used to optimize life-cycle cost, save time, increase profit, improve quality, expand market share, solve problems, and/or use resources more effectively.

**Work Breakdown Structure (WBS).** A deliverable-oriented grouping of project elements that organizes and defines the total work scope of the project. Each descending level represents an increasingly detailed definition of the project work.

**Work Package.** A deliverable at the lowest level of the WBS that may be assigned to another project manager to plan and execute. This may be accomplished through the use of a subproject where the work package may be further decomposed into activities.
References:

Project Management (PM) Information Sites: Example PM documents:

Project Situation Studies

Situation # 01 Conflict Resolution
Jane and John are two senior software development specialists supporting a project managed by Dennis for a large consulting firm. Jane and John are from the same area of activities providing software development support to various projects on an as needed basis. As project manager, Dennis is new to the project as the project has been on hold for last six months after the original project manager retired. Within a few weeks on the job, Dennis sent an e-mail announcing that Jane would be responsible for developing the database. In a time when projects are hard to come by, this made John very unhappy, as he had a verbal understanding from the previous manager that he would be the choice for the job when the project came alive.

Q1: What did Dennis do right?

Q2: What would you do if you were the project manager?

Situation # 02 Stakeholders
In the project to rebuild World Trade Center (WTC, Twin Towers) which was attacked and demolished by terrorist on September 11, 2001 (known as 9-11), there are many stakeholders with numerous interests.

The property around the WTC is owned by the New York – New Jersey Port Authority, an entity created by the then governors of the two states. In the early 70’s, the Port Authority built WTC as a business center that housed businesses, retail, and underground Mass Transit Stations. Before 9-11, in June of 2001, the Port Authority signed a 99-year NNN (Triple net) lease of the WTC properties to a wealthy developer named Larry Silverstein. The agreement provides Mr. Silverstein the right and obligation to rebuild the towers as they were. The lessee did not foresee or cover the collapse of any buildings.

As the lessee, Mr. Silverstein definitely is interested in realizing his financial commitment as per the agreement he has with the Port Authority.

The families of the victims and concerned citizens all around the nation have some demands and expectations as to the new use of the site, called ground zero after the attack. A popular demand is that some sort of memorials be built at the ‘foot print’ of the WTC.

New York City, even though does not own the property, also has ideas to convert the area into a livable integration into the surrounding city with active retail, & busy 24/7 commercial and housing uses. They want to build housing complexes along with office buildings.

The MTA, Metropolitan Transportation Authority, also has interest in what happens with the location as their New Jersey and lower Manhattan underground commuter lines have the junction point at the WTC area.

The state of New York representing the residents of the state have vested interest in the new shape and form of the center around the WTC.

Finally, the LMDC, or Lower Manhattan Development Corporation has been created to reinvest federal funds into the site & lead the redevelopment effort.

Other Stakeholders: The President and the White House, the Congress of the US, the State of New Jersey, etc.

Q1: If you were the project manager, where would you anticipate most of your time will be spent in the early stage of the project initiation?
Answers to Module Exercises

Module 0 Introduction
Ans.Q0.1  c.  Ans.Q0.2  c.  Ans.Q0.3  b.  Ans.Q0.4  c.  Ans.Q0.5  d.

Module 1
Ans.Q1.1  A stakeholder is an individual or organization that is involved in or may be affected by the outcome of the project.

Ans.Q1.2  Program (From Guide to PMBOK®)
Ans.Q1.3  When cumulative revenue equals cumulative costs.
Ans.Q1.4  Concept phase.

Ans.Q1.5a  The net cumulative cash flow is the sum of cash flow in and cash flow out. Payback period is the point in time when the net cumulative cash flow (CCF) equals zero. The cumulative cash flow at end of year 1 is -700,000; 2, -400,000, 3, +50,000, etc.

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Cash Flow In</th>
<th>Cash Flow Out</th>
<th>Cum Cash Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>700,000</td>
<td>-700,000</td>
</tr>
<tr>
<td>2</td>
<td>450,000</td>
<td>150,000</td>
<td>-400,000</td>
</tr>
<tr>
<td>3</td>
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<td>125,000</td>
<td>65,000</td>
<td>+135,000</td>
</tr>
<tr>
<td>6</td>
<td>100,000</td>
<td>50,000</td>
<td>+185,000</td>
</tr>
</tbody>
</table>

Cum Cash Flow (CCF) = Past year CCF + Cash Flow In – Cash Flow Out

Since the CCF at end of year 2 is -400,000 and that at end of year 3 is +50,000, the payback period is close to 3 year.

The exact time location for payback in months is:

\[
\text{Year} + \left( \frac{400}{450} \right) \times 12 \text{months} = 24 + 10.66 = 35 \text{ months}
\]

Ans.Q1.5b  +185,000 (see table above)
Ans.Q1.5c  The formula for present value (P) calculation from given interest rate and future value is

\[
P = \frac{F}{(1 + I)^n}, \text{ where } F = 185,000, I = 0.10, \text{ and } n = 6
\]

Thus

\[
P = \frac{185000}{(1.10)^6} = 104,428
\]

Ans.Q1.6  The scope is verified by checking to see that the project outcome is produced and delivered to what the stakeholders asked for. For example, in a project to develop software, reviewing the performance of an installed software module will be a way of verifying the scope.

Ans.Q1.7  One of the first things a project manager should do is to write a project charter. According to Guide to the PMBOK®, Project Charter is the document issued by senior management that provides the project manager with the authority to apply organizational resources to project activities.
Ans. Q1.8 The cost of the project goes up based on the cost of changes and the cost of investigating the effect of changes. These two together, in this case is $65,000. Therefore, the cost of the project now will be $1,015,000 ($950,000 + $65,000).

Ans. Q1.9 The formula for the present value of money is

\[ P = \frac{F}{(1 + i)^n} \]  
where F = future value, i = interest rate, n = number of years

Present value of savings = \( \frac{130,000}{1.10} \) = 118,182

Note that the negative cash flow occurs at the beginning of the year when the computer system is purchased. The positive cash flow, on the other hand takes place at the end of one year, which is then transformed to its present value.

Net Present Value (NPV) = -75,000 + 118,182 = $43,182

Ans. Q1.10 A statement of work describes the project in terms of what it is all about and what will be delivered at completion of the project. A project plan is a comprehensive document that contains detailed work that the project will do, complete with tasks descriptions and schedule, cost, and scope baseline containing real schedule and budget.

Module 2
Ans. Q2.1 To complete the precedence diagram with dates of start and finish, you will need to calculate the precedence data (prepare the precedence data table) shown below. Perform the forward pass to calculate ES and EF and perform the backward pass to calculate LS and LF shown in Table Q2.1.

(a) Which activities have floats and how many days? (BDF)?
Ans. Activities C, D, and F have floats. All of them have 7 days of float.

(b) What is a free float?
Ans. The FREE FLOAT or SLACK is the amount of time that an activity can be delayed before it affects the schedule of any other activity. Activities F and D both have 7 days of free floats (total float or plain old float). Activity F has free float, activity D does not. When calculating schedules and floats with lead and lags, it is best to look at the next activity with no lead or lag and, after determining the dates, change them by the amount of the lead or lag.
### Table Q2.1 Precedence Data (Bridge Repair Project)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Description</th>
<th>Duration</th>
<th>Predecessor</th>
<th>ES</th>
<th>EF</th>
<th>LS</th>
<th>LF</th>
<th>Float</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td></td>
<td>1 days</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>B.</td>
<td></td>
<td>3</td>
<td>A</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>C.</td>
<td></td>
<td>3</td>
<td>A</td>
<td>2</td>
<td>4</td>
<td>9</td>
<td>11</td>
<td>7</td>
</tr>
<tr>
<td>D.</td>
<td></td>
<td>2</td>
<td>B</td>
<td>5</td>
<td>6</td>
<td>12</td>
<td>13</td>
<td>7</td>
</tr>
<tr>
<td>E.</td>
<td></td>
<td>7</td>
<td>B</td>
<td>5</td>
<td>11</td>
<td>5</td>
<td>11</td>
<td>0</td>
</tr>
<tr>
<td>F.</td>
<td></td>
<td>4</td>
<td>D</td>
<td>5</td>
<td>8</td>
<td>12</td>
<td>15</td>
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<tr>
<td>G.</td>
<td></td>
<td>4</td>
<td>E,C</td>
<td>12</td>
<td>15</td>
<td>12</td>
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<tr>
<td>H.</td>
<td></td>
<td>5</td>
<td>F,G</td>
<td>16</td>
<td>20</td>
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</tbody>
</table>

Note: ES = Early Start, EF = Early Finish, LS = Late Start, LF = Late Finish, Float = (Late start – Early start)

### Figure Q2.1A Precedence Diagram Bridge Repair Project

![Precedence Diagram](attachment://precedence_diagram.png)
(c) What is the free float for activity F? Ans. 7 days. (See answer to previous question.)
(d) What is the free float for activity D? Ans. 0 days.
(e) What day in June will activity D have for its early finish date? Ans. June 6
(f) What is critical path and what is the critical path for the project?
Ans. Critical path is the list of activities that have zero total float. Path A B E G H is the critical path for this project.

(g) How many days will the project take to finish as scheduled?
Ans. 20 days. The first work of the project is done on June 1, and the last work for the project is completed on June 20th.

(h) What is the late start for activity F?
Ans. June 12. It has a late start that is calculated to be two days before the late finish of activity D. With leads and lags, it is best to calculate the LS of the dependent activity (F in this case), then the LF of the independent activity (6/11 for D), and then adjust the LF of the independent activity to consider the FS lead/lag (adjust LF for D from 6/11 to 6/13, see Fig. Q2.1A).

(i) What is the early start date for activity C? Ans. June 2
(j) If for some reason activity starts 5 days late, what will be the effect on project completion date?
Ans. No effect at all.

(k) What is the early finish and late dates of Activity A? Ans. June 1 for both.

Ans. Q2.2 c
Ans. Q2.3. d. The baseline schedule as well as the baseline budget and baseline scope is the original project plans plus or minus any approved changes.

Ans. Q2.4 b. In resource leveling an attempt is made to reduce overutilization of resources to their normal level.

Ans. Q2.5 c. Monte Carlo analysis is a simulation technique that assigns durations to tasks in a schedule and then calculates the schedule information. It repeats this task duration assignments and the subsequent calculation many times, and then reports statistical results, including the percent of time a task is on the critical path.

Ans.Q2.6. By completing the precedence diagrams (forward and backward passes); you will find that, activities B, D, and E have floats and that activities A, C, F, and G make up the critical path. The duration for the project is obtained by adding expected values (EV) of all activities in the critical path.

Using the formula for the expected value (EV) and standard deviation (SD), the PERT statistics can be calculated as shown in Table Q2.6a.

Expected Value, \( EV = \) \[\text{Optimistic} + 4 \times \text{Most likely} + \text{Pessimistic}\] (or PERT Weighted Average)
Standard deviation, SD = (Pessimistic – Optimistic) / 6

Also Variance = SD² or SD = (Variance)¹/²

Sample calculation for activity A:

EV = (4 x 6 + 8 + 5 )/6 = 6.17,
SD = ( 8 – 5 )/6 = 0.5, and Var = ((0.5)² = 0.25

<table>
<thead>
<tr>
<th>Activity</th>
<th>Likely</th>
<th>Pes.</th>
<th>Opt.</th>
<th>EV</th>
<th>SD</th>
<th>Var</th>
<th>EV</th>
<th>Var</th>
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<tbody>
<tr>
<td>A.</td>
<td>6 wks</td>
<td>8</td>
<td>5</td>
<td>6.17</td>
<td>0.5</td>
<td>0.25</td>
<td>6.17</td>
<td>0.25</td>
</tr>
<tr>
<td>B.</td>
<td>5</td>
<td>4</td>
<td>6</td>
<td>5.0</td>
<td>0.33</td>
<td>0.11</td>
<td>12.17</td>
<td>0.69</td>
</tr>
<tr>
<td>C.</td>
<td>12</td>
<td>15</td>
<td>10</td>
<td>12.17</td>
<td>0.83</td>
<td>0.69</td>
<td>12.17</td>
<td>0.69</td>
</tr>
<tr>
<td>D.</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E.</td>
<td>6</td>
<td>7</td>
<td>4</td>
<td>5.83</td>
<td>0.5</td>
<td>0.25</td>
<td>8.17</td>
<td>0.69</td>
</tr>
<tr>
<td>F.</td>
<td>8</td>
<td>11</td>
<td>6</td>
<td>8.17</td>
<td>0.83</td>
<td>0.69</td>
<td>8.17</td>
<td>0.69</td>
</tr>
<tr>
<td>G.</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>3.83</td>
<td>0.167</td>
<td>0.028</td>
<td>3.83</td>
<td>0.028</td>
</tr>
</tbody>
</table>

(Critical Path) Total = 30.34 1.658

SD = (1.658)¹/² = 1.29

Notations: EV = Expected Value, SD = Standard Deviation, Var = Variance

Ans Q2.6a. EV = 30.34 Weeks.
Ans Q2.6b. Range of EV for 95% confidence level is found by 30.34 +/- 2 x SD Weeks.

Or 30.34 +/- 2 x 1.29 ➔ 27.76 and 32.92 weeks.

Ans Q2.6c. Duration of C is 12.17 weeks.
Ans Q2.6d. Standard deviation of C is 0.83.
Ans Q2.7 Range of project completion duration: 90 +/- 2x3 = 84 and 96 days.

Ans Q2.8 d. Work Breakdown Structure
Ans Q2.9 c. Identify team roles and responsibilities
Ans. Q2.10 a. Critical path is reduced.
Ans. Q2.11 b. Crashing the schedule
Ans. Q2.12 See answer in Glossary of Terms.

Module 3
Ans. Q3.1 b. Staffing Plan
Ans. Q3.2 c. Is able to repeat some of the things speaker said
Ans. Q3.3 d. Co-location
Ans. Q3.4 a. Design of experiments
**Module 4**

Ans. Q4.1 d.

Ans. Q4.2  The project is considered done when all of the work is completed. EV is an indication of the work that is completed, and BAC represents the total of all the work that is planned to be done. Thus, when EV equals BAC, all of the work must have been done.

Ans. Q4.3 b.
Ans. Q4.4a.  $60/50 = 1.2$
Ans. Q4.4b.  $140/130 = 1.077$

Ans. Q4.4c.  $215,000$. The BAC for the project does not change from week to week. It will also be the same as the sum of all EV earned each week.

Ans. Q4.4d.  EAC is the estimated cost of the project that is expected at the end of the project based on what we know about the cost performance today.  
EAC = BAC/CPI = $215 / (140/160) = $ 245,714

Ans. Q4.5  A contingency budget is some amount of money set aside for known, identified risks. This gives more control to the project and reduces the problem of known risks using budget that was set aside for the work of the project, which may potentially cause cost overruns in the project.

Ans. Q4.6a.

$36 \text{ weeks} \times 40 \text{ hour/week} \times $45 \text{ per hour} \times 1.3 \text{ fringe benefits} \times 1.5 \text{ overhead} = \$126,360.$

In this case, the designer works 36 weeks full time as a team member and is paid for 36 weeks. The productivity and utilization factors affect the amount of time paid in comparison to the hours of effort required to complete the job. These factors do not come into play in this calculation.

Ans. 4.6b.

$[60 \text{ hours} / (0.70 \times 0.85)] \times $45 \text{ per hour} \times 1.3 \text{ fringe benefits} \times 1.5 \text{ overhead} = \$8,848.74$

Here, the cost of 60 hours of effort must be adjusted for person’s utilization and productivity. People of lower productivity takes proportionally longer time as they more mistakes, but usually cost less

**Module 5** (No exercises)

**Module 6** (No exercises)

P&P-T Answers: 1c, 2d, 3c, 4a, 5b, 6c, 7c, 8c, 9b, and 10d
# Self-Test Your PM Knowledge

**How well are you managing your projects?**

To test, answer the following questions:

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>Not Sure</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I have identified and assigned title to all projects under my responsibilities or the ones I’m involved.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Budgets for all projects have been approved</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. All projects have clearly defined and agreed upon goals</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>4. Schedules for all projects have been established and published</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Resources for all projects have been allocated</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>7. Personnel and vendors in the projects have the adequate skills and are trained to do the job</td>
<td></td>
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<tr>
<td>8. All individuals in the team are aware of the project goals and are enthusiastic about achieving the objectives</td>
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</tr>
<tr>
<td>9. We have clear communication among the team and any potential conflicts are easily resolved</td>
<td></td>
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</tr>
<tr>
<td>10. Potential problems are often easily identified and corrective actions are implemented before it gets out of hand.</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>11. I am always clear on the current progress and status of the project I am involved with.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Other project participants are cooperative and respond to my requests related to the project in time</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. When conflicts arise new agreements are reached quickly and with minimum disruption of work</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Project modifications are regularly communicated and are always understood by the teams</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. My projects always meet specifications and are consistently completed within time and budget</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

**Scoring:** 0 point for “No” or “I don’t know”, 1 point for “Yes”. 13 – 15

*Congratulation. You are an excellent project manager (Find new material in this seminar). 9 – 2 You are doing OK. But, there are define areas of weakness. Below 9 – you are perceptive and honest about the affairs in your company. This seminar will definitely help you complete project in a timelier manner and with less anxiety.*
Example Project Charter (CEP Payment Project)

PURPOSE: The purpose of this Charter is to define the mission, authority, conduct of operations or responsibilities, and membership for the CEP Payments project team.

SCOPE AUTHORITY: This Charter applies to all personnel assigned to, directing, or supporting the CEP Payments project.

AUTHORITY: Ultimate authority lies with Dinah Smith, SDSD Application Technical Manager and Meg Killgorecathcart, SDSD Information Systems Coordination Unit Manager.

PROJECT PURPOSE: To research alternative payment process solutions, recommend a solution, and ensure the successful implementation of the solution that addresses the business objectives.

CONDUCT OF OPERATIONS:

1. The delivery of the solution will be planned and managed loosely as a project using the standard set of the Project Management Institute’s project management phases – Initiating, Planning, Executing, Controlling, and Closing.

2. The project will identify, communicate, and obtain agreement of other affected groups or individuals who will be needed to support the project’s solution in the project plan.

3. The solution will be delivered in three phases. Phase one will incorporate processing daily check runs and checks printing at the DAS print plant. Phase two will incorporate removing SDSD CEP accounting from OMAP and process accounting functions through SDSD. Phase three will incorporate direct deposit processing.

4. Provide informal status to and receive guidance from the sponsors as called for by the Project Manager or Sponsor. Provide a weekly formal status to the SDSD Application Technical Manager.

5. The members of the core project team will track project time and submit to the SDSD Application Technical Manager.

MEMBERSHIP:

a. Core Members are dedicated 100 percent of their time upon joining the project, excluding leave and required overhead duties. The core members shall perform the majority of the project work. The proposed Core Members and their primary roles are:

   Natalie Rodgers  Project Manager/Systems Analyst
   Two (2) FTE  Developers

b. CEP Payments Sponsor provides the executive leadership, priority, and commitment to the project, its goals and objectives. The sponsor assures appropriate resources, funding, and the final decision on issues irresolvable by the project. The CEP Payments Sponsor is:

   Dan Kaplan  Associate Director, SDSD

c. CEP Payments Business Partners participate as required providing insight, additional data, and verification of the work of the project.

Preliminary estimated time commitment is 0-8 hours per week for length of project. The CEP Payments Business Partners are:

   Meg Killgorecathcart  SDSD Information Systems Coordination Unit (ISCU) Manager
   Joan Larson  Provider and Consumer Services Unit (PCSU) Manager
   Gene Sundet  SDSD-LTCQ-CEP Program Manager
   Wayne Breach  DO-FSS-Accounting/SDSD Manager


d. **Other Support** is the individuals or groups that the project will interface with to provide the solution. Their roles are varied and include supporting the development infrastructure and processes, providing technical assistance, answering questions that may arise during the course of development regarding specific functionality and processes, to assist in testing CEP Payment system enhancements and additions to insure the business objectives are met, and to test data passed from the SDSD systems to their respective systems.

Preliminary estimated time commitment is 0-4 hours per week for length of project. The known contacts are:

- Katherine Allen  SDSD ISCU Business Systems Analyst
- Tish Powers  SDSD ISCU Business Systems Analyst
- Dianne Finn  OIS-ISE-SDSD Senior Systems Analyst
- Jim Mlynczak  DO-FSS-Accounting/AFS
- Roberta Laux  DO-FSS-Accounting/SDSD/DO/OMAP
- Dave Hillier  DO-FSS-Accounting/SDSD
- Terrance Alley  MHDDSD

**AFS Application Team**
**OMAP Application Team**
**Computer Resource Management (CRM)**
**Data Resource Management (DRM)**
**DAS Print Plant**

**State Treasury**

**REVISION:** This charter will be reviewed, communicated, and revised as deemed necessary by the Project Manager and the SDSD ISCU Manager.

<table>
<thead>
<tr>
<th>Name,</th>
<th>Name,</th>
</tr>
</thead>
<tbody>
<tr>
<td>Title</td>
<td>Title</td>
</tr>
</tbody>
</table>

Hardcopy with signatures, dated mm/dd/yyyy filed in CEP Payment Project Notebook
Example Project Plan

Oregon Department of Human Services, Office of Information Services
Initial Client Contact Information, Client Demographic Display
CCAP – Centralized Client Access Project
Integrated Project Plan

Purpose of the Document
The Integrated Project Plan is used to guide both project execution and project control. It is required to ensure that the various elements of the project are properly coordinated. It is a document or collection of documents, which communicate the project’s plan. The integrated plan should be expected to change over time, as more information becomes available to the project.

The amount of planning performed should be commensurate with the scope of the project and the usefulness of the information developed.

Document Change Activity
The following is a record of the changes that have occurred on this document from the time of its original approval

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<tr>
<th>#</th>
<th>Change Description</th>
<th>Author</th>
<th>Date</th>
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<tr>
<td>1</td>
<td>Misc. changes per input from Kristen Duus</td>
<td>Debra</td>
<td>7/6/01</td>
</tr>
<tr>
<td>2</td>
<td>Misc. changes per input from Julie Mallford and Bryan Nealy</td>
<td>Debra</td>
<td>7/10/01</td>
</tr>
<tr>
<td>3</td>
<td>Changes regarding assumptions, issues, and developers per project team meeting 7/10/01</td>
<td>Debra</td>
<td>7/11/01</td>
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<tr>
<td>4</td>
<td>Add assumption regarding no updates during ICC</td>
<td>Debra</td>
<td>7/16/01</td>
</tr>
<tr>
<td>5</td>
<td>Update plan with new implementation date</td>
<td>Debra</td>
<td>8/21/01</td>
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</table>

Contents:
1 Background

1.1 Problem/Opportunity

Initial Client Contact Information:

As DHS moves to an integrated approach to service delivery, and a “no wrong door” policy is pursued, it is critical that the initial client information be captured only once, as close to the point of entry as possible, and then used by multiple systems.

Currently, each specific program area captures client information individually. This requires the entry and storage of the same information multiple times in multiple DHS systems.

Client Demographics Display

DHS workers need the ability to serve the client in an integrated fashion by having easy access to DHS client information.

Currently, they do not have easy access to this information, including information on the DHS Divisions from which the client may be receiving services. This creates a hardship for workers who must look up client information on several different systems, and who may not have the authority to look at some systems to gain this information.

1.2 Context or Alignment

These initiatives have been identified as IT projects that can be launched in the short term to support the DHS reorganization effort.
1.3 Planning Inputs or References

The primary inputs to this project are the DHS Reorganization Plan, the Initial Client Contact Information Executive Summary and the Client Demographics Display Executive Summary. In addition, numerous Project Management documents outlining and tracking the project will be stored on the DHS Pky-co server in the CCC directory using the Project Management directory structure.

2 Scope

2.1 Statement

The scope of this project is to develop user-friendly, Graphical User Interfaces (GUI) to enter initial client information and display basic client demographic and service level information.

The initial client contact information data collection will interface with the Client Information System (CI) through the TRACS system.

The client demographics data will be pulled from CI and will only display information for Divisions and/or clients whose information currently resides on this system. The information displayed will be read-only.

These GUIs will be developed as client-server applications using Powerbuilder development tools. They will be developed for one pilot site only. After implementation at the pilot site, they will be evaluated for future potential release.

2.2 Objectives & Measurements

Objective-1

Provide an integrated, user-friendly tool to be used by staff and partners to gather basic client and service-level information and display client demographics.

Measurement-1:
Upon completion of the project, staff and partners will be presented with GUIs that provide consistency of approach and help to minimize time and number of questions asked.

Objective-2

Provide an “initial point of entry” and a client demographic display via DHS systems that have the potential to be common to all clients.

Measurement-2:
Upon completion, a pilot site will have the use of a GUI “Initial point of Entry” and use of a GUI client demographic. Both will be based on existing data.

Objective-3

Determine a schedule for other DHS applications to also access and utilize this same information.

Measurement-3

Deliverable will be an evaluation of the pilot site and a plan for a new project to address the long-term need for Initial Client Contact Information and Client Demographics Display functions. The plan will include a proposed roll-out schedule.

2.3 Major Deliverable Milestones

<table>
<thead>
<tr>
<th>Milestone Description</th>
<th>Planned Completion</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2.4 Assumptions

Any policy decisions that affect this project made after August 1, 2001 will not be included for consideration in the project design.

The deliverable will be installed at one pilot site only by the November 1st delivery date. The pilot site will be selected by the Steering Committee.

This project does not address ongoing support that will be required once the proposed solution has been implemented. Instead, an evaluation of the pilot and a plan for a new project to address the long-term need for this functionality will be prepared.

Confidentiality polices regarding ownership and access to data has not been established by the Business Entities. As a result, no user security levels based upon user profiles will be included in the scope of this project. Users with authorization to the system will have access to all data available in the system.

The Initial Client Contact Information program will add clients to the Client Index ONLY, there will be no updating of existing information in the scope of this project.

2.5 Issues

Determine responsibility for user administration policies and processes. Information Technology will provide the tools for administration but the persons selected to do it need to be determined.

2.6 Completion Criteria

This project will be considered complete when an application meeting the objectives and measurements has been installed at one pilot site and a plan for future deployment and integration has been presented to and approved by the Steering Committee.

3 Work Plan

3.1 Work Breakdown Structure (WBS)

The Work Breakdown Structure (WBS) dictionary is a grouping of project elements that organizes and defines the total scope of the project: work not in the WBS is outside the scope of the project. This WBS dictionary is intended to confirm a common understanding of project scope. Each descending level of the WBS dictionary represents an increasingly detailed description of the work required to manage the project and deliver the customers request.

The WBS Dictionary is located in the appendix of this document due to the page orientation and size.
3.2 Schedule

<table>
<thead>
<tr>
<th>Phase</th>
<th>Duration</th>
<th>Assigned to</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Planning</td>
<td>7/1 to 7/15</td>
<td>Debra, Bryan, Pete</td>
</tr>
<tr>
<td>Requirements Analysis</td>
<td>7/1 to 8/24</td>
<td>Business Analysts, Bryan, Pete, a Powerbuilder resource &amp; others as needed (CRM, DRM, etc.)</td>
</tr>
<tr>
<td>Application and System Design</td>
<td>8/15 to 9/15</td>
<td>Bryan, Pete, and Tina (1/2 time)</td>
</tr>
<tr>
<td>Development</td>
<td>8/27 to 10/15</td>
<td>Bryan, Pete, and 4 contract developers</td>
</tr>
<tr>
<td>Testing</td>
<td>10/1 to 10/31</td>
<td>Bryan, Pete, Users (for user acceptance testing)</td>
</tr>
<tr>
<td>Training</td>
<td>10/21 to 11/1</td>
<td>(not identified yet)</td>
</tr>
<tr>
<td>Implementation (Pilot Site Only)</td>
<td>10/28 to 11/1</td>
<td>Bryan and Pete</td>
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<tr>
<td>Project Evaluation</td>
<td>11/10 to 11/20</td>
<td>Steering Committee, Project Team, Sponsor</td>
</tr>
</tbody>
</table>

3.3 Technical Feasibility and Recommendations

Due to the tight timeframe for development and implementation, it is necessary to carefully manage the scope and choice of the technical solutions for this project to be feasible.

There are three basic categories available for a technical solution for this project – 1) Traditional 3270 mainframe “green screen”, 2) web based or 3) client server.

1) While the mainframe green screen solution would be the most expedient, cheapest and least risky, it would not be well received by the users and therefore is being eliminated as a possibility.

2) The web-based solution is probably the best strategic choice, but neither the technical nor the organizational infrastructure is in place to support this technology, so this solution must also be eliminated.

Recommendation:
3) This leaves us with a client server solution with some of the technical aspects definitely set, but with the flexibility for several variations within our current operating environment:
   - The user interface will be coded in Powerbuilder.
   - The database will be either Sybase on UNIX or DB2 on the mainframe, or a combination of both.
   - The application will either reside on the desktop as a “fat client”, or will run on Met frame, or a combination of both.

Further technical details will be determined when a better understanding of the business requirements has been acquired.

3.4 Budget Projection

<table>
<thead>
<tr>
<th>Resource</th>
<th>Initial Client</th>
<th>Contact Information</th>
<th>Client Demographics</th>
<th>Display</th>
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<tr>
<td>State Staff: IS Engineering</td>
<td>1560 Hours</td>
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<td>1440 Hours</td>
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<td>3000 Hours</td>
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### 4 Organization

#### 4.1 Project Team Composition

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<th>Role</th>
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<td>State Staff: Business Analysts</td>
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<tr>
<td>Total</td>
<td></td>
<td>$440,000</td>
</tr>
</tbody>
</table>

#### 4.2 Internal Roles & Responsibilities

**Steering Committee – Policy and Practice Team**

The Policy and Practice Team is the steering committee for the project. They will be responsible for approval of the Project Charter and Project Plan. All changes in scope and implications thereof must be approved by the Steering Committee.

Members of the Policy and Practice Team are Maureen Casterline, Chair, Bill Fink, Shirley Iverson, Don Probasco, Jeanette Toninato, Charlotte Hartwig, Debbie Bowers, and Cecile Bentley.
Maureen Casterline, the Business Sponsor, will be responsible for providing the leadership, priority, and commitment to the project from the Business perspective. Serves as liaison to the Business, communicating the goals and objectives of the project and assures appropriate resourcing.

**OIS Oversight**

Kristen Duus, the OIS Oversight, will be responsible for providing the leadership, priority, and commitment to the project from the perspective of OIS. Assures appropriate resourcing and interfaces with the Steering Committee. Makes the final decision on escalated issues, with the approval of the Steering Committee.

**Project Coordinator**

Robert Green, the Project Coordinator, is responsible for coordinating all of the OIS reorganization initiatives.

**Project Manager**

Debra Herrli, the Project Manager, will be responsible for the project plan, organization, work execution, and controls to ensure successful project performance relating to cost, schedule and quality. Delivers the agreed-upon business goals and objectives on time, within budget, and with the expected level of quality. Works closely with the sponsors to plan the project, resolve issues, and monitor team activities. Manages day to day project activities and supervises project team.

**System Architecture Team Lead**

Brian Nealy, the System Architecture Team Lead, will be responsible for the system design and the leadership of the Business Analysts and the Systems Integration/Database Developer during the Requirements, Design, and Development phases. He provides knowledge of the TRACS and Client Index projects and uses that knowledge to guide the integration of this project with TRACS.

**Application Development Team Lead**

Pete Hale, the Application Development Team Lead, will be responsible for assisting in system design and leading the Powerbuilder developers during the Development, Testing, and Implementation phases of the project. Pete has broad experience leading development staff and designing and developing systems, including extensive experience developing Internet and Internet/interactive applications. He will apply his expertise in developing seamless user-friendly systems to this project.

**Technical Resource**

Tina Seshadri, the Technical Resource, will be responsible for assisting with the system design, specifically in regards to the Powerbuilder development environment. She will provide advice and oversight of the design so that it is feasible within the Powerbuilder environment and that it maximizes the use of the technology.

**Business Analysts**

The Business Analysts will be responsible for gathering business requirements while keeping a vision of long-term needs in mind, writing requirements documents, creating and executing test plans, and training. They will also act as an ambassador and facilitator to the business for the project.

**Note:** The final testing and training does not require a Business Analyst, but if a Business Analyst is not used, another business resource with appropriate testing and training skills would be required.

**Developers**

The project will need one Systems Integration/Database Developer to provide expertise on integration, one COBOL programmer who can take the WEBM Find program and turn it into an Open Server program,
and two Powerbuilder Developers who will be responsible for programming the system to meet the design specifications. All developers will be responsible for unit testing of their code and system testing.

### 4.3 Other Group Roles & Responsibilities

**Networking and Desktop Services (NDS)**

Responsible for providing network and desktop support, primarily during implementation planning and rollout.

**Computer Resource Management (CRM)**

Responsible for providing computer resource support, primarily during implementation planning and rollout.

**Data Resource Management (DRM)**

Responsible for providing data management support, primarily during implementation planning and rollout.

### 5 Facilitating Controls

#### 5.1 Risk Management Plan

**Risk #1 – Aggressive Project Completion Target Date**

Time frame for project completion is very tight. Possibility of missing targeted completion date is high.

**Rating:** High

**Trigger:** Slippage of any of the major milestones will be a signal that the risk may occur.

**Mitigation Plan:** Define scope of project tightly. Use proven technology. Manage expectations to match what is feasible. Immediately raise a warning flag if any of the major milestones are missed.

**Risk #2 – Business involvement has been low**

The involvement of the business in defining the project objectives has been limited to a very small group of people. Information regarding the project has not been widely disseminated. Support from the business is weak. There is a perception, true or not, that this is an OIS project. If the business is responsible for judging the success or failure of the project, without their buy-in the probability of success of the project is low.

**Rating:** High

**Trigger:** Lack of cooperation from the business entities during project design.

**Mitigation Plan:** Have the OIS Sponsor and Business Sponsor establish a communications (public relations) campaign targeting the business entities to inform them of the project. Get numerous business representatives involved in the project. Have Bobby Mink communicate to the business (all levels) about the purpose and importance of these projects.

**Risk #3 – Differing and Vague Objectives**

The Project Manager has observed differing expectations from various individuals involved in creating the Executive Summary. Although it has been communicated that the application being delivered is not a long-term solution, some team members have indicated that there will be a roll-out of the developed solution, while others have indicated that the solution will be installed at a pilot site only. In addition, although there is no
indication in the Executive Summary of selected technology, there is a clear direction toward certain technology.

**Rating:** High

**Trigger:** Observation of disparate executive expectations.

**Mitigation:** Clearly define objectives, including technology decisions. Present the objectives in writing and get full executive and business approval. Manage the project scope to the specific objectives. Get OIS Sponsor and Business Sponsor to be responsible for communication and enforcement of objectives.

### Risk #4 – Involvement of multiple OIS Groups

It will be necessary to obtain support from NDS, CRM, and DRM (possibly others) during the duration of the project. Exact resources needed will not be known until the project is more specifically designed. Resources in all units are tight; therefore it may be difficult to get skilled assistance at short notice, which may be necessary.

**Rating:** Medium

**Trigger:** Resources from other units not available when needed.

**Mitigation:** Communicate with each unit that their resources may be needed at the beginning of the project. Keep each contact informed as to the project progress. Alert units ahead as much as possible for needed resources. Obtain OIS upper management support for allocation of resources on short notice if needed.

### 5.2 Change Management

All changes will be logged and evaluated for impact to the scope, schedule, and cost of the project. OIS, the Business Sponsor, and the Project Manager will recommend whether to incorporate the changes or hold changes for a future release. Because the scope of this project must be tightly managed, the impact of changes will be carefully considered, communicated, and approved by the Steering Committee or sponsors prior to approval and incorporation.

### 5.3 Project Document Standards, Approval, and Controls

Document Standards – the project will use a consistent document style and layout for internal and external products produced.

Changes to documents will be tracked via a change activity log located in the document.

All internal work products being drafted or revised will be in located on Pky-co server in directory CCC. No project products will be stored on an individual’s hard drive.

An electronic project notebook or folder using the standard project management directory structure established by the Project Management Office will organize the project documentation. A copy of the folder will produce the project notebook. A hardcopy of document approvals will be included in the hardcopy notebook.

### 5.4 Communication Plan & Management

### 5.5 Status Reporting

The Steering Committee meets each Tuesday from 8:30 to 11:00AM at HSB. The Project Manager and OIS Oversight person will report to them on a weekly or bi-weekly basis as needed.

In addition, the Project Manager and OIS Oversight person will report to the OIS Executive Management team as requested.

### 5.6 Procurements & Contracts
A contract for procurement of outside Powerbuilder developers will be created for this project.

5.7 Quality Assurance

No formal QA will be conducted on this project.

5.8 Time Tracking

Time tracking will be informal. The Technical Team Lead will track time expended on the development effort. Rough estimates of all other tasks will be tracked.

5.9 Issue & Decision Management

Issues raised formally or informally that impact the scope, schedule, cost, or quality of the project will be tracked by the Project Manager on a formal issue-tracking document. Issues that the Project Manager can not resolve will go to the sponsors and ultimately the Steering Committee for a final resolution or decision.

Appendix A – WBS Dictionary

The Work Breakdown Structure (WBS) is a grouping of project elements that organizes and defines the total scope of the project: work not in the WBS is outside the scope of the project. This WBS dictionary is intended to confirm a common understanding of project scope. Each descending level of the WBS dictionary represents an increasingly detailed description of the work required to manage the project and deliver the selected PMO functions.

The Layout or description of the template is as follows:

First Column – Indicates the WBS grouping and numbering convention. The groupings are a hierarchy of Phase, Activity, Task, and Milestone.

The numbering convention is standard engineering numbering.

The Phase level is represented by a single number (i.e. 1.).

The Activity level is represented by a 2 digit number (i.e. 1.1),

The Task level is represented by a 3 digit number (i.e. 1.1.1).

The Milestone is represented by a four digit number (1.1.1.1)

Second Column – Indicates the Phase, Activity, Task, or Milestone name and a brief description that describes the work at each level. The activity level is the level for status and change control. The task and milestone level describe the specific work assignment to be accomplished.

Third Column – Indicates, at the task and milestone levels only, the assigned deliverable name.

Fourth Column – Indicates, at the task level only, the anticipated “effort in hours” to fully accomplish the defined task.

Fifth Column – Indicates, at the task and milestone levels only, the other tasks that this task or milestone is critically dependent on.

Sixth Column – Indicates, at the task and milestone levels only, the type of resource recommended, or most likely kills to have to complete the assignment.
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- The Task level is represented by a 3 digit number (i.e. 1.1.1).
- The Milestone is represented by a four digit number (1.1.1.1)

**Second Column** – Indicates the Phase, Activity, Task, or Milestone name and a brief description that describes the work at each level. The activity level is the level for status and change control. The task and milestone level describe the specific work assignment to be accomplished.

**Third Column** – Indicates, at the task and milestone levels only, the assigned deliverable name.

**Fourth Column** – Indicates, at the task level only, the anticipated “effort in hours” to fully accomplish the defined task.

**Fifth Column** – Indicates, at the task and milestone levels only, the other tasks that this task or milestone is critically dependent on.

**Sixth Column** – Indicates, at the task and milestone levels only, the type of resource recommended or most likely to have the skills to complete the assignment.

<table>
<thead>
<tr>
<th>#</th>
<th>WBS Dictionary</th>
<th>Del Name &amp; #</th>
<th>Eff Est</th>
<th>Critical Depend</th>
<th>Resp</th>
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</thead>
<tbody>
<tr>
<td>1.</td>
<td>Phase</td>
<td></td>
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<tr>
<td></td>
<td><strong>Initiate</strong> – Obtaining agreement on the business requirement and charting the project.</td>
<td>N/A</td>
<td></td>
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<tr>
<td>1.1</td>
<td>Activity</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td><strong>Determine the Business and OIS Sponsors</strong></td>
<td>N/A</td>
<td></td>
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</tr>
<tr>
<td>1.1.1</td>
<td>Task</td>
<td></td>
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</tr>
<tr>
<td></td>
<td><strong>Acquire project sponsorship from both the Business and OIS.</strong></td>
<td>Project Sponsors</td>
<td></td>
<td>OIS Sponsor</td>
<td></td>
</tr>
<tr>
<td>1.2</td>
<td>Activity</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td><strong>Charter the Project</strong> – Obtain the commitment and agreement between the sponsor and project team indicating how the project will be conducted and who needs to be involved.</td>
<td>N/A</td>
<td></td>
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<tr>
<td>1.3</td>
<td>Activity</td>
<td></td>
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<tr>
<td></td>
<td><strong>Conceptualize the Project</strong> – Determine the type and size of project and rough order magnitude (ROM) estimates.</td>
<td>N/A</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>2.</td>
<td>Phase</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td><strong>Plan</strong> – Creation and approval of the core work plan and facilitating plans, which will guide project execution and control.</td>
<td>N/A</td>
<td></td>
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<tr>
<td>2.1</td>
<td>Activity</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td><strong>Develop the Core Work Plan (CWP)</strong> – Develop the work scope, supporting schedule, budget, and project organization that focuses and guides the project work effort.</td>
<td>N/A</td>
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<tr>
<td>2.1.1</td>
<td>Task</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td><strong>Create Implementation and Resource Planning Group</strong> – To include representatives from the Help Desk, DRM, CRM, and NDS.</td>
<td>Resource Planning Group</td>
<td></td>
<td>PM</td>
<td></td>
</tr>
<tr>
<td>#</td>
<td>WBS Dictionary</td>
<td>Del Name &amp; #</td>
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</tr>
<tr>
<td>2.1.2. Task</td>
<td><strong>Database Support</strong> – Acquire database administration support</td>
<td>Formal Database Support</td>
<td></td>
<td></td>
<td>PM</td>
</tr>
<tr>
<td>2.1.3. Task</td>
<td><strong>Organize Project &amp; Staff Acquisition</strong> – provide an overall framework to describe the roles, responsibilities and membership of the Project. Obtain the staff needed for the core team. Obtain management commitment regarding utilization of core team. <strong>Obtain Business Analysts - Obtain</strong> BAs needed from other groups in the organization that will be cross-committed to the project. Obtain from management commitment regarding utilization of the BAs.</td>
<td>Organization</td>
<td></td>
<td></td>
<td>PM</td>
</tr>
<tr>
<td>2.2. Activity</td>
<td><strong>Develop the Facilitating Plans for Controls</strong> (FPC) – The plans for ongoing work required to ensure that the project can anticipate possible problems, solve, and make coordinated work plan adjustments.</td>
<td>N/A</td>
<td></td>
<td></td>
<td>PM</td>
</tr>
<tr>
<td>2.2.1. Task</td>
<td><strong>Risk Management</strong> – Determine which risks are likely to affect the project, evaluate potential risk outcomes and indicators, define plan to respond to key risks indicators.</td>
<td>FPC – Risk Id and Mgmt</td>
<td></td>
<td></td>
<td>PM</td>
</tr>
<tr>
<td>2.2.2. Task</td>
<td><strong>Project Standards, Approval, And Document Controls</strong> – Define and setup the documentation standards, document storage locations, project notebook, document approval and promotion process, and securities. Determine the approval process for technical decisions.</td>
<td>FPC – Stds, Apvls, Cntrs</td>
<td></td>
<td></td>
<td>PM</td>
</tr>
<tr>
<td>2.2.3. Task</td>
<td><strong>Communication Plan and Management</strong> – Outline a plan that identifies “who” needs “what” communications, in “what” media, “how” often and by “whom”. Define how status will be reported, by whom, how often, and in what formats and media.</td>
<td>FPC – Comm. Plan &amp; Mgmt</td>
<td></td>
<td></td>
<td>PM</td>
</tr>
<tr>
<td>2.2.4. Task</td>
<td><strong>Procurements &amp; Contracting</strong> – Determine resources to procure and when, document requirements and identify potential sources.</td>
<td>FPC – Proc. &amp; Cntrkg</td>
<td></td>
<td></td>
<td>PM</td>
</tr>
<tr>
<td>2.2.5. Task</td>
<td><strong>Change Management</strong> – Outline a simple change management process to coordinate approved changes in the project plan. <strong>Issue and Decision Management</strong> – Determine process for raising and resolving project issues that impact the scope, schedule, cost or quality of the project.</td>
<td>FPC – Iss. &amp; Decision Mgmt</td>
<td></td>
<td></td>
<td>PM</td>
</tr>
<tr>
<td>2.3. Activity</td>
<td><strong>Develop the Project Plan</strong> – Integrating the results of the other planning activities into a coherent document to guide the project execution and control.</td>
<td>N/A</td>
<td></td>
<td></td>
<td>PM</td>
</tr>
<tr>
<td>2.3.1. Task</td>
<td><strong>Plan Integration</strong> – Summarize and incorporate the outputs of the planning activities into a single reference document – the Initial Client Contact Information and Client Demographics Display Project Plan. The plan is the reference document for work to be performed by all involved in the project and must be made easily accessible to all in electronic format.</td>
<td>Project Plan</td>
<td></td>
<td></td>
<td>PM</td>
</tr>
<tr>
<td>2.3.2. Task</td>
<td><strong>Plan Presentation and Review</strong> – Distribute, review and obtain approval of the project plan from the project directing authority(s) and managers who have staff assigned to the project.</td>
<td>Presentation, &amp; Document Approval</td>
<td></td>
<td></td>
<td>PM, Sponsors</td>
</tr>
<tr>
<td>2.3.2.1. Mile</td>
<td><strong>Plan and Schedule Approved by Steering Committee</strong></td>
<td>Approved Project Plan</td>
<td>0</td>
<td></td>
<td>PM, Steering Com., Sponsors</td>
</tr>
<tr>
<td>3. Phase</td>
<td><strong>Execute</strong> – Definition of the required work activities to define, construct, pilot, and implement the product scope or selected system functions.</td>
<td>N/A</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>3.1. Activity</td>
<td><strong>Requirements Analysis (RA)</strong></td>
<td>N/A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1.1. Task</td>
<td><strong>System Solution</strong> – Develop application and system architecture solution.</td>
<td>RA – System Solution</td>
<td></td>
<td></td>
<td>BN and BAs</td>
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<tr>
<td>#</td>
<td>WBS Dictionary</td>
<td>Del. Name &amp; #</td>
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<td>Critical Depend</td>
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<tr>
<td>3.1.2. Task</td>
<td><strong>Client Demographics</strong> – Determine client demographics screen specifications – data and characteristics</td>
<td>RA – Data and Screen requirements</td>
<td>BN and BAs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1.3. Task</td>
<td><strong>ICCI</strong> – Define basic client information elements.</td>
<td>RA – Client Info Elements</td>
<td>BN and BAs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1.4. Task</td>
<td><strong>Data Ownership and Security</strong> - Determine who is the owner of the data. Determine security and access policies.</td>
<td>Policies</td>
<td>BN and BAs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1.5. Task</td>
<td><strong>RA Document</strong> - Compile Requirements Into Requirements Analysis Document</td>
<td>Requirements Analysis</td>
<td>BN and BAs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1.5.1. Mile</td>
<td><strong>Requirements Analysis Document Approval</strong></td>
<td>Approved Requirements</td>
<td>0</td>
<td>PM, Sponsors</td>
<td></td>
</tr>
<tr>
<td>3.2. Activity</td>
<td>Application Design – Create technical design of the system. (AD)</td>
<td>N/A</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>3.2.1. Task</td>
<td>Develop application and system architecture solution</td>
<td>AD – Architecture solution</td>
<td>BN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.2.2. Task</td>
<td><strong>Client Demographics Display</strong> – Design client demographics screen, data, and characteristics.</td>
<td>AD – Client Demo Design</td>
<td>BN</td>
<td></td>
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</tr>
<tr>
<td>3.2.3. Task</td>
<td>ICCI Design – Design Initial Client Contact screen, data, and characteristics.</td>
<td>AD – ICCI Design</td>
<td>BN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.2.4. Task</td>
<td>Integration Design – Design system integration components.</td>
<td>AD – Integration Design</td>
<td>BN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.2.4.1. Mile</td>
<td><strong>Application Design Document Approval</strong></td>
<td>Approved System Design</td>
<td>PM, Sponsors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.3. Activity</td>
<td>Construct the System – Create the system according to the Application Design</td>
<td>N/A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.3.1. Task</td>
<td>Technical System Development – Construct screens, tables, and system integration processes.</td>
<td>Programs per Design</td>
<td>PH, Developers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.3.2. Task</td>
<td>System Unit Testing – Internally test system components.</td>
<td>Unit tests</td>
<td>PH, Developers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.3.2.1. Mile</td>
<td><strong>Application ready for Testing</strong></td>
<td>Untested Application</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.4. Activity</td>
<td>System Testing – Test integrated system, conduct user acceptance testing</td>
<td>N/A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.4.1. Task</td>
<td>Create test plan – Create system testing plan.</td>
<td>Test Plan</td>
<td>BN, PH, BAs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.4.2. Task</td>
<td>Environment – Set up testing and training environment.</td>
<td>Testing and Training Environment</td>
<td>BN, PH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.4.3. Task</td>
<td>Integrated systems test – Test screens, tables, and system integration process. Test all components of the system as an integrated unit.</td>
<td>Technically tested system</td>
<td>BN, PH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.4.4. Task</td>
<td>User Acceptance Testing – Conduct acceptance testing of system by users.</td>
<td>User tested and accepted system</td>
<td>BN, BAs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.4.4.1. Mile</td>
<td><strong>Tested System Ready for Implementation</strong></td>
<td>Tested System</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.5. Activity</td>
<td>Training – Train users on new system</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.5.1. Task</td>
<td>Environment – Confirm training environment (should have been set up prior to testing.)</td>
<td>Training Environment</td>
<td>BN, BAs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.5.2. Task</td>
<td>User Training Strategy – Create training plan.</td>
<td>Training Plan</td>
<td>BAs</td>
<td></td>
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</tbody>
</table>
### Appendix

<table>
<thead>
<tr>
<th>#</th>
<th>WBS Dictionary</th>
<th>Del Name &amp; #</th>
<th>Eff Est</th>
<th>Critical</th>
<th>Resp</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.5.3. Task</td>
<td>User Training – Conduct user training.</td>
<td>User Training</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.5.3.1. Miles</td>
<td>Users Have been Trained</td>
<td>Trained Users</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.6. Activity</td>
<td>Implementation – Implement system at one pilot site</td>
<td>N/A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.6.2. Task</td>
<td>Pilot Site Selection – Select Pilot Site.</td>
<td>Pilot Site</td>
<td>BN, PM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.6.3. Task</td>
<td>System implementation – Install system at Selected Pilot Site. Deploy to users. Support users during implementation phase.</td>
<td>Installed system</td>
<td>BN, PH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.6.3.1. Miles</td>
<td>System Installed and Operational at Pilot Site</td>
<td>Implemented System</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Phase</td>
<td>Controls – Administer and manage work controls to ensure project performance.</td>
<td>N/A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.1. Activity</td>
<td>Project Procedures and Controls</td>
<td>N/A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.1.1. Task</td>
<td>Risk Management – Manage risks by responding to identified risk indicators as they occur.</td>
<td>FPC – Risk Id and Mgmt</td>
<td>PM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.1.2. Task</td>
<td>Change Management – Identify, plan, and conduct ongoing change control of the project. Ensure that the requirements, budget, and schedule milestones remain in line with the current approved project plan or are changed officially providing new requirements, budget, or schedule milestones.</td>
<td>FPC – Chg Mgmt</td>
<td>PM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.1.3. Task</td>
<td>Project Standards, Approval, And Document Controls – Conduct administration of approvals, project library, administrative filing, and securities.</td>
<td>FPC – Sds, Approvals, &amp; Cntls</td>
<td>PM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.1.4. Task</td>
<td>Communication Management – Deliver communications or facilitate communication delivery and conduct ongoing administration of communications</td>
<td>FPC – Comm. Plan &amp; Mgmt</td>
<td>PM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.1.5. Task</td>
<td>Status Reporting – Conduct ongoing project status reporting of work activities, budgets achievements and issues.</td>
<td>FPC – Status Rptg</td>
<td>PM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.1.6. Task</td>
<td>Procurements &amp; Contracting Management – obtain quotations, bids, offers, or proposals, choose from among potential vendors, administer the contract, and close. Obtain Contract Developers – Create contracts and obtain approval to hire contract developers needed for the projects.</td>
<td>FPC – Procurements &amp; Contracting</td>
<td>PM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.1.7. Task</td>
<td>Quality Assurance – monitor and identify way to eliminate causes of unsatisfactory quality performance.</td>
<td>FPC</td>
<td>PM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.1.8. Task</td>
<td>Time Tracking – administer the time tracking activities and team recording of individual time</td>
<td>FPC – Time Tracking</td>
<td>PM, BN, PH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.1.9. Task</td>
<td>Issue and Decision Management – Administer the issue and decision process.</td>
<td>FPC – Issue and Decision Mgmt</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Phase</td>
<td>Close – Evaluate the projects achievement of scope, objectives, and measurements. Identify the maintenance plan, turn-over to maintenance, and release project resources.</td>
<td>N/A</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### WBS Dictionary

<table>
<thead>
<tr>
<th>#</th>
<th>Activity</th>
<th>Description</th>
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<th>Eff Est</th>
<th>Critical Depend</th>
<th>Resp</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1. Activity</td>
<td>Project Evaluation – Recognize the achievements and lessons learned of the project, and determine readiness to close the project.</td>
<td>N/A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.1.1. Task</td>
<td>Evaluate Pilot Implementation and Determine a schedule for other DHS applications to also access and utilize this same information - Evaluate the pilot site and create a plan, including a schedule, for other DHS applications to access and utilize the Initial Client Contact Information and Client Demographics Display.</td>
<td>Deliverable for Milestone #4</td>
<td></td>
<td>PM, BN, PH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.1.2. Task</td>
<td>Prepare a project evaluation – Review the project’s completion criteria, scope, objectives, measurements, and lessons learned. Document and analyze the information and review with the sponsors. Obtain agreement from the sponsors on readiness to proceed with project closure.</td>
<td>Project Evaluation &amp; Lessons Learned</td>
<td></td>
<td>PM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.1.3. Task</td>
<td>Close out Project – Prepare for and celebrate project closure. Release project resources.</td>
<td>Project Celebration Closing</td>
<td></td>
<td>PM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.1.3.1. Milestone</td>
<td>Project successfully closed</td>
<td>N/A</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.1.4. Task</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

**Sample Closing Letter**

**From:** Smith, Robin R  
**Sent:** Monday, May 19, 2003 12:50 PM  
**To:**  
**Cc:**  
**Subject:** RE: GMAC Mortgage AIX Upgrade to FNETSD-May 17-18 CMWO: 7010406005

Thanks to all of you for successfully completing the GMAC Mortgage AIX Upgrade project this past weekend. Once again you all proved that you are a skilled and supporting team of people.

Thanks again everyone for a great job.

*Robin Smith, PMP*

Project Manager, Solutions Consulting Application Services-FPM Application Delivery  
MS 6266, 1800 Tower Drive, Troy MI 48098
Sample Project Description

The Shuttle Small Payloads Project (SSPP) designs, develops, tests, integrates and flies a group of small payload carrier systems for the Space Shuttle. These carriers - the Hitchhiker, Get Away Specials (GAS), Space Experiment Module (SEM) support payloads supplied by NASA, other US government agencies, universities, high schools, domestic commercial customers, and foreign nationals and governments. These carriers can support payloads that range in size between 50 lbs (23 kg) and 4000 lbs (2270 kg).

But the carriers are only one part of the SSPP. We have an experienced and knowledgeable staff that will work right along with you, every step of the way, until your experiment is safely in space. 

You build it. We launch it. You control it.
"NASA is deeply committed to spreading the unique knowledge that flows from its aeronautics and space research..."

Project Mercury
Initiated in 1958, completed in 1963, Project Mercury was the United States' first man-in-space program.

Project Gemini
The second U.S. manned space program was announced in January 1962. Gemini involved 12 flights, including two unmanned flight tests of the equipment.

Apollo-Soyuz
The mission started with the Russian Soyuz launch on July 15, 1975, followed by the U.S. Apollo launch on the same day. Docking in space of the two craft occurred on July 17, and joint operations were conducted for two full days. Both spacecraft landed safely and on schedule.

Space Shuttle
The Space Shuttle is a viable part of American History. Standing as one of NASA's foremost projects, the shuttle has accomplished many tasks that have enhanced the quality of life on Earth. View archives of every shuttle mission here.

"I believe this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the Moon and returning him safely to Earth. No single space project in this period will be more impressive to mankind or more important in the long-range exploration of space; and none will be so difficult or expensive to accomplish."

John F. Kennedy
Special Joint Session of Congress
May 25, 1961

Skylab
Designed for long duration missions, Skylab program objectives were twofold: To prove that humans could live and work in space for extended periods, and to expand our knowledge of solar astronomy well beyond Earth-based observations.

Shuttle-Mir
Phase 1 was a NASA program encompassing 11 space shuttle flights over a four-year period. It used existing assets - primarily U.S. shuttle orbiters and the Russian Space Station Mir - to build joint space experience and start joint scientific research.

International Space Station
The most complex engineering and construction project in the world is taking place in space. 16 countries and over 100,000 people are contributing to this monumental achievement.

NASA’s History Office
Since its inception in 1958, NASA has accomplished many great scientific and technological feats in air and space.

NASA Histories On-line
On-line versions of more than 100 NASA history publications are available at this Web site.

Walking to Olympus: An EVA Chronology
An online PDF (3.5M) chronicle of EVAs conducted since the dawn of the space age.

Yesterday's Space Facts
Search the Human Space Flight Web's archive of Space Facts.
PMP Exam Preparation Materials

This section contains materials on content and preparation for Project Management Professional (PMP) certification examination and is included for discussion in the seminar extending beyond the standard 4 days.

PMI & Project Management Professional (PMP®) Examination

Visit http://www.pmi.org

To be eligible for the PMP certification, you must first meet specific education and experience requirements and agree to adhere to a code of professional conduct. The final step in becoming a PMP is passing a multiple-choice examination designed to objectively assess and measure your project management knowledge. This computer-based examination is administered globally.

In addition, those who have been granted the PMP credential must demonstrate an ongoing professional commitment to the field of project management by satisfying PMI’s Continuing Certification Requirements Program.

Steps for preparation:

1. Read books, practice PM, and attend seminar (35 hours or more) on PM
2. Visit http://www.pmi.org and get application forms and download sample questions and review questions included in this section.
3. Read preparatory books like
4. Take exam (allow 4 weeks or more for preparation)


June 2009 – Fees (Current Information): http://www.pmi.org/Pages/default.aspx

Membership Status: PMI global community - more than 265,000 professionals in over 170 countries. http://www.pmi.org/CareerDevelopment/Pages/PMP_Expiration_Date_Change.aspx

PMI Membership Fee: membership for just $119 (US) plus a $10 (US) application fee for new members.

PMP Certification Exam Fee: http://www.pmi.org/CareerDevelopment/Pages/AboutCredentialsPMP.aspx $405 for members, $555 for non-members
The Project Management Professional (PMP®) Credential  (Nov. 2007)

http://www.pmi.org/CareerDevelopment/Pages/Obtaining-Credential.aspx

Individuals who hold PMI’s PMP credential demonstrate a proficient level of project management leadership skills, and as a result are able to command salaries that exceed those of their non-credentialed counterparts.

To be eligible for a PMP credential, you must meet specific guidelines that objectively measure experience, education and professional knowledge. You also must agree to adhere to the PMI Code of Ethics and Professional Conduct and pass a rigorous multiple-choice examination that assesses your abilities in project management.

Eligibility

- Applicants must have 35 hours of specific project management education.
- With a Bachelor's Degree (or the global equivalent): Applicants must have a minimum three years’ professional project management experience, during which 4,500 hours are spent leading and directing project tasks, up to eight years from the time of application.
- Without a Bachelor's Degree (or the global equivalent): Applicants must have a minimum five years’ professional project management experience, during which at least 7,500 hours are spent leading and directing project tasks, up to eight years from the time of application.

The PMP Credential Examination

This four-hour examination composed of 200 multiple-choice questions measures your ability to apply knowledge, skills and techniques used in project management. The examination is developed by groups of individuals from around the globe who hold the PMP credential and is routinely reviewed and revised to ensure the best and consistently objective assessment.

Examination preparation tips:

1. Review the PMP credential handbook, the PMP Examination Specification and the PMP Sample Questions document (not for commercial use).
2. Study the PMBOK® Guide—Third Edition and other texts that discuss the management of communications, cost, human resources, integration, procurement, quality, risk, scope and time, as well as a project manager's social and professional responsibilities.
3. Enroll in formal study courses.

You should download the PMP Credential handbook, print, and review these two PDF files for complete information about the content, preparation and learn how to take the PMP exam. PMP Credential Handbook contains detail description of the requirements for the certification process.
The Project Management Professional (PMP) certification, sponsored by the Project Management Institute (PMI), is the most recognized and respected certification credential in the field of project management.

To achieve PMP certification, each candidate must satisfy all educational and experiential requirements established by PMI, agree to adhere to a code of professional conduct, and must demonstrate an acceptable and valid level of understanding and knowledge of project management. The PMP certification examination tests this knowledge. PMP-certified professionals must also demonstrate ongoing professional commitment to the project management field by satisfying PMI continuing certification requirements program. For more information, check the certification page on the PMI Web site.

**Tips on taking the PMP exam**
The PMP certification examination is a computer-based exam that is offered at PMI locations in the United States, Canada, and in other countries worldwide.

The exam is based on information from the entire project management body of knowledge. The “Guide to the Project Management Body of Knowledge” (PMBOK®), which is published by PMI, provides an outline of the topics covered.

The examination covers the five groups of project management processes and professional responsibility. (See Figure below).

<p>| Breakdown of Questions by Process Group (New: 175 + 25 pre-test questions) |</p>
<table>
<thead>
<tr>
<th>Process Group</th>
<th>Approximate Number of Questions</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initiating</td>
<td>17 of 200</td>
<td>8.50</td>
</tr>
<tr>
<td>Planning</td>
<td>47</td>
<td>23.50</td>
</tr>
<tr>
<td>Executing</td>
<td>47</td>
<td>23.50</td>
</tr>
<tr>
<td>Controlling</td>
<td>46</td>
<td>23.00</td>
</tr>
<tr>
<td>Closing</td>
<td>14</td>
<td>7.00</td>
</tr>
<tr>
<td>Professional Responsibility</td>
<td>29</td>
<td>14.50</td>
</tr>
</tbody>
</table>

PMI PMP Exam Q&A: [http://www.pmi.org/info/PDC_Cert_FAQ_Exam_PreP.asp](http://www.pmi.org/info/PDC_Cert_FAQ_Exam_PreP.asp)
The 2005 PMP exam will contain 25 pretest questions. Although the overall number of questions will still remain at 200, 25 of these questions will not count toward your overall score.

**Questions on the PMP exam are grouped by project management processes:**
The basic PMP exam is not industry specific. The PMI Certificate of Added Qualification (CAQ), which tests your knowledge of a particular industry, can be added to certify your expertise in Information Technology Project Management, Establishing a Project Management Office, and Project Management in the Automotive Industry.

**Tips for taking the PMP exam**
Passing the PMP exam requires extensive preparation. Use the following tips and techniques as part of that preparation, which should also include developing a comprehensive understanding of the PMBOK® concepts and terminology, practicing previous exam questions when possible, and attending a few project management-training courses.
Good site for info: Visit this site for detail PMP exam and how to prepare for it.
http://www.whizlabs.com/articles/pmp-certification-article.html

30 November 2005 announcement from PMI
http://allpm.com/modules.php?op=modload&name=PNphpBB2&file=viewtopic&t=547

PMI lowered the passing mark to 61%.

PMI Adjusts Passing Score for New PMP® Exam Originally Announced on November 30, 2005
http://www.rmcproject.com/about/20051130-pmp-exam-scoring-changes.aspx

RMC has been notified by the Project Management Institute that they have lowered the passing score for the new PMP exam to 61% (106 correct out of 175 possible +25 Pretest questions). We have also been informed that this new score will be retroactively applied to all examinations taken since September 30th of 2005. Note that this change in passing score is a permanent act on behalf of PMI, and will remain until the exam is changed in four to five years.

PMI® Adjusts the Passing Score for the PMP® Exam
http://www.cheetahlearning.com/newsletter/happenings3.htm

Cheetah Learning recently received official notice from PMI® that they have recalibrated the pass score for the new PMP® exam, based on statistical analysis done on the over 800 exams taken since they began giving the new exam September 30th, 2005. The passing score for the new exam has now been changed from 81% to 61%. PMI® has applied the new passing score to all examinations taken since September 30th, 2005, by candidates who sat for the new exam.

PROFESSIONAL DEVELOPMENT UNITS (PDUs)

PMP Certification is granted for a period of 3 years, during which you will need to register with PMI that you have an on-going commitment to the project management profession and log up 60 Professional Development Units (PDUs).

These are usually achieved through training courses accredited by PMI or by attending Chapter Meetings and numerous other methods as outlined in the Continuing Certification requirements handbook (CCR).

PMP Exam Online Self Assessment Test - 75 Sample Questions -

General Observations & Recommendations:

1. If you have a bachelor level education and 5 or more years of experience, you are most likely to enough project management experience to satisfy requirements for qualifying to take exam.
2. Regardless of positions you worked, you probably have enough project experience. The challenge, however, is to view your experience as projects and express them in written format in line with project management practices.
3. You will require project management education (35 hours of seminar/training). This will help you articulate your project experience.
4. The rest is up to how you prepare for the exam. A preparatory text with questions and answers will be of help. Allow about 2 hours/day for 2 months for preparation.
PMP EXAM TYPE SAMPLE QUESTIONS

COMMUNICATION

1. Due to the cost overruns, Diane has sent a status report to the CEO of her company. Assuming he reads it, she can expect him to remember what percent of the report?

   A. 73% to 77%
   B. 23% to 27%
   C. -25% to 75%
   D. 50%
   Answer: A

2. Which of the following methods to resolve conflict is most likely to create a "wounded warrior"?

   A. Forcing
   B. Compromising
   C. Accommodation
   D. Avoidance
   Answer: D

3. "Decoder" is not synonymous with "receiver" because

   A. the decoder interprets based on his or her frame of reference
   B. the decoder is not a position on the team
   C. the decoder evaluates, uses assumptions and self-interest while the receiver sees or hears
   D. the decoder uses skills and credibility to challenge the encoder
   E. a and c
   Answer: E

4. People generally remember __ % of the spoken word in 1-2 days and __ % in 2 months.

   A. +50, +75
   B. +50, +25
   C. +75, -25
   D. +10, -5
   Answer: B

5. In a simple, interactive, one-on-one communication process, there are the sender and receiver of information. The sender is the one who transmits the signals, while the receiver ________ the signals.

   A. accepts
   B. mixes
   C. rejects
D. interprets [PMBOK® ]
Answer: D

6. The communication process must have a medium to convey information between two or more parties. The three common media are ________.

A. written, spoken, and signalized
B. visual, audio, and tactile
C. seeing, talking, and listening
D. seeing, listening, and touching
Answer: B

7. Communications between two individuals can be affected by either the attitude of either party or an external source disrupting the flow of information. An example of a barrier between the parties involved in verbal communications and an example of a disruptive influence could be ________.

A. a wall between desks and a difference in language skills
B. a third party injecting comments and a fourth party attempting to change the subject
C. an attitude of hostility by the receiver or sender and a ringing telephone nearby
D. a confrontation over schedules and a lack of a scheduling tool
Answer: C

8. Of the five basic approaches to conflict resolution that characterize an individual's human resource management style, the one that produces a "win-lose" outcome whereby the project manager uses his/her power to overrule the participant in the conflict is ________.

A. confrontation
B. compromise
C. smoothing
D. forcing
Answer: D

9. Management styles affect the confidence level given a project manager by subordinates, peers, and superiors. When a project manager is judicial in his/her management style, s/he is ________ .

A. honest, sincere, able to motivate and to press for the best and fairest solution, and one who generally goes "by the books"
B. marked by an eagerness to fight or be disagreeable over any given situation
C. encouraging subordinates to realize their full potential, cultivates team spirit, and lets subordinates know that good work will be rewarded
D. one who exercises sound judgment in most areas of the project
Answer: D

10. Communications between individuals while talking may also involve nonverbal communications, or body language. Body language is most commonly associated with ________.

A. twisting and shrugging
B. gestures and facial expressions
C. toe tapping and foot shuffling
11. Communication, as the key to successfully implementing a project, is reflected in many forms and styles. The communication medium/media used in the project can be a ________.

A. budget  
B. schedule  
C. configuration management plan  
D. meeting agenda  
E. all of the above  
Answer: E

12. In negotiations, there are always ongoing communications in an attempt to reach a position that is mutually agreeable to all parties. One means (facilitator) of communication during the negotiation phase is to ________.

A. obtain written concurrence at the end of each session  
B. be calm, poised, and patient  
C. use surprise as required  
D. not be afraid to say no  
E. all of the above  
Answer: E

13. Communication includes understanding the other person and reaching a consensus as to what was said. The use of ________ is a means of giving feedback to the speaker by rephrasing the speaker's words to ensure there is a level of understanding.

A. give-back  
B. active listening  
C. double talk  
D. double speak  
Answer: B

14. Communications between the project manager and a team member take many forms, but it would not include a ________.

A. memorandum announcing a meeting of the team  
B. letter of commendation to a team member  
C. performance appraisal for a team member  
D. newsletter article reviewing the project's progress  
Answer: D

15. In face-to-face communications, individuals send two messages when they speak. The two message aspects are content and command. The first contains that part of the message about which two or more persons can agree, and the second contains ________.
A. that portion that is intentionally meant to be misunderstood
B. that portion that imposes behavior and the relationship between the parties
C. inferences as to future messages to be sent
D. reinforcement of prior messages
Answer: B

16. Barriers to communication can be invisible to the casual observer but can often be greater obstacles than physical barriers. However, barriers do not include ________.

A. semantic ordinates, or absolute words
B. differences in frames of reference
C. lack of credibility or trust
D. an overly technical approach to communicating
Answer: D

17. Team members may "filter" information to the project manager for several reasons. Filtering, a selective reduction in the quantity and quality of information, is promoted through all of the following except when the team member ________.

A. does not believe the information to be important
B. receives an adverse reaction when "bad news" is given
C. fails to understand the information in the context given
D. takes too long in obtaining the correct information
Answer: D

18. The factors of the structural environment can be manipulated (positively and negatively) to improve or degrade the effective communications within a project team. Of the following factors, the one that can be manipulated the most to change the level of communications is ________.

A. mobility opportunity
B. status
C. organizational climate
D. autonomy
Answer: C

19. Project managers must strive to improve communications within the project team as well as with external elements. The project manager can improve communications by removing ________ of the information.

A. delays, impediments, and barriers
B. filtering, distortion, and blockage
C. haste, waste, and redundancy
D. pushing, pulling, and putting aside
Answer: B

20. The most basic model for the communication process consists of three basic elements ________.
When these three elements are present, communication may result.

A. words, illustrations, and mathematics
Appendix

Why?
Solve Problems
Optimize products

Where?
Manufacturing
Development
Design

B. people, transmission medium, and information processor
C. verbal, nonverbal, and physical
D. sender, receiver, and message
Answer: D

COST

001. The relationship between the budgeted actual cost, actual work completed and work planned will determine the
A. Schedule estimate at completion
B. Cost estimate at completion
C. Cost Performance Index
D. Schedule Performance Index
Answer: A

002. All work packages are complete
A. at EAC time
B. when BAC is equal to EAC
C. when BCWP intersects BCWS
D. when schedule variance is zero
Answer: B

003. Earned value is
A. the base line plan
B. completed work value
C. cost/cost variance
D. percent over or under budget
Answer: B

004. You could tell Diane was worried about her project. Her folks had been working on the project since Independence Day. Here it was already Halloween and they were just finishing up work that was supposed to have been completed by Labor Day. "Oh dear", she confided to her friend, "Instead of completing by Christmas, at this rate I expect we won't be done until
A. New Year's Day
B. St. Patrick's Day
C. Easter
D. the 4th of July
Answer: D

005. Diane was so concerned about her project that she woke up dreaming about it. She thought to herself, "Well, our BCWP is 2, our ACWP is 4 and our BCWS is 6, so that means
A. our productivity was less than planned
B. our cost estimate at completion is 6
C. our CPI and SPI are both positive
D. our cost variance is negative
E. a, c and d
Answer: E

006. The measurement which best shows the difference between actual work and actual costs is

A. Cost variance
B. Percent over or under
C. Schedule variance
D. CPI
Answer: A

007. Rework costs ____ times budgeted costs.

A. +75, -25
B. +25, -10
C. 25 to 50
D. 10 to 15
Answer: C

008. If part of a project's costs will be paid in future years, the best way to determine the value of those costs in today's dollars is

A. estimated project payout
B. return on investment
C. net present value
D. discounted cash flow
Answer: D

009. If the ACWP exceeds the BCWP, the cost estimate at completion will

A. increase
B. decrease
C. depend on the BCWS
D. exceed the schedule estimate at completion
Answer: A

010. If the BCWS = $1,000,000, the BAC = $2,000,000, the ACWP = $1,500,000, the BCWP = $500,000 and you're halfway through the project after two years, what is the cost estimate at completion?
A. $2,000,000
B. $4,000,000
C. $6,000,000
D. $8,000,000
Answer: C
011. Cost management requires a critical look at future expenditures and the controls exercised over those expenditures. The three types of cost estimates through which project expenditures are made are ________.

A. rough order of magnitude, guestimate, and actual
B. traditional, classical, and contemporary
C. order of magnitude, budget, and definitive
D. concept, budget, and design

Answer: C

012. The cost estimate with the most precise estimate (i.e., the smallest range of error) is the ________ estimate.

A. engineering
B. budget
C. concept
D. definitive

Answer: D

013. The cost estimate that has a range for error of minus 10 percent to plus 25 percent is the ________ estimate.

A. budget
B. definitive
C. parametric
D. analogy

Answer: A

014. There are usually two types of reserves in a project's budget. The ________ reserve is for cost variances from the plan because of inaccurate estimates or pricing and costs overruns, while the ________ is to accommodate costs for project work that were not included in the plan through error or oversight.

A. project; budget overrun allowance
B. engineering; management allowance
C. management; contingency allowance
D. management; mismanagement allowance

Answer: C

015. Feasibility studies are evaluations of both the technical and economic aspects of a potential project. In the economic area, one would look at such items as interest rates, present worth factors, capitalization costs, and ________.

A. human resource skills
B. depreciation costs
C. prospective projects managers
D. implementation of cost controls

Answer: B
016. Project financing can be extremely complex and can come from a variety of sources. However, ________ is not a potential source of financing for a project.

A. borrowing money from a bank  
B. selling stocks in the project or corporation  
C. selling bonds on the project  
D. selling lottery tickets on the project  
Answer: D

017. Life cycle costing is a concept whereby all costs for a system are computed to determine the total cost of ownership. Life cycle cost categories include ________.

A. purchase, repair, and operation  
B. development, procurement, and operation/maintenance  
C. procurement, lease, and disposal  
D. procurement, operation, and disposal  
Answer: B

018. The integration of cost and schedule to provide measures of the project's performance is the earned value system, or contract performance measurement. The baseline for the earned value system is depicted as a slight "S" curve because ________.

A. there are fewer costs at project initiation until the work force is fully staffed  
B. there are workers who have not been paid, so the expense is not shown on the chart  
C. there are more expenses to get a project started than are required on a normal operating basis  
D. this is just a traditional method of plotting the costs and has no relationship to the actual expenditures  
Answer: C

019. The pricing of a project can be extremely complex in the development of valid cost estimates and price quotes from vendors. The tool that facilitates the pricing of a project by a structured decomposition of the total into individual elements of labor, material, and equipment is the ________.

A. project management plan  
B. budget  
C. work breakdown structure  
D. configuration management plan  
Answer: C

020. In estimating the cost of work, the best source of cost information can be obtained from the ________.

A. customer  
B. historical records  
C. senior engineers  
D. top management  
Answer: B
PROCUREMENT

001. Which is not an element of procurement management?
A. Purchasing  
B. Expediting  
C. Acquisition  
D. C and D  
Answer: D

002. The purchasing cycle consists of all the following elements except?
A. Defined Need  
B. Transmit Need  
C. Inspection  
D. Price & Terms  
Answer: C

003. The cost of corrective action taken by the purchaser and chargeable to the supplier under the terms of the contract is
A. Payment authorization  
B. Bid cost considerations  
C. Release payment  
D. Back charge  
Answer: D

004. _________ is a narrative description of the work to be accomplished or resource to be supplied.
A. Purchase order  
B. Level of effort work  
C. Scope of work  
D. Contract stipulation  
Answer: C

005. By which means is a contractor able to control costs overruns due to changing requirements?
A. Project Data review  
B. Change order  
C. Change Control  
D. Contract negotiations  
Answer: C

006. _________ is a written order directing the contractor to make changes according to the provisions of the contract documents.
A. Change order/purchase order Amendment  
B. Contract order Modifications.  
C. Contractor claim  
D. Owner Directive  
Answer: A
007. _______ defines when the work is ready for or is being used for the purpose intended and is so certified.
A. Final Completion
B. Substantial Completion
C. Final Acceptance
D. Mechanical Completion
Answer: B

008. _______ is a request for interim stoppage of work due to non conformance, funding or technical considerations
A. Bid Protest
B. Stop Work order
C. Notice to Proceed
D. Supplier Default Notice
Answer: B

009. The process that may be used by an unsuccessful supplier to seek remedy for a non award of work is
A. Bid Protest
B. Stop Work Order
C. Back charge
D. Contract Dispute
Answer: A

010. The ________ specification describes, defines or specifies the goods/services to be supplied.
A. Performance
B. Functional
C. Technical
D. Bid
Answer: C

011. The Bid Evaluation process is characterized by all of the following activities except?
A. Evaluation of suppliers financial resources
B. Ability to comply with technical specifications,
C. Competitors' method of sourcing
D. Performance Record
Answer: C

012. Which is not a consideration in a make or buy decision?
A. Cost factors
B. Sales Volume
C. Existence of sufficient administration/technical personnel
D. Political and, social factors with the organization
Answer: B
013. There are four methods of government procurement. Which is not one of these methods?
A. Assistance  
B. Sealed Bidding  
C. Competitive proposals  
D. Acquisition  
Answer: D

014. A purchasing operation does not contain this classification of work  
A. Management  
B. Buying  
C. Follow up and expedition  
D. Marketing  
Answer: D

015. ________ is a register of suppliers invited to submit bids for goods/services as specified.  
A. Procurement invitation  
B. Bid List  
C. Resource Identification  
D. Supplier's Rankings  
Answer: B

016. ________ is a formal invitation to submit a price for goods and/or services as specified.  
A. Request for Quotation  
B. Bid Response  
C. Intention for Bid  
D. Invitation for Bid  
Answer: A

017. Which contract type should be used by the owner on a high risk project?  
A. Cost Plus Percentage of Cost  
B. Cost Plus Incentive Fee  
C. Lump Sum  
D. Fixed Price Plus Incentive Fee  
Answer: C

018. Cost Reimbursable contracts are equivalent to  
A. Progress Payment Contracts  
B. Extra Work Order Contracts  
C. Cost Plus Contracts  
D. Fixed Price Contracts  
Answer: C

019. Fixed price and incentive type contracts place responsibility for performance and financial risks associated with delay or non performance on the  
A. Contractor
B. Owner  
C. Lending Institution  
D. Project Manager  
Answer: A

020. __________ is based on information gathered and analyzed about demand and supply. This forecast provides a prediction of short and long term prices and the underlying reasons for those trends.  
A. Sales forecast  
B. Consumer Price Index  
C. Production forecast  
D. Price forecast  
Answer: D

QUALITY

1. A project manager is monitoring specific project results to determine if they comply with relevant standards and eliminate causes of unsatisfactory results. This activity is a part of quality:  
A. planning.  
B. assurance.  
C. work results.  
D. control.  
ANS: D

2. A project is in progress and the project manager is working with the quality assurance department to improve stakeholders' confidence that the project will satisfy the quality standards. Before they can begin this process, which of the following do they need to have?  
A. Quality problems  
B. Results of quality control measurements  
C. Quality management plan  
D. Quality audits  
ANS: C

3. Which of the following is an example of the cost of conformance to quality?  
A. Rework  
B. Quality training  
C. Scrap  
D. Warranty costs  
ANS: B

4. All of the following are outputs of quality planning EXCEPT?  
A. Quality management plan  
B. Quality improvement
C. Creation of checklists
D. Metrics

ANS: B

5. A project manager has access to a tremendous amount of historical information on projects and wants to use this information to mathematically forecast the future outcome of projects. Which of the following is the project manager MOST likely to use?
   A. Benchmarking
   B. Trend analysis
   C. Variance analysis
   D. Decision trees

ANS: B

6. Standard deviation is a measure of how:
   A. far the estimate is from the average estimate.
   B. far the measurement is from the mean.
   C. correct the sample is.
   D. much time remains in the project.

ANS: B

7. A project manager needs to determine how the manufacturing is going for the new micro satellites. Each satellite takes about three days to manufacture and costs US $125,000. The inspection process has been a source of concern. The satellites are so small that inspection would destroy them. Under these circumstances, what should the project manager do?
   A. Outsource the inspection to another firm with more expertise
   B. Evaluate the attributes of the population
   C. Inspect a sample of the satellites
   D. Decrease the costs of quality

ANS: C

8. A project manager decides to change the paint color of his new hand-held computer to see if the different color provides increased end-user satisfaction. In doing this, the project manager is performing a:
   A. fishbone analysis.
   B. design of experiments.
   C. benchmark.
   D. statistical analysis.

ANS: B

9. A cause-and-effect diagram and an Ishikawa diagram are both:
   A. flow charts.
   B. fishbone diagrams.
   C. control charts.

ANS: B
D. Pareto charts.

ANS: B

10. During project execution a project team member informs the project manager that based on her observations, the project cannot meet the quality standards set for it. The project manager meets with all parties concerned to analyze the situation. In which step of the quality management process is the project manager involved here?
   A. Quality analysis
   B. Quality assurance
   C. Quality control
   D. Quality planning
   ANS: B

11. A Pareto diagram helps the project manager:
   A. focus on the most critical issues to improve quality.
   B. focus on stimulating thinking.
   C. explore a desired future outcome.
   D. determine if a process is out of control.
   ANS: A

12. Some organizations are now using 6-sigma for quality control. Which method is usually used?
   A. 2-sigma
   B. 3-sigma
   C. 4-sigma
   D. 5-sigma
   ANS: B

13. During the completion of the project, a project manager wants to ensure that the quality of the end product is acceptable. The BEST way to do this is by:
   A. checking quality levels against the standards set in the quality plan.
   B. identifying the quality standards you want the end product to meet.
   C. performing cost/benefit analyses.
   D. determining the cause of a problem using a fishbone diagram.
   ANS: A

14. Warranty and inventory costs are going up causing the project manager to worry about the costs of non-conformance. What is the BEST advice you can give the project manager?
   A. Increase scrap
   B. Increase rework
   C. Perform a quality audit
   D. Look for benchmarks
   ANS: C
15. During the execution of the project a new ISO version of standard 9000 is issued and the project team is meeting with the quality department to determine how the standard will apply to the project. This is part of which quality process?
A. Quality planning
B. Quality control
C. Quality analysis
D. Quality assurance

ANS: D

16. A project manager is working with quality professionals in the quality assurance phase of the project. Which of the following activities is being performed?
A. Quality control
B. Determining if the right quality standards are being used
C. Determining what quality standards should be used
D. Evaluating quality against the standards

ANS: B

17. The line in the middle of a control chart is called the:
A. mean.
B. specification limit.
C. rule of seven.
D. upper and lower control limit.

ANS: A

18. Which statement BEST explains the phrase "quality is planned in, not inspected in."
A. It is more expensive to determine quality by inspection than by planning.
B. Quality activities occur during the planning phase of the project.
C. Quality is part of planning, not inspection.
D. Planning for quality is after the fact.

ANS: A

19. Management as a policy regularly evaluates project performance. This is done in order to ensure quality product standards. This is an example of?
A. Quality planning
B. Quality assurance
C. Quality control
D. Quality management

ANS: B

20. All of the following are part of quality control EXCEPT?
A. Cost of quality
B. Inspection
C. Control charts
D. Flowcharting

ANS: A
PROFESSIONAL RESPONSIBILITY

001. You have just found out that a major subcontractor for your project consistently delivers items late. You decide that you have bigger problems to address, so you do nothing. What conflict resolution mode are you using?

A. Ignoring
B. Compromise
C. Smoothing
D. Withdrawal

ANS: D

002. You are a new project manager for company B. You previously worked for company A that had an extensive project management practice. Company B has its own procedures, but you are more familiar with those from company A. You should:

A. use the practices from company A but include any forms from company B.
B. use the forms from company B and begin to instruct them on ways to upgrade their own.
C. talk about changes to the change control board of company B.
D. interact with others in an ethical way by sharing the good aspects of company A's procedures.

ANS: B

003. Payment for any decision made or encouraged by a foreign official with respect to whether a company will be awarded business is BEST described as:

A. common practice.
B. a sunk cost.
C. a bribe.
D. a progress fee.

ANS: C

004. In the initiation phase of your project, it is apparent that factions within the client's company have significantly different views on how the project should be structured and how the deliverables should be defined. Which of the following is the BEST thing to do?

A. Ask the client when they will be in agreement on the project requirements
B. Work with leadership from each area to collaboratively engineer a mutually acceptably solution
C. Make sure the terms and conditions of the contract are clear
D. List the consequences of changes in the contract's requirements section

ANS: B

005. While testing the strength of concrete poured on your project, you discover that over 35% of the concrete does not meet your company's quality standards. You feel certain the concrete will function as it is, and you don't think the concrete needs to meet the quality level specified. What should you do?

A. Change the quality standards to meet the level achieved
B. List in your reports that the concrete simply "meets our quality needs"
C. Ensure the remaining concrete meets the standard
D. Report the lesser quality level and try to find a solution

ANS: D

006. Another project manager in your company is having difficulty managing his project. You have found that he has not used a project charter and that is probably the cause of the problem. How can you help?
A. Provide him with a copy of an article about project charters
B. Work with his boss to get him a mentor
C. Develop a draft charter for his use
D. Talk to him about his project and offer help in creating a project charter

ANS: D

007. You are the project manager for a new international project, and your project team includes people from four countries. Most of the team members have not worked on similar projects before, but the project has strong support from senior management. What is the BEST thing to do to ensure that cultural differences do not interfere with the project?
A. Spend a little more time creating the work breakdown structure and making sure it is complete
B. As the project manager, make sure you choose your words carefully whenever you communicate
C. Ask one person at each team meeting to describe something unique about their culture
D. Carefully encode all the project manager's communications

ANS: C

008. You are four months into a three year project when your project team makes significant discoveries on your project. What is the BEST thing to do?
A. Make certain the discoveries are included in the project lessons learned
B. Make certain the discoveries are in the monthly status report
C. Make certain you mention them at the senior management meeting in two months
D. Make certain you tell the other project managers involved in this program at the weekly meeting

ANS: D

009. During a meeting with some of the project stakeholders, the project manager is asked to add work to the project scope of work. The project manager had access to correspondence about the project before the charter was signed and remembers that the project sponsors specifically denied the scope of work mentioned by these stakeholders. The BEST thing for the project manager to do would be to:
A. let the sponsors know of the stakeholders' request.
B. evaluate the impact of adding the scope of work.
C. tell the stakeholders the scope cannot be added.
D. add the work if there is time available in the project schedule.

ANS: C
0010. You have just been assigned project manager for a new telecommunications project. There appear to be many risks on this project, but no one has evaluated them to assess the range of possible project outcomes. What needs to be done?

A. Risk identification
B. Risk quantification
C. Risk response planning
D. Risk monitoring and control

ANS: A

011. You are the project manager for a large project under contract with the government. The contract for this two year, multi-million dollar project was signed six months ago. You were not involved in contract negotiations or setting up procedures for managing changes, but now you are swamped with changes from the sponsor and from people inside your organization. Who is normally responsible for formally reviewing major changes to the project/contract?

A. The change control board
B. The contracting/legal department
C. The project manager
D. Senior management

ANS: A

012. While preparing your risk responses, you realize that you have not planned for unknown risk events. You need to make adjustments to the project to compensate for unknown risk events. These adjustments are based on your past project experience when unknown risk events occurred and knocked the project off track. What should you do?

A. Apply a general contingency to try to compensate
B. Document the unknown risk items and calculate the expected monetary value based on probability and impact that result from the occurrence
C. Determine the unknown risk events and the associated cost, then add the cost to the project budget as reserves
D. Add a 10% contingency

ANS: A

013. There are over 30 stakeholders on your project. The project is being done in another country with people from three countries as team members. Which of the following is the MOST important thing to keep in mind?

A. The communication channels will be narrow.
B. Many competing needs and objectives must be satisfied.
C. There must be one sponsor from each country.
D. Conflicts of interest must be disclosed.

ANS: B

014. Which of the following is NOT a measure that determines whether a business practice used by another country is an unfair business practice?
A. It hurts the right to physical movement.
B. It is a common practice in the other country.
C. It does not supply a decent wage for the country and the type of work.
D. It discriminates against women.

ANS: B

015. A company puts a new product into the marketplace without any reports of problems. However, your internal research indicated that there is a possibility of two serious injuries per year and would cost US $20,000,000 to fix. What should you do?

A. Make the modifications necessary in current products
B. Recall all existing product
C. Wait until an injury to verify the impact
D. Obtain insurance to cover the anticipated damages

ANS: B

016. You are approached by company A to produce certain software. During the middle of the project a competitor of company A asks you to produce similar software. What should you do?

A. Do not do the new project since it is a conflict of interest
B. Do the project using some of the material created for company A
C. Do the project with all new work
D. Review the intellectual property clause for the first project to help determine the approach

ANS: D

017. You've been assigned to take over managing a project that should be half-complete according to the schedule. You discover that the project is running far behind schedule, and that the project will probably take double the time originally estimated by the previous project manager. However, upper management has been told that the project is on schedule. What is the BEST course of action?

A. Try to restructure the schedule to meet the project deadline
B. Report your assessment to upper management
C. Turn the project back to the previous project manager
D. Move forward with the schedule as planned by the previous project manager and report at the first missed milestone

ANS: B

018. What is the project manager's KEY role during negotiations?

A. Protect the relationship between buyer and seller
B. Negotiate a price under the seller's estimate
C. Ensure that all project risks are thoroughly delineated
D. Ensure that an effective communication plan is established

ANS: A

019. A major negotiation with a potential subcontractor is scheduled for tomorrow when you discover there is a good chance the project will be canceled. What should you do?
A. Do not spend too much time preparing for the negotiations
B. Cut the negotiations short
C. Only negotiate major items
D. Postpone the negotiations

ANS: D

020. Payment for routine government action by a foreign official is:
A. a bribe.
B. allowed.
C. not payable upon violation of government law.
D. allowed only if they process the project schedule.

ANS: B

[Ref. Sample by CyberTech Solutions – http://cybertechsoln.s5.com/]

Process Interactions – The project Management Process Groups are related to each other by the output they produce. Generally, output of one process is the input to the next or it is the deliverable of the project.

A guide to the
Project Management Body of Knowledge

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<th>Cost</th>
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<td>10.5 Report Performance</td>
<td>11.5 Plan Risk Responses</td>
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<td></td>
<td>11.6 Monitor &amp; Control Risks</td>
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As a PMI member, you have the access to the current version of PMBOK® (2008, 4th Edition) from www.PMI.org. In addition, you can also freely download a set of presentation slides, and over 400 samples Q&A from Nutek site: [http://www.nutek-us.com/wp-pmp.html](http://www.nutek-us.com/wp-pmp.html).
Girded Paper for Break-Even-Chart and Other Graphs
**Practice Drawing Precedence Diagram**

Tips on drawing Precedence Diagram:
- Start first activity/box at left
- End activity at most right
- Place other activities as appropriate
- Start and End activities always have the same early and late START FINISH dates

**Project: Oil Change at Jiffy Lube**

S: Drive into garage (1 min)
A: Drain oil (7 min, **first mechanic in the pit**)
B: Change filter (3 min, **first mechanic in the pit**)
C: Fill Engine oil (2 min, **first mechanic in the pit**)
D: Check Air Filter & PCV valve (**second technician**, 4 min, and finish before F starts)
E: Check Tire pressure (**third technician**, 3 min, finish before G starts)
F: Start engine and check oil (1 min, **first mechanic in the pit**)
G: Pay and drive out (2 min)

**Draw the Precedence Diagram** by placing the activities properly and connecting them with precedence relationships (Arrows).
Precedence Diagram – I. Repaint Garage Floor

Project Completion Time = ?
Precedence Diagram – II. Grocery Shopping and Prescription Drug Pick Up
Practice Forward & Backward Pass (Precedence Diagram – Oil Change at Jiffy Lube)
Family Vehicle Purchase Project

Determine activities in the CRITICAL PATH analysis: Based on the tasks and duration for this project, PRECEDENCE DIAGRAMS and PRECEDENCE TABLE are shown below. (Assume that the project starts on Monday Jan. 9, 2006)

<table>
<thead>
<tr>
<th>Activity Description</th>
<th>Duration (days)</th>
<th>Predecessors</th>
<th>ES</th>
<th>EF</th>
<th>LS</th>
<th>LF</th>
<th>Float</th>
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<tbody>
<tr>
<td>A0: Decide to Purchase Vehicle</td>
<td>20</td>
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<td>A1: Select Vehicle Type</td>
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<td>A2: Visit Dealers</td>
<td>8</td>
<td></td>
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<tr>
<td>A3: Decide to Purchasing</td>
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<tr>
<td>A4: Pick up Vehicle</td>
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<tr>
<td>A5: Receive Vehicle Title</td>
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<tr>
<td>B1: Call for Insurance</td>
<td>1</td>
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<tr>
<td>B2: Drop Insurance for Old Car</td>
<td>1</td>
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<tr>
<td>C1: Clean Old Car</td>
<td>1</td>
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<tr>
<td>C2: Place Ad for Sale</td>
<td>1</td>
<td></td>
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<tr>
<td>C3: Show and Sell Old Car</td>
<td>20</td>
<td></td>
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</tr>
</tbody>
</table>

Note: ES = Early Start, EF = early Finish, LS = Late Start, LF = Late Finish, Float = (Late Start – Early Start)
Precedence Diagram – Vehicle Purchase Project

(Scheduled in terms of calendar dates)

Completed (forward Pass)
**Practice Backward Pass (Precedence Diagram – Vehicle Purchase Project)**
Appendix

**Precedence Diagram – Vehicle Purchase Project**

*(FORWARD AND BACKWARD PASS - SOLUTION)*

**Completed (Forward Pass)**

---

**Precedence Data with Floats – Family Vehicle Purchase Project**

<table>
<thead>
<tr>
<th>Activity Description</th>
<th>Duration (days)</th>
<th>Predecessors</th>
<th>ES</th>
<th>EF</th>
<th>LS</th>
<th>LF</th>
<th>Float</th>
</tr>
</thead>
<tbody>
<tr>
<td>A0: Decide to Purchase Vehicle</td>
<td>20</td>
<td>-------</td>
<td>1</td>
<td>20</td>
<td>1</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>A1: Select Vehicle Type</td>
<td>12</td>
<td>A0</td>
<td>21</td>
<td>32</td>
<td>21</td>
<td>32</td>
<td>0</td>
</tr>
<tr>
<td>A2: Visit Dealers</td>
<td>8</td>
<td>A1</td>
<td>33</td>
<td>40</td>
<td>33</td>
<td>40</td>
<td>0</td>
</tr>
<tr>
<td>A3: Decide to Purchasing</td>
<td>5</td>
<td>A2</td>
<td>41</td>
<td>45</td>
<td>41</td>
<td>45</td>
<td>0</td>
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<tr>
<td>A4: Pick up Vehicle</td>
<td>1</td>
<td>A3, A1</td>
<td>47</td>
<td>47</td>
<td>47</td>
<td>47</td>
<td>0</td>
</tr>
<tr>
<td>A5: Receive Vehicle Title</td>
<td>12</td>
<td>A4</td>
<td>48</td>
<td>59</td>
<td>57</td>
<td>68</td>
<td>9</td>
</tr>
<tr>
<td>B1: Call for Insurance</td>
<td>1</td>
<td>A3, A0</td>
<td>46</td>
<td>46</td>
<td>46</td>
<td>46</td>
<td>0</td>
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<tr>
<td>B2: Drop Insurance for Old Car</td>
<td>1</td>
<td>C3, B1, A5</td>
<td>69</td>
<td>69</td>
<td>69</td>
<td>69</td>
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</tr>
<tr>
<td>C1: Clean Old Car</td>
<td>1</td>
<td>A0</td>
<td>21</td>
<td>21</td>
<td>47</td>
<td>47</td>
<td>26</td>
</tr>
<tr>
<td>C2: Place Ad for Sale</td>
<td>1</td>
<td>A4</td>
<td>48</td>
<td>48</td>
<td>48</td>
<td>48</td>
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</tr>
<tr>
<td>C3: Show and Sell Old Car</td>
<td>20</td>
<td>C2</td>
<td>49</td>
<td>68</td>
<td>49</td>
<td>68</td>
<td>0</td>
</tr>
</tbody>
</table>

**Note:** ES – Early Start, EF – early Finish, LS – Late Start, LF – Late Finish, Float = (Late Start – Early Start)
Practice Forward & Backward Pass (Precedence Diagram – Door Replacement Project)

1. Develop Project Plan 15 days
2. Plan Approval 5 days
3. Order & Deliver (Interior Doors) 3 days
4. Order & Deliver (Exterior Doors) 20 days
5. Security System, Doorbell, Closet 1 day
1.1 Install (Interior Doors) 1 day
3.2 Finish (Interior Doors) 10 days
4.1 Install (Exterior Doors) 1 day
4.2 Finish (Exterior Doors) 15 days

Required Information:
- List of activities
- Duration of each of the activities
- Predecessor for each activities
### Table 2.1 Precedence (Door Replacement Project)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Description</th>
<th>#</th>
<th>Duration</th>
<th>Predecessor</th>
<th>ES</th>
<th>EF</th>
<th>LS</th>
<th>LF</th>
<th>Float</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Develop Project Plan</td>
<td>15</td>
<td>days</td>
<td></td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Plan Approval</td>
<td>5</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Order Interior Doors</td>
<td>3</td>
<td></td>
<td>2</td>
<td>3,4</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>3.1</td>
<td>Install</td>
<td>1</td>
<td></td>
<td>3,4</td>
<td>3,1</td>
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<td></td>
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<tr>
<td>3.2</td>
<td>Finish Doors</td>
<td>10</td>
<td></td>
<td>10</td>
<td>3,1</td>
<td></td>
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</tr>
<tr>
<td>4</td>
<td>Order Exterior Doors</td>
<td>2</td>
<td></td>
<td>2</td>
<td></td>
<td></td>
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<tr>
<td>4.1</td>
<td>Install Doors</td>
<td>20</td>
<td></td>
<td>2</td>
<td></td>
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</tr>
<tr>
<td>4.2</td>
<td>Finish Doors</td>
<td>15</td>
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<td>2</td>
<td>4,1</td>
<td></td>
<td></td>
<td></td>
<td>4,1</td>
</tr>
<tr>
<td>5</td>
<td>Close Project</td>
<td>1</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>3,2,4,2</td>
</tr>
</tbody>
</table>

**Notations:** ES = Early Start, EF = Early Finish, LS = Late Start, LF = Late Finish
Appendix

Practice Forward Pass (Precedence Diagram – Deck Building Project)

Figure 2.16 Critical Path Method (Deck Building Project)

Required Information:
- List of activities supplied
- Duration of each of the activities
- Predecessor for each activity

A. Plan Deck Project, 5 days
B. Apply for Permit, 10 days
C. Buy Patio Furniture, 4 days
D. Finish Detail Deck Design, 5 days
E. Order Materials, 5 days
F. Install Posts for Deck, 8 days
G. Construct Deck, 2 days
H. Clean up and Close Project, 2 days
### Table 2.5 PERT Statistics (Deck Building Project)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Description</th>
<th>Likely</th>
<th>Pes.</th>
<th>Opt.</th>
<th>EV</th>
<th>SD</th>
<th>Var</th>
<th>EV</th>
<th>Var</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Develop Deck Plan</td>
<td>5 days</td>
<td>10</td>
<td>3</td>
<td></td>
<td>5.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. Apply for Permit</td>
<td>10</td>
<td>15</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>C. Buy Patio Furniture</td>
<td>4</td>
<td>8</td>
<td>2</td>
<td></td>
<td>4.33</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. Finish Detail Design</td>
<td>5</td>
<td>10</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. Order Lumber</td>
<td>5</td>
<td>8</td>
<td>3</td>
<td></td>
<td>5.17</td>
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<td></td>
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<tr>
<td>F. Install Posts</td>
<td>8</td>
<td>15</td>
<td>5</td>
<td></td>
<td>8.67</td>
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<td></td>
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<tr>
<td>G. Construct Deck</td>
<td>2</td>
<td>4</td>
<td>1.5</td>
<td></td>
<td>2.25</td>
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<tr>
<td>H. Clean &amp;Close Project</td>
<td>2</td>
<td>5</td>
<td>1</td>
<td></td>
<td>2.33</td>
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<td></td>
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<tr>
<td>Activity Description</td>
<td>Duration (days/other)</td>
<td>Predecessors</td>
<td>ES</td>
<td>EF</td>
<td>LS</td>
<td>LF</td>
<td>Float</td>
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</tbody>
</table>

Note: ES = Early Start, EF = early Finish, LS = Late Start, LF = Late Finish, Float = (Late Start – Early Start)
Activities in CRITICAL PATH:
### PERT Statistics (Proj: ________________ )

<table>
<thead>
<tr>
<th>Activity Description</th>
<th>ML</th>
<th>Pess.</th>
<th>Opt.</th>
<th>EV</th>
<th>STD</th>
<th>VAR</th>
<th>EV-CP</th>
<th>VAR-CP</th>
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<tbody>
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</tbody>
</table>

Note: ES = Early Start, EF = early Finish, LS = Late Start, LF = Late Finish, Float = (Late Start – Early Start)
Pareto Chart (Project/Exercise: ____________________________)

C  u  m  u  l  a  t  i  v  e  
P  e  r  c  e  n  t  a  g  e

P  e  r  f  o  r  m  a  n  c  e

Data Type
Class Project Report Preparation and Presentation Guidelines

a. Prepare a summary report of ONE page. Include additional pages when needed
b. Make copies/(or PDF) for all attendees + instructor
c. Be prepared to present your group project to the class (with report or visual aides)

Report Content:
Page 1 (include answers to items 1 – 9 below in this cover page)
1. PROJECT TITLE
2. Project participants (name and contact email and/or phone number)
3. Course title, location, instructor’s name, and date.
4. PROJECT DESCRIPTION (Problem statement in 2 – 4 connected sentences)
5. Project Objectives (at least two bulleted description, SMART)
6. List all ACTIVITIES in the CRITICAL PATH and their durations.
7. Indicate the FINISH TIME for the last activity in the project.
8. State the PROJECT COMPLETION TIME with 95% confidence level.
9. Identify the activity in the critical path that has the longest duration and establish the completion time with 99% confidence level.

Page 2 and more

10. WBS for the project with durations
11. PDM showing FORWARD and BACKWARD passes.
12. PRECEDENCETABLE with FLOATS
13. Additional descriptions such as: VISION, MISSION, PURPOSE, BENEFITS, ASSUMPTIONS, planned DELIVERABLES, HR, RISKS, PROCUREMENT, COMMUNICATIONS, etc.
A. Notes: (Blank Page)
Program Evaluations

Program Title_____________________________________   ____________________________________________

Program completion date

Instructor ____________________________  Training Location/host. ____________________________________________

We appreciate your comments and suggestions. Please take a moment to let us know how we can improve and serve you better.
(Please use the following numbers for evaluation purposes).


1. Overall Reaction to Program:     6        5         4         3        2        1    (Circle one number)

Comments: ______________________________________________________________________________________

_______________________________________________________________________________________________

2. Reaction to Instructor:   6     5     4     3     2     1    (Circle one number)

Comments: ______________________________________________________________________________________

_______________________________________________________________________________________________

3. What should be added and/or deleted to improve this program? (Please be specific)

_______________________________________________________________________________________________

4. What portions of this program do you feel will be most helpful at your work?   How?

_______________________________________________________________________________________________

_______________________________________________________________________________________________

5. Do you feel the training provided you enough understanding of the technique for you to be able to start applying it to your own projects if opportunities were available?

   [ ] Yes   [   ] No   [   ] May be

6. Would you consider/recommend us for training at your facility?      [ ] yes     [ ] No      [ ] May be

   Who should we contact for training at your facility __________________________   Ph: ___________________

7. Would you recommend that others attend this seminar?      [ ]YES     [ ]NO

8. Portion of class sessions you attended [   ] 100%   [   ] Over 90%   [   ] Over 75%   [   ] Over 50%

9. Percent of class problems and assignment you completed and/or took active part:  [   ] 100%  [   ] Over 80%  [   ] 50%

   (Optional)
   Your Name_______________________________   Your Ph#/ & E-mail:__________________________________

THANK YOU for taking the time to complete this evaluation.
**Pre and Post Test Questions**
*(Please write your answers in right two columns)*

<table>
<thead>
<tr>
<th>Questions</th>
<th>Answers</th>
<th>Pre-</th>
<th>Post-</th>
</tr>
</thead>
</table>
| 1. A project manager is employed by an IT company for developing a new application software package. One of the first things he/she must do for the project is to write a: | a. Product Description  
b. Work Breakdown Structure  
c. Project Charter  
d. Project Plan |      |       |
| 2. A manager that manages a group of related projects is called a:       | a. Project Manager  
b. Senior Project Manager  
c. Program Coordinator  
d. Program Manager |      |       |
| 3. The original schedule for a project or a work package, plus or minus approved changes, is called: | a. The target Schedule  
b. The working Schedule  
c. The Baseline Schedule  
d. The Performance Schedule |      |       |
| 4. Which of the following is known as a simulation technique?             | a. Monte Carlo Analysis  
b. GERT Analysis  
c. PERT analysis  
d. Critical Path Method (CPM) |      |       |
| 5. The main purpose for contingency budget is to:                        | a. Pay for scope increases  
b. Reduce probability of cost overruns  
c. Minimize scope changes  
d. Maintain project cost |      |       |
| 6. The primary advantage of the functional type of organization is:      | a. Better project orientation  
b. Easy team formation  
c. Stable organization structure  
d. Well defined point of contact |      |       |
| 7. The fund set aside under *management reserve* is to:                  | a. Offset missing schedule objective  
b. Cover for missing cost objectives  
c. Offset missing cost and schedule objectives  
d. Avoid unknown risks |      |       |
| 8. In view of quality leaders Deming and Juran, quality problems in production floors are due to faults controlled by: | a. The purchasing manager  
b. Project manager  
c. Upper management  
d. Team members |      |       |
| 9. The Deming cycle is generally denoted by:                            | a. XYZ  
b. PDCA  
c. TQM  
d. ISO |      |       |
| 10. Identify the group activity that allows participants to be anonymous. | a. Crawford Slip  
b. Nominal Group  
c. Brainstorming  
d. Delphi Technique |      |       |
Participant’s Experience & Expectation Survey
(Please take a few minutes and complete this page before the start of the session)

Your Name ____________________________________________________________
(First)                                                                 (Last)

1. Name a recent work-related project you were a team member/leader or project manager.

Project Title: ___________________________________________________________

How long __________________________ Start Date __________   End Date ________

2. Name a personal/family project you completed recently.

Project Title: ___________________________________________________________

How long __________________________ Start Date __________   End Date ________

3. How many years of school/college/university education do you have?   Ans. _____ Years.

Please indicate your reasons for attending this seminar (Check all correct answers):

[  ] Learn to apply PM in projects at work
[  ] Refresh PM application knowledge
[  ] Audit course for evaluation purposes
[  ] I have immediate PM application needs (describe if you wish)
[  ] I was asked to attend this class by my management
[  ] Not sure why I’m here

[  ] Other ______________________________________________________________