Project Management Techniques for Engineers – Part 1

Florida Board of Professional Engineers

Approved Course No. 0010329

4 PDH Hours

A test is provided to assess your comprehension of the course material – 24 questions have been chosen from each of the above sections. You will need to answer at least 17 out of 24 questions correctly (>70%) in order to pass the overall course. You can review the course material and re-take the test if needed.

You are required to review each section of the course in its entirety. Because this course information is part of your Professional Licensure requirements it is important that your knowledge of the course contents and your ability to pass the test is based on your individual efforts.

Course Description:

This course is intended to provide professional engineers with some basic techniques that will improve the way you manage projects. You may or may not hold the official title of "Project Manager" but chances are as a PE you will be called upon sometime in your career to lead a project. And whether that project is big or small, complex or simple, the project fundamentals are the same. This course is NOT intended to be a study guide for taking the Project Management Professional (PMP) Exam but WILL introduce you to many of the principles outlined in the Project Management Body of Knowledge (PMBOK Guide). This course will introduce to you, or maybe reinforce, some key project management practices that will help your projects be more successful.

NOTE: This course was originally provided as a 4 PDH Project Management Course. The course content has now been revised and enhanced to provide additional discussion on the People Side of Project Management (the "Soft Skills) The two part course now is 8 PDH total – Part 1: 4 PDH; Part 2: 4 PDH.

This is Part 1 (4 PDH) of a two course series and covers:

1. Project management basics
2. Project planning techniques
3. Shoring up the schedule
4. Building the right schedule
5. Budgeting
6. Managing Risk
7. Earned Value

In Part 2 (4 PDH) of the series the following is covered:

1. Soft Skills for Project Managers
2. Making the Right Assignments (Team Members)
3. Identifying Project Stakeholders
4. How to Build Highly Effective Teams
5. Project Structure – The Matrix

How to reach Us …

If you have any questions regarding this course or any of the content contained herein you are encouraged to contact us at Easy-PDH.com. Our normal business hours are Monday through Friday, 10:00 AM to 4:00 PM; any inquiries will be answered within 2 days or less. Contact us by:

EMAIL: bajohnstonpe@aol.com
Phone: 888-418-2844 (toll free)
FAX: 813-909-8643

Refer to Course No. 0010329,

Project Management Techniques for Engineers – Part 1

How the Course Works…

What do you want To do?	LOOK For This!
 **Search for Test Questions and the relevant review section**	 Q1 **Search the PDF for: Q1 for Question 1, Q2 for Question 2, Q3 for Question 3, Etc…** **(Look for the icon on the left to keep you ON Target!)**

Easy-PDH.com (FBPE Approved Provider 442)
Britian Arthur Johnston PE (50603)
Johnston Service Corp
CA No. 30074
11909 Riverhills Drive, Tampa FL 33617
Email: bajohnstonpe@aol.com
Toll Free: 888-418-2844 FAX: 813-909-8643

TEST QUESTIONS

Q1. [Section I: Project Management Basics] The Channel Tunnel project started construction in 1988 but was not completed until 1994 and grossly over budget. What went wrong with the project:

A. Cost overruns because of lack of historical precedents to build estimates from
B. Schedule delays from Poor communication between teams
C. Change in design specifications
D. All of the Above

Q2. [Section I: Project Management Basics] Projects sometimes fail for obvious reasons and sometimes for more subtle reasons. Which of the following is NOT an obvious reason for project failure:

A. A project comes in over budget
B A project takes longer than planned
C A project does not meet the desired quality requirements
D The desired project outcome was not clearly communicated

Q3. [Section I: Project Management Basics] To effectively apply Project Management techniques you need to make sure you have a project. Which of the following is NOT a Key Characteristic of a project:

A. A project is an on-going effort that is repetitive
B A project has a beginning and ending
C A project has a budget and requires commitment of resources
D A project is unique

Q4. [Section I: Project Management Basics] In which stage of the Project Life Cycle are the costs and staffing levels of the project the lowest and risk and uncertainty the highest:

A. Project Initiation
B Perform the Work
C Organize and Plan
D Schedule the Project

Q5. [Section I: Project Management Basics] Project Management, in its simplest form, is the process of managing what is known as the TRIPLE Constraint to meet the project stakeholders expectations. What are the three (3) elements of the TRIPLE Constraint:

A. Schedule, Budget, Risk
B. Schedule, Budget, Communication
C Schedule, Budget, Scope
D Schedule, Budget, Project Team

Q6. [Section II: Project Planning] At the beginning of a project it is important to develop a high-level project planning document called the Project Scope Statement. A written Scope Statement is necessary for all of the following EXCEPT:

A. Binding and committing the project team to produce the agreed results
B. Identifying restrictions that could affect the project work
C Identifying assumptions made
D Identifying preliminary close-out documents

Q7. [Section II: Project Planning] A good Project Scope Statement will be comprised of relevant sections that are subdivided for clarity (Project Justification, Objectives, Scope Description, Acceptance Criteria, Constraints, and Assumptions). Of these, in which section should potential bottlenecks to the project be listed:

A. Objectives
B. Scope Description
C Constraints
D Assumptions

Q8. [Section II: Project Planning] There are many examples of constraints to look for on a project. The most common are budget and schedule constraints. A less common constraint is a called a Technology Constraint. Which of the following is an example of a Technology Constraint that could be imposed on a project:

A. Use of a specified revision of software to produce deliverables
B. Use of teleconferencing equipment
C Use of a leased computer equipment vs buying
D Use of high volume copiers

Q9. [Section III: Shoring Up the Schedule] In order to successfully manage a project you will need to break the project down into manageable defined pieces that can be measured and monitored. A proven approach is the use of a WBS - What does the acronym WBS mean?

A. Work Build Structure
B. Work Breakdown System
C Work Breakdown Structure
D Work Bubble Structure

Q10. [Section III: Shoring Up the Schedule] The work package should be lowest level on your WBS and be described with the use of what types of words at this step.

A. verbs
B. nouns
C. adjectives
D. none of the above

Q11. [Section III: Shoring Up the Schedule] Again referring to the work package level of the WBS it is suggested to NOT breakdown your project into a TO DO LIST and one rule to help you not decompose your deliverables too far is called the 8/80 rule. What does the 8/80 rule represent?

A. a work package should not take less than 80 hours to complete or more than 8 days to complete
B. a work package should not take less than 8 hours to complete or more than 80 hours to complete
C. a work package should take between 8 days and 80 days to complete
D. a minimum of 80 percent of a work package should be completed in less than 8 days

Q12. [Section III: Shoring Up the Schedule] You are creating your graphical WBS and want to include Project Management. Which is the best WBS level to include PROJECT MANAGEMENT:

A. Level 0
B. Level 1
C. Level 2
D. Level 3

Q13. [Section III: Shoring Up the Schedule] Once the WBS is complete , specifically all of the work packages have been identified relative to its parent deliverable, the work packages should be compiled into a detailed support document called the:

A. WBS Dictionary
B. WBS Diary
C. WBS Diagram
D. WBS Detail

Q14. [Section IV: Building the Right Schedule] All of the following are the building blocks to the baseline schedule EXCEPT:

A. WBS
B. Scope Statement
C. WBS Dictionary
D. Stakeholder List

Q15. [Section IV: Building the Right Schedule] In the 1950s the Department of Defense developed a statistical analysis technique for determining the probability of a project activity duration for use on the US Navy Polaris project called PERT. What does the acronym PERT stand for?

A. Program Evaluation and Resource Technique
B. Program Evaluation and Relocation Technique
C. Program Estimating and Review Technique
D. Program Evaluation and Review Technique

Q16. [Section IV: Building the Right Schedule] Using the PERT formula calculate the Expected Value of Activity 101 in your project schedule given the following: Optimistic Time = 16 weeks; Most Likely Time = 18 weeks; Pessimistic Time = 22 weeks)

A. 17.33 weeks
B. 17.50 weeks
C. 18.33 weeks
D. 20.33 weeks

Q17. [Section IV: Building the Right Schedule] We looked at the relationships between project activities in Section IV and how they are used in the project schedule. What is the most commonly used activity relationship:

A. Finish To Start
B. Start to Start
C. Finish to Finish
D. Start to Finish

Q18. [Section V: Budgeting: Calling All Costs] When developing the project budget you need to consider ALL costs including direct and indirect costs. Direct costs are costs for resources that are solely used on your project. Indirect costs are costs for resources that may be used on multiple projects but cannot be directly identified or charged against an individual project. Which of the following is an example of an Indirect Cost:

A. Project team Salaries
B. Design Expert costs
C. Vacation time for project team members
D. Project travel expenses

Q19. [Section V: Budgeting: Calling All Costs] You have been assigned as the Project Manager on a fast track project and have subject matter experts available for consultation. The project sponsor is requesting a BALL PARK estimate for company board approval. As the PM you need to let the project sponsor know the realistic accuracy of your estimate will be approximately:

A. -50% to +50% (Rough Order of Magnitude)
B -10% to +25% (Budget Estimate)
C. -5% to +10% (Definitive Estimate)
D. Estimate accuracy cannot be determined

Q20. [Section V: Budgeting: Calling All Costs] Your project is well underway and the project budget has been approved. Which of the following common occurrences in the life of the project could affect the project budget:

A. You lose an experienced team member and have to hire an inexperienced replacement
B A subcontracted technical expert requires a higher billing rate than originally estimated
C. The high volume printer you expected to use on the project is no longer available
D. All of the above

Q21. [Section VI: Managing Risk] Risk Management is a process of identifying and mitigating risks on your project. Effective Risk Management requires a series of steps. What is the FINAL step in effective Risk Management:

A. Developing a Plan to Mitigate the Risk
B Ongoing Monitoring of Identified Risks
C. Continually Identifying New Risks
D. Communicating to stakeholders about Risks

Q22. [Section VI: Managing Risk] You have been asked to calculate the Expected Value of Risk for your project given 4 alternatives: Risk 1: 10% chance at $1100 cost; Risk 2: 15% chance at $900 cost; Risk 3: 50% chance at $250 cost; Risk 4: 30% chance at $500 cost.

Which alternative has the lowest Expected Value of Risk?

A. Risk 1
B Risk 2
C. Risk 3
D. Risk 4

Q23. [Section VII: Did You Earn It] By using the Earned Value Technique you will be able to QUANTIFY:

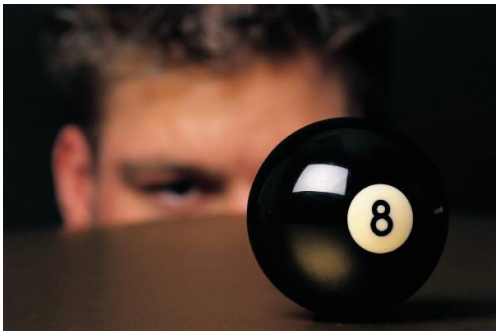
A. The amount of work that has been accomplished on a project to date
B. The amount of work that should have been accomplished on a project to date
C. A calculated value of what is left to complete a project
D. All of the Above

Q24. [Section VII: Did You Earn It] What are the three (3) primary metrics that are used in all Earned Value Calculations:

A. Schedule Variance (SV) , Planned Value (PV), Actual Cost (AC)
B. Cost Variance (CV) , Planned Value (PV), Actual Cost (AC)
C. Schedule Performance Index (SPI), Cost Performance Index (CPI), To Complete Cost Performance indicator (TCPI)
D. Earned Value (EV) , Planned Value (PV), Actual Cost (AC)

END OF TEST QUESTIONS

You may or may not hold the official title of "Project Manager" but chances are as a PE you will be called upon sometime in your career to lead a project. And whether that project is big or small, complex or simple, the project fundamentals are the same. This course is NOT intended to be a study guide for taking the Project Management Professional (PMP) Exam but WILL introduce you to many of the principles outlined in the Project Management Body of Knowledge (PMBOK Guide). This course will introduce to you, or maybe reinforce, some key project management practices that will help your projects be more successful.



Let's keep you from getting behind the 8 Ball … 7 Study Areas to Becoming a Better Project Manager:

- Project Management Basics – Let's start out on the right foot
- Project Planning – Let's build a solid Project Scope Document
- Foundations of a Good Schedule – Let's Strengthen the Schedule
- Constructing a Good Schedule – Let's look at how the schedule is built
- Project Budgets – Let's look at all of the true costs
- Project Risk – Let's understand how to Manage Risk
- Earned Value – Let's use Statistics to Actually Measure Cost and Schedule Performance

So let's begin by answering the following questions about the 7 Key Study Areas that are important for project success. Your answers to the questions will help assess your project management style and show how sections of this course will help you.

I PROJECT MANAGEMENT BASICS

Q1: Have you ever thought about why projects fail?

Q2: Do you know what makes a "project" a Project?

To know where you want to go you need to understand where to begin so we'll take a look at the foundations of project management.

In Section I we will introduce you to some common project definitions to help you understand the key characteristics of a project and the project life cycle.

II PROJECT PLANNING

Q1: At the beginning of a project do you formally outline the – who, what, why, how, and when of the project - using some type of Project Scope Document so that the complete project team understands how the project is expected to come together?

Q2: Do you tend to let the project plan develop on its own, as time passes, in order to maximize flexibility to respond?

The start of the project is the best point to (1) develop a strong understanding of the project's goals and the stakeholder's expectations and (2) outline how the project plan will need to be developed to reach a successful outcome.

In Section II we will help you prepare a Project Scope Document to develop a solid plan at the start of your project.

III SHORING UP THE SCHEDULE

Q1: Do you create work packages before creating the schedule or do you make the project team assignments in advance and then make the assigned team members responsible for creating the work packages?

Just as a project's scope can "creep", so can the time required for completion. Therefore it is very important to clearly define the work scope in small manageable chunks, including the desired sequences, so that the schedule can be built with ample time and contingencies to meet the project goals. Clear definition will also ensure that the work is complete and acceptable by the project stakeholders.

In Section III we will help you develop a suitable Work Breakdown Structure (WBS) which should be used to develop your project schedule.

IV BUILDING THE RIGHT SCHEDULE

Q1: Do you prepare, in advance, a specific timeline including sequenced activities to manage the project to its scheduled completion?

Q2: Do you understand the relationships between project activities and how these relationships form the longest timeline to bring your project to completion?

Your schedule is a series of interrelated tasks that together when completed must meet the stakeholder's expectations. Therefore it is very important to understand the relationships between these tasks and to identify a timed path that gets the project complete in the shortest amount of time.

In Section IV we will help you build a schedule using specific methods such as Gantt Charts and Critical Path Analysis to manage and track various activities and bring your schedule analysis to maximum efficiency.

V BUDGETING: CALLING "ALL" COSTS

Q1: When developing the project, do you "pad" the budget so that as the project progresses and "unknowns" become "knowns" you hopefully have enough extra dollars to meet the project budget at the end?

Q2: Do you consider all information sources including the project team, history, subject matter experts, and even the project stakeholders when developing the project budget?

Once you have identified the project scope you need to use a systematic approach to estimating and budgeting for the project. Be sure to consider both direct and indirect costs and be prepared to have in place a system to monitor and control the project budget especially in light of potential project changes that may occur as you progress.

In Section V we will discuss how to identify project costs and forecast and control costs throughout the project lifecycle.

VI MANAGING RISK

Q1: In the planning stages of a project do you and your project team identify as many potential project risks as possible and then incorporate them into a plan to manage each one of them – large or small?

Q2: As your project progresses do you routinely monitor the known project risks and scan for additional yet unknown risks?

Risk is presented in every project situation and it's your role as the project manager to understand the risks and develop plans to minimize the impact of the risk. Risk is in fact is uncertainty and so the more you clearly identify risks and risk impacts upfront the better chance you have to handle the risk if it occurs.

In Section VII we will discuss how to identify risks in all stages of your project life cycle in order to get in "front" and manage that risk.

VII DID YOU EARN IT?

Q1: Can you measure current scope, schedule, and cost performance?

Q2: Can you predict future scope, schedule, and cost performance?

The fact is that as a Project Manager you can never really know with great degree of precision how far along you are in a project but with a technique called Earned Value Management (EVM) you can get a close estimate.

In Section IX we will discuss how you can calculate Earned Value and get a better measurement of the performance of your project.

Throughout this course you are going to find text boxes that look like this. These are nuggets of information for the section you're in and meant to keep you … On Target!

SECTION I

Project Management Basics

In this section you will be introduced to some common project definitions to help you understand the key characteristics of a project and the project life cycle and we'll explore why projects fail and what benefits good Project Management can provide.

1. FAILING BIG or SMALL

The ill effects resulting from bad project management can reach astronomical levels representing a significant waste of time and money and posing a threat to organizations that rely on the success of both small-scale and large-scale projects. Bad project management practices also have non-financial costs. Consider the Columbia Shuttle disaster where the death of seven astronauts has been attributed to organizational problems and a weakened safety culture at NASA. Let's look at a few projects that have failed, big and small:

The Channel Tunnel or "Chunnel"

- 31 mile tunnel running beneath the English Channel connecting the UK and France
- Construction started in 1988, completed in 1994 (20% schedule overrun 6 vs 5 yrs)
- 80% over budget (4.6 billion pounds vs. a 2.6 billion pound forecast)
- It was a unique project but not unprecedented (consider the Seikan Tunnel in Japan)

So what went wrong?

1. Cost overruns resulted from lack of historical precedents to build estimates from
2. The project was plagued by schedule delays from:
    a. Poor communication between teams (French and British) who were starting from different sides and meeting in the middle
    b. Change in design specifications (ex. Need for addition of ventilation systems for safety considerations not in the original design)

The Big Dig (Boston's Central Artery/Tunnel Project)

- Largest technically challenging highway project in American History
- Initial cost estimates were $2.56 billion – final cost was 5X the original estimate
- Reasons reported for cost overruns: cost escalation, poor assessment of unknown subsurface conditions, environmental costs, expanded scope

- The project was led by Bechtel/Parsons Brinckerhoff, one of the largest and experienced teams in infrastructure programs
- Project start 1991; scheduled completion 1998; ACTUAL completion December 2007

So what went wrong?

A collaborative, integrated project management team that should have been involving all parties in decision making was not in place until July 1998 when design of the project was 99% complete and construction was 45.9% complete.

How about "Your" Project

- It wasn't smallest or largest in your history
- The construction schedule overrun was only a month on a 9 month project
- We were only slightly over budget, say 15% on a $500,000 project
- You though you assembled a pretty good, technically sound project team

So what went wrong?

You may not really be sure! But looking at the 2 big failures above … have you ever heard this:

2. WHY DO PROJECTS REALLY FAIL?

Let's first define "failure"? We typically think of failure as not meeting the required delivered cost or failing to meet desired quality or not meeting the required schedule. But in fact projects fail in obvious ways, in subtle ways, and sometimes in ways that are pure based on perceptions. Have you ever felt like:

This is the stakeholders vision of the project

This is how the project team sees the project being completed

This is what actually gets delivered

The OBVIOUS ways a project may fail include:

- The project comes in over budget – or the project may have to be halted prior to completion due to insufficient funding

- The project takes longer than planned – or the project runs out of time before the desired goals are achieved

- The project does not meet the desired quality requirements - or of lower value than expected

Some more SUBTLE ways a project may fail include: 

- Project objectives may have not been clearly defined for the project team

- The desired project outcome was not clearly communicated

- The final end user of the project was not consulted about their needs

- The project team may have lacked specific training / expertise in the project area

But more often than not a project is considered a failure when the results are not delivered "in line with expectations". And unfortunately "in line with expectations" is not always that clear. For example, say the key project stakeholders agree that a project must exceed the initial budget to hit a "must meet" project schedule. In this case the project could still be considered a success. Or say a project delivers everything in the original design specifications but fails to meet a key requirement of one of the primary stakeholders – this could be considered a failure. So it is important to monitor the stakeholders and ensure the project is perceived "in line with expectations".

Perception is Reality

Perceptions can be very closely aligned with stakeholder expectations. For example, if a stakeholder perceives a project team as being unresponsive and lacking direction, they will tend to expect bad service. And any instances of good service will be perceived as an exception. And since we all have a tendency to remember the bad experiences much more strongly than the good experiences this project team will more than likely meet failure on their project.

So to overcome negative feelings, here are 3 things to consider, if as the project manager, you want to change stakeholder perceptions:

1. Try to improve your rapport with your stakeholders and try open more effective channels of communication (outside of what you are doing now – change it up!)
2. Improve your "street cred" or credibility with your stakeholders by providing more accurate and timely information that precisely meets their needs (Why not ask them what they think?)
3. As much as possible, try to differentiate and distance your current project from previous negative experiences (Show them your different and can expect different)

Unfortunately project failure is not always about the FACTS or what was ACTUALLY delivered. Remember Perception is Reality! Watch your stakeholders and keep them close as your project progresses.

3. MAKE SURE YOU HAVE A PROJECT - KEY CHARACTERISTICS OF PROJECTS

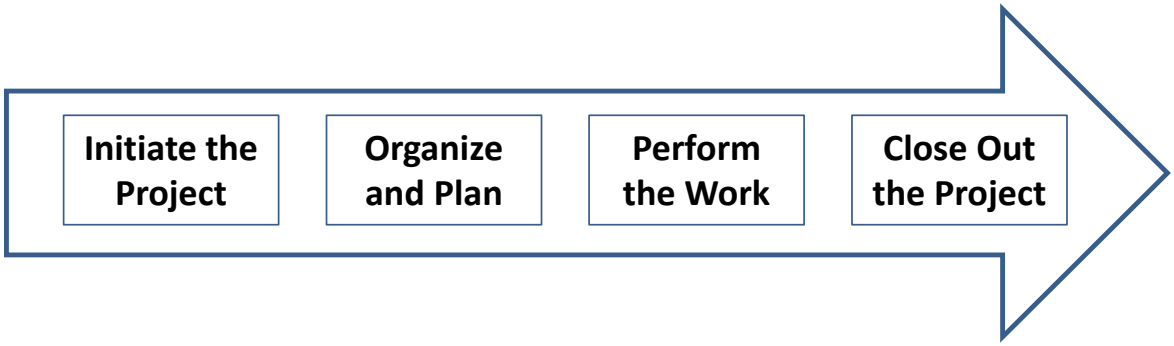
You cannot learn about how to manage a project unless you're sure you actually have a project. A project can be described as a sequence of tasks that are planned from beginning to end with a specific defined outcome. Common Project attributes include:

- A project must have a beginning
- A project must have a budget and requires a commitment of resources
- A project must have an ending (usually when all of the project goals have been met and all of the work of the project has been accomplished)
- A project has some type of constraints that limit and define the required progression
- A project usually includes multi-disciplined project teams bringing unique individual skills to the project when needed (the right people at the right time)
- A project is temporary (not necessarily short in duration and yet not an on-going effort that is repetitive – this is an operational function)
- A project is unique (typically something that has never been done before). For example, a contractor may construct many houses but each one is unique in its layout, location, etc and should be considered a unique project.
- A project always has one or more "stakeholders" that define the needs and expectations that must be met by completion of the project
- A project always involves a certain degree of uncertainty

Projects vs Operations - Make sure you have a Project and not an Operation. If your project definition starts to look like a series of ongoing activities that are required, repetitive, and will produce the same product or service your work will continue and never end – you have an Operation. Employment of good Project Management techniques will not be as effective in this case.

4. THE PROJECT LIFE CYCLE Q4

OK, now that you know you have a project you need to understand that successful projects, large or small, all need to pass through the same four stages. Together these distinct phases are combined to form the Project Life Cycle.



STAGE 1: Initiation (Starting the Project)

In this stage the project manager defines what the project is and what stakeholders hope to achieve by completing the project. This stage also involves framing the general approach to performing the project and the agreement to prepare a detailed project plan. Your job is to develop the project framework.

Output from this stage may include (1) documentation of rough estimates of time and resources, (2) development of a Project Charter, and (3) preliminary list of project stakeholders. (See below)

"I think what coaching is all about, is taking players and analyzing there ability, put them in a position where they can excel within the framework of the team winning. And I hope that I've done that in my 33 years as a head coach." Don Shula, Head Coach of the Miami Dolphins, (1970 to 1995)

STAGE 2: Organization (Planning the Project)

In this stage, specific work plans need to be developed including the desired results from the project. Determination of the work to do, the required time, costs, and needed resources have to be made. In addition, key project risks and project assumptions should be identified and documented.

Output from Stage 2 may include a project plan which documents the intended project results and the supporting processes needed to achieve them.

STAGE 3: Perform the Work of the Project

In Stage 3, the project team and support systems are put into action to perform the planned work. Frequent Monitoring and Controlling functions should be in place to ensure the project is adhering to the project plan. The project manager is in charge of updating the project plans to reflect actual progress.

Output from this stage may include project results, project progress reports, and other project status communications.

STAGE 4: Closing Out the Project

In Stage 4, the results of the project are assessed against the project plan. Stakeholder approvals are required and project team members begin the process of transitioning off of the project. Financial accounts are closed and post-project evaluations should be complete.

Outputs from Stage 4 may include final stakeholder approved documentation and evaluation of applying "lessons learned" to potential similar project efforts in the future.

Managing stakeholder expectations is very important in Phase 1 (Project Initiation). Since the stakeholders are often managers or directors of an organization they tend to have more influence. Make certain you communicate with these stakeholders often in order to resolve issues, implement requested changes ,and manage concerns before these become potential problems in

Resist the temptation to fast-track from Phase 1 to Phase 2 as the highest risk is in these earlier phases when the available information is at its lowest. Also costly re-work and error corrections can be avoided in later phases if the project assumptions are found to be incorrect later.

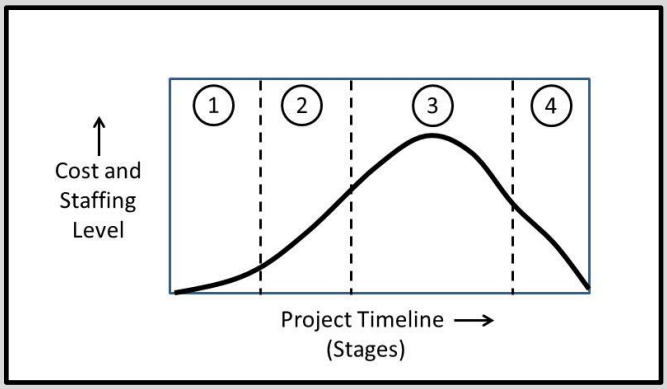
COMMON ELEMENTS TO EACH STAGE OF THE PROJECT LIFECYCLE

- In order to improve management and control of the project, the project phases are designed to aligned in a logical sequence and segregated

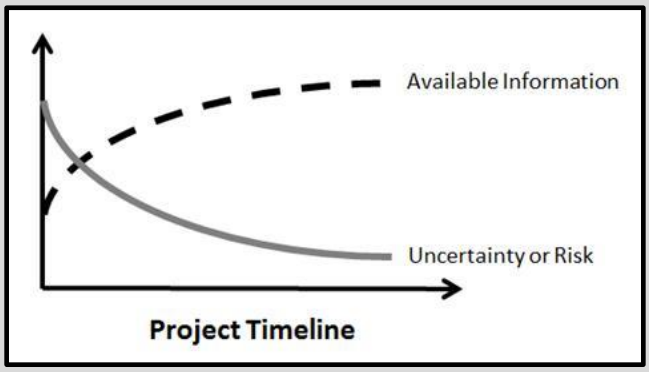
- The conclusion of one phase typically precedes moving to the next phase. At this point before moving to the next phase a review of both deliverables and project performance at the conclusion of each project phase will (1) determine if the project should continue on to the next phase and (2) allow for detection and correction of errors. This review is often called a phase exit, kill point, or stage gate.

  Note: Sometimes a subsequent phase is started prior to approval of the previous phase deliverables -- when the risks are deemed acceptable. The practice of overlapping phases is often called fast tracking.

- Cost and staffing levels are low at the start of the project and higher toward the end and then drop rapidly as the project draws to a conclusion



- Risk and uncertainty are highest at the start of the project and thus the probability of successfully completing the project is lowest. (See Figure 2)



- Stakeholders have the largest influence over the project scope and final costs at the beginning of the project and gets progressively lower as the project continues. (Because the cost of changes and error correction increases as the project continues through each progressive stage)

5. PROJECT MANAGEMENT DEFINED  Q5

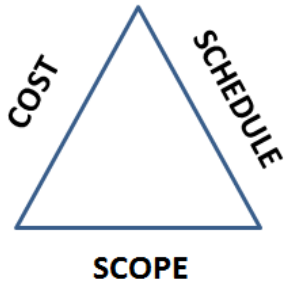
Project Management definition:

project, job
The process of planning, organizing, staffing, directing and controlling the production of a system

Substitute "system" with "project" and let's expand our definition to say –

PROJECT MANAGEMENT:

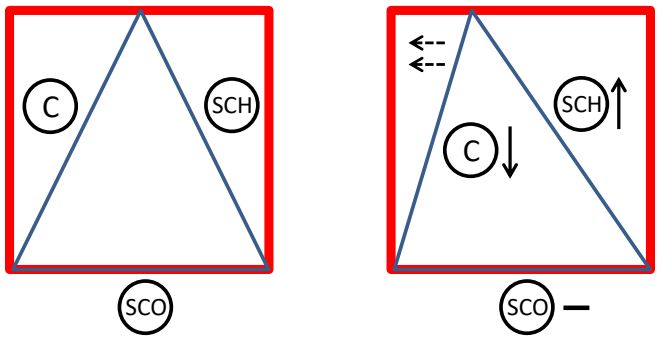
- Is the process of planning and organizing the components of a project into a desirable timeline **[SCHEDULE]**
- Requires the use of sets of tools and techniques to effectively manage a project against a pre-defined resource budget **[BUDGET]**
- Continually assesses the progress of the project against the goals and expectations of the stakeholders of the project **[SCOPE]**



The "Triple" Constraint

So, Project Management becomes the effective process of managing the triple constraint of schedule (time), cost (resources) and quality (scope) while meeting the expectations of the project stakeholders. These three elements work in tandem which each other whereas if one element is restricted or extended then the other elements will need to be extended/increased or restricted/reduced in some way. Draw a triangle for yourself and stretch any one side and see how the other sides are affected. Note where: C = Cost, SCO = Project Scope, SCH = Project Schedule, Outer Box is the Stakeholder Expectation Boundary. Let's look at some examples of managing within the "Triple" Constraint:

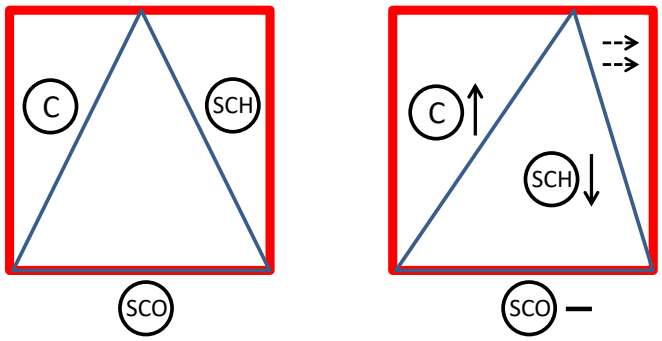
Example 1:
Desire to Reduce Cost – No Change in Scope



Original Plan **Revised Plan**

A desired reduction in project costs without a reduction in the project scope could possibly be achieved by extending the project schedule and optimizing the allocation of resources to the project (i.e. maybe less overtime or the additional time allowance could allow for lower cost outsourcing of some deliverables of the project)

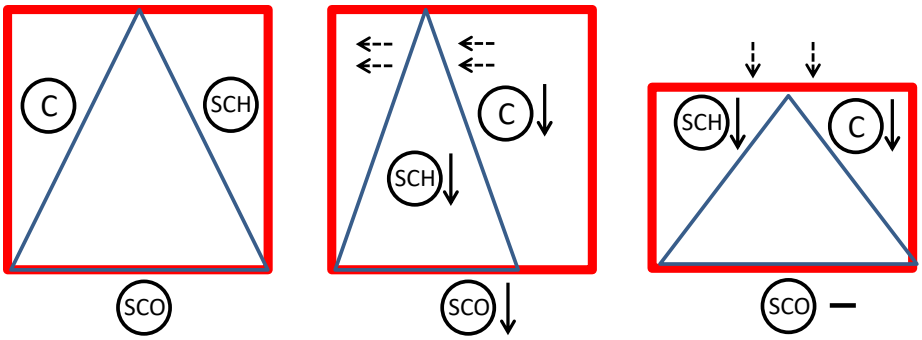
Example 2:
Desire to Shorten Project Schedule – No Change in Scope



Original Plan **Revised Plan**

A desired reduction in the project schedule without a reduction in the project scope could possibly be achieved by increasing the project budget to allow for additional resources to be used on the project (i.e. more overtime or adding short term workers to complete tasks quicker)

Example 3:
Desire to Shorten Project and Costs – The Dream



Original Plan **Revised Plan 1** **Revised Plan 2**

As in most projects there is always a desire to reduce the project schedule and the project costs. 2 Proposed options could be available to achieve this goal, which would need the explicit approval of the stakeholders: (1) Reduce the project scope or (2) Reduce the quality of the deliverables while maintaining the project scope (if possible)

In successful Project Management the more common challenge will be the role of the Project Manager to educate your client or stakeholders that if a project is to be completed at a certain level of quality, then a certain amount of time and money need also to be invested in the project. Likewise, a project that has strict time constraints will require an increased amount of assigned resources or a reduction on quality or scope to meet the schedule.

6. BENEFITS OF PROJECT MANAGEMENT

You, as a Project Manager ultimately are expected to produce RESULTS! And not just any results, your results have to meet the needs of your client, be on-time, and be on-budget. But, remember, Project Management requires a commitment of time and resources. If challenged, here's 8 Reasons your client needs Project Management:

1. You've Got to Control Scope Creep and Manage Change

Change in a project is inevitable and can come from your project team, your customer, your suppliers and vendors, or even other stakeholders. The changes, however uniquely small, could accumulate to create "scope creep" that could overrun the budget or the schedule.

2. You've Got to Deliver the Project On Time and On Budget

Once the projects justification is in place (the expected costs are in place) it's up to the Project Manager to maintain on-time and on-budget performance otherwise the project justification could be invalidated.

3. You've Got to Keep the Team Focused

The natural human tendency of work groups is to easily drift off topic and spend too much time on the wrong tasks. As the Project Manager you have to keep the team focused and keep your team from being distracted from outside influences

4. You've Got to Define and Defend the Critical Path

Again since a project is a series of connected activities with each having its own constraints, if someone isn't responsible to identify the optimal path of action how can the project team find or even stay on track?

5. You've Got to Keep an Eye on the Costs

As we saw above the project has a defined budget – who is going to keep an eye on the budget progress?

6. You've Got to be the Messenger

Who is going to communicate the good, the bad, and the ugly? The Project Manager is the communicator responsible for relaying information to the project stakeholders about project progress, changes, stumbling blocks, or even successes.

7. You've Got to Expect the Unexpected

Every project will run into an unforeseen issue but who is going to plan and execute the alternate course of action? - The Project Manager

8. You've Got to END the Project

Every project has to START and every project has to END. Before moving on to the next project the Project Manager has to provide the proper close-out documentation, turnover and acceptance documents, and the historical archive of "lessons learned" for the next project.

SECTION II

Project Planning

On your Mark, Get Set, GO!

Your project has been initiated and everyone is excited to GO! But hold on … Let's start at the beginning and focus on the "On Your Mark"

At the beginning of any project it's important to establish a solid foundation starting with understanding the project's goals and let's start with some Planning.

In this section you will be introduced to a basic outline to start your project off on the right footing – with PLANNING. Let's ask some basic questions as we get "On Your Mark"

How Would Your [Project Stakeholders] Describe the Project?	Explain what the "big picture" vision and purpose of the project is. Once completed, how is the project expected to increase productivity, help customers, or the company?
What are the Highest Level Project Goals and Objectives?	What are we trying to accomplish? Are the project goals clear and written and better yet measureable and even achievable?
Who will actually benefit from the Project?	Our Clients, Our customers or even the community or the environment?
What does the schedule look like?	Is the project anticipated to take months or years? Will the project need to be completed in phases? Are there any specific milestone dates?
Are there any external parties or collaborators that will be involved with the project?	Are there any external experts required to support the project? How about external agencies (i.e. environmental or government regulators)
Any special equipment or systems required?	Be sure to consider infrastructure requirements such as computers or specialized software
How will You [Project Stakeholders] evaluate Project Success?	Include measures of progress and effectiveness - Will there be process evaluations as we progress or evaluation of the outcome at the end?
Who is going to Approve Major Decisions?	There needs to be a defined process for submitting items for review and approval. Who approves and Who breaks an impasse if the team can't come to consensus?
Any other Open Issues?	Keep a list of running unanswered questions and unknowns – how much risk is associated with these unknowns?

1. GETTING STARTED  Q6

Let's start by getting everyone on the same page. This is accomplished by developing a high-level project planning document called the Project Scope Statement. Your Project Scope Statement is going to answer the basic questions of What? Why? Who? How? When? A written agreement, the Scope Statement, is necessary to:

- Bind and commit the project team to produce the agreed results
- Identify restrictions that could affect the project work
- Identify assumptions made and how to handle assumptions that prove to be invalid
- Ensure that project stakeholders 100% accept the results if the objectives are met

Parts of the Scope Statement

Section	Description
Justification	Project background and why the project is needed and the business need it addresses
Objectives	Also known as deliverables – the results the project is expected to produce
Scope Description	A Narrative description of the scope including objectives and expected results
Acceptance Criteria	Description of agreed upon conditions and characteristics required by the project stakeholders
Constraints	Anything that restricts the project from achieving its objectives – anything that may work as a bottleneck
Assumptions	Acceptance of "what if" scenarios when given uncertainty

Your Scope Statement is your agreement between the project team and your stakeholders. Think of it as your "Definition of Done"!

2. YOUR SCOPE STATEMENT 

A. JUSTIFICATION

Project justification essentially signals that a project has moved from being a concept to reality by validation of the project needs through a business case. The project business case, identification that benefits outweigh the costs of doing the project itself, is the responsibility of the project initiator or project sponsor.

But your role as the project manager in the project justification process is to (1) continually clarify and confirm the business case in support of the project sponsor and to (2) communicate if the business case is being compromised (i.e. higher cost, schedule risks, project results not meeting expectations, etc). Remember, project justification is only a description of what will happen **IF** the project is approved and executed to completion. Consider the benefits expected of the project and how you can support the project sponsor:

Projects with "Hard" Benefits:

- Example – new equipment installation: sales increase or cost decrease as a result of completing the project
- The project results are measurable and can be quantified
- The role of the project team is to **MEASURE AND QUANTIFY** the deliverables

Projects with "Soft" Benefits:

- Example – DCS (distributive control system): a process improvement that improves productivity or increases functionality of an existing system
- The project results may be hard to quantify
- The role of the project team is to **VALIDATE FUNCTIONALITY** of the deliverables

If you, the Project Manager do your part, it is then the role of the project sponsor to determine if the business case was met as promised.

Once your project has been initiated by your client, don't be in such a rush to start without understanding the business case for the project. You need to help your project sponsor validate his business case.

B. OBJECTIVES

Objectives are quantifiable criteria and describe "what" the project is trying to accomplish. Quantifiable objectives should at least include descriptions of the required project schedule, cost, and quality measures. It's also OK to include Project Exclusions in your objectives. Project Exclusions clearly delineate anything that will not be included as a deliverable or work product and are useful to help manage the project scope statement and manage stakeholder expectations throughout the project.

As your project's deliverables, your objectives must be unambiguous in order to achieve project success. Since objectives are critical for project acceptance, be sure to recognize there may be resistance by some to keep the objectives clear and concise. Keep your descriptions brief – short and clear is better – avoid using a full page for each objective. Here are some tips to use to create clear objectives:

- Avoid technical jargon – keep your written descriptions in language common to people of all backgrounds, avoid use of industry specific acronyms
- Make the objectives measurable – clearly state the criteria to be used to measure whether objectives are met
- Make sure you have 100% commitment from the project team – ensure the team believes the objectives can be met
- Assure driver's and supporters agree – your role is to eliminate resistance to meeting your objectives

Project Objective EXAMPLE: Intranet Project

1. Redesign website layout of 3 existing sites into a single web site by 1/31/12
2. Develop website content (instructions and input forms) for all listed existing administration functions on the current websites by 2/28/12
3. New website fully functional by 3/30/12

C. SCOPE DESCRIPTION

The scope description is a written narrative that should collectively define the product, service, or result of the project and the work needed to produce these results. As an agreement between the project and the project stakeholders, the scope description should simply tell everyone concerned with the project exactly what they're going to get when the work is complete. The risks of poor scope descriptions could lead to cost increases, rework, schedule delays, and poor team member morale. A good scope description will:

- Provide the stakeholders with a clear understanding of the project scope
- Provide the project team with a clear definition of the work and work processes
- Provide the project team and stakeholders a basis to evaluate change as the project progresses
- Provide the project team and stakeholders a criteria to determine if the project has been completed successfully

A poorly written scope statement provides an unclear project baseline and will make change or approval decisions much harder if there are questions arise between the project team and the project stakeholders. Who decides if "work" is Out of Scope or the "work" is complete for Approval? The project team and the project stakeholders with a clear scope statement!

D. CONSTRAINTS Q8

Some typical examples of constraints or limitations to look for include:

Limitation	Description	Example
Time frame Limitations	Results that must be produced in a specific time period – an enforced deadline in which all activities are driven by this due date	Website layout complete by 1/31/12
Budget Limitations	Cost constraint that limits the amount of $$ resources available to the project team	Maximum of $1000 allowed for printing of training materials
Resource Constraints	Limit of type and availability of resources to the project (Non $$)	Two staff accountants are available to assist in the project 40 hours per week for 2 weeks
Scope Constraint	Limits on the deliverables of the scope of work	Redesign of intranet site shall include consolidation of Websites 1, 2, and 3 and not 4
Quality Constraints	Limit defined in an accepted specification of a product or service	Roof installation to meet client design criteria for Metal Roofs
Technology Constraints	Specific use of technology (software or equipment)	All final drawings must be produced in ACAD 2012
Stakeholder Directives	Specific policies or practices that are required by the project stakeholders	All purchasing must follow the client's purchase guideline for including minority businesses

E. PROJECT ACCEPTANCE CRITERIA

Project acceptance outlines the criteria that will be used to determine whether the deliverables and results of the project are acceptable to the project stakeholders. The Acceptance criteria can represent essential requirements to be met at the completion of the project or specific conditions that must be met during the project work process.

Tip: To avoid an outright refusal to accept a project deliverable at the end of a project, provide your stakeholders with a multiple series of acceptance criteria to allow for conditional approval. For example, "acceptance pending modification or correction". By gaining conditional approval the project can make early identification of stakeholders shortcomings on the deliverable.

F. ASSUMPTIONS

Assumptions are things that the project assumes to be true. Therefore it is essential that all assumptions are identified and documented upfront. But even after a project has started it is important to continue to document new assumptions and refine old ones as more information becomes available. As a starting point, consider the factors we usually take for granted when trying to identify assumptions (i.e. key team members' availability, management support, vendor capabilities, timely approvals, access to information and equipment. Some typical examples of assumptions for consideration and corresponding clarifications that could change the original assumption are as follows:

Assumption	Example	Refinement to Assumption
Plentiful Availability of Materials	Sufficient supply of drywall available for large office building project	Fire at major drywall plant in southeast disrupts production causing shipping delays
Limited Availability of Skilled Craftsmen	Welders are in short supply due to large pipeline project in surrounding state – higher wages expected to be required	Pipeline project delayed due to environmental permits – supply of welders now ample
Client Resources Available	Client will provide on-site office space for project team	Office space made unavailable – other accommodations required
Vendor Delivery	Delivery of Machine agreed to by vendor for 1/1/2012	Delay to 1/15/12 identified
Client approval of key documents	Client approval needed of design basis document	Key manager on vacation delays final approval

Assumptions, not properly documented, could worst case kill a project or make it unfeasible. Lesser catastrophic issues could arise including project acceptance problems or inability to justify a scope change.

Example Project Scope Statement

Warehouse 21 Construction

1.0 PROJECT OVERVIEW

This project is being undertaken at ABC Company's Atlanta Georgia facility in order to construct a new warehouse for storage of valves and pipe necessary for the maintenance at the facility.

2.0 PROJECT JUSTIFICATION

The project sponsor, Jim Williams of ABC Company has provided approval and justification for the construction of Warehouse 21 based on reduction of maintenance down time as critical spare parts including required valves and pipe will be stored on-site rather than relying on supply from local vendors.

3.0 PROJECT OBJECTIVES

A. Provide approved detailed design specifications and details for construction of the warehouse to meet all current Georgia building codes
B. Warehouse interior space shall be a minimum of 2000 square feet
C. Design shall be submitted for client approval by 1/1/13
D. Submital for building permit approval shall be within 30 days of client approval
E. Construction shall be complete 180 days from receipt of building permit
F. Project cost shall not exceed $100,000.00
G. Exclusions: warehouse will have no interior partitions, offices, or bathrooms

4.0 PROJECT SCOPE

A. Warehouse will be engineered and constructed to current Georgia building codes
B. Warehouse construction shall cost of suitable concrete foundation and be constructed as pre-fabricated metal building with minimum 20' height limit and qty 2 - 14' wide bay doors for truck access
C. Electric and lighting shall be design and constructed per current building codes
D. Ventilation systems shall be designed and constructed per current building codes
E. Fire protection systems shall be designed and constructed per current building codes
F. Painting of exterior metal surfaces shall be per ABC Company paint spec 1.0

Example Project Scope Statement (Continued)

Warehouse 21 Construction

5.0 ACCEPTANCE CRITERIA

A. Issuance of certificate of occupancy and compliance, including compliance with the project scope, constitute 100% acceptance

6.0 CONSTRAINTS

A. No access to ABC Company's Atlanta Facility will be allowed from 3/1/13 12:00 AM to 3/4/13 12:00 AM due to major outage
B. Normal access to the facility (except for the outage period listed above) will be limited to the hours of 7 AM to 5:00 PM Monday through Saturday
C. All engineering drawings shall be signed and sealed by licensed Georgia PE and be provided in ACAD 12.0

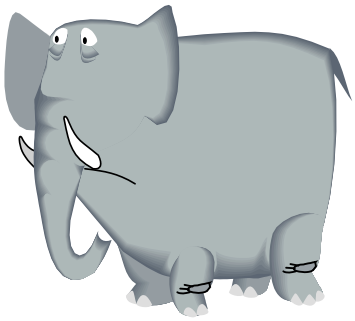
7.0 ASSUMPTIONS

A. No environmental site remediation efforts are required for warehouse siting
B. No fire protection systems are required for installation in the warehouse
C. There are no flood mitigation requirements for the warehouse site

SECTION III

SHORING UP THE SCHEDULE

Break Your Project into Bite-Size Chunks – Your WBS Q9



We've all heard the saying … How do you eat an elephant?
Answer: 1 bit at a time

This is the same approach you need to follow as you plan your project. You need a structured, 1 bite at a time approach, in organizing and identifying all of the work required so let's look at the Work Breakdown Structure (WBS) as the approach to defining the scope of the project.

1. Work Breakdown Structure (WBS) Defined

The WBS organizes and defines the project scope of work and as defined by Your WBS should be your foundation for project planning and control and is the connecting point for cost estimates, schedule information, and actual work efforts. As such, your WBS must exist BEFORE the project manager can plan all of the vital parts of the project.

The WBS is the best way to understand the detailed work of the project when you have to build a schedule from scratch. The WBS is used to break the project down into the major phases, deliverables, and work components that will be built by the project. These work components can then be further broken down or decomposed into detailed activities.

Your WBS must function under the 100% Rule. Basically stated, your WBS should include 100% of all the work defined in the project scope statement and management plan and capture 100% of all of the project deliverables including internal and external. We'll talk about the 100% rule in more detail ahead.

Incomplete or BAD Project WBS? – look for these signs:

- Repeatedly re-plans and extensions of a project
- Unclear work assignments
- Scope creep or frequent changes to the project scope
- Budget overruns
- Missed deadlines
- Project deliverables that do not meet stakeholder expectations

2. Work Breakdown Structure (WBS) Details

Let's consider some Key Facts about your WBS:

- The WBS is NOT a project schedule – the schedule answers "Who" and "When"
- The WBS is NOT a detailed description of the project work processes
- The WBS is NOT going to outline task dependencies or resource needs
- The WBS is NOT a "To-Do List" - decomposition into too small levels is not good
- The WBS IS a set of deliverables required of the project – both internal and external
- The WBS answers the "What" of a project – the total scope of the project
- Three to Four levels of a WBS is usually adequate
- The WBS is a hierarchy with each descending level representing an increasing detail definition of the project work
- The lowest level of the WBS should be manageable, able to be estimated and measureable and is called a work package

3. Work Breakdown Structure (WBS) – What's the Purpose?

So why do you need to create a WBS for your projects? Why should you spend the time to create a WBS rather than getting the project team started on the actual work of the project? The purpose of a well thought out WBS is threefold:

1. To help more accurately define and organize the scope of the total project and clearly communicate the scope to the entire project team – ***less ambiguity***
2. To help assign responsibilities and assist with resource allocation so that project resources are used efficiently – ***increased control and monitoring***
3. To help precisely define the project deliverables and keep alignment with the project team on what is required for each deliverable – ***reduced project scope creep***

4. Your WBS - Getting Started

We now know what the WBS should represent, some of the key points, and why we need an accurate WBS. So, let's start and consider that ultimately we want a diagram or representation that will express the project scope in simple graphic terms. Remember it's a hierarchical approach so the upper levels are the deliverables and the lowest level will be the work packages that define activities supporting the deliverables. Here's a simple hierarchy layout:

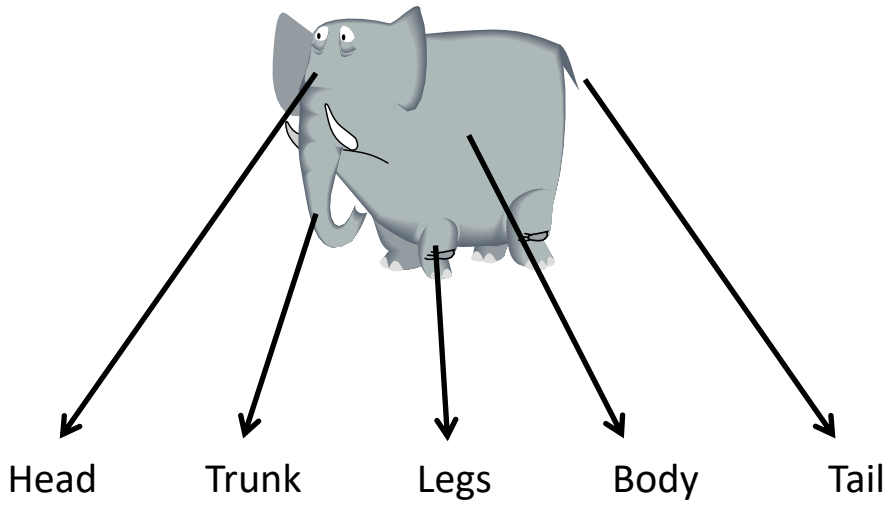
1.1.1.1 Install Bathroom Vanity

Level 4 – Activity Level
Level 3 – WBS Entry
Level 2 – Project Deliverables
Level 1 – Project Itself

Let's look at our elephant example:

STEP 1: Identify Project Deliverables

The very first thing to do is to identify the project deliverables or milestones. These deliverables will be the products that later you will decompose and break down into tasks in order to produce work packages. The deliverables become the high-level elements in the WBS and should match the nouns used to describe the expected project outcomes from the Scope of Work. Use nouns or noun / adjectives to describe the deliverables. We're breaking down the elephant. This will be Level 2 on you WBS. (Level 1 – the top level is the Project itself)



Step 2: **Decompose the Project Deliverables**

Write down each deliverable on a post-it-note and then start to break down each deliverable into components and write each component on another separate post-it note. This is a process known as decomposition in which you take a top-down approach to determining tasks and subtasks. The idea is to move from the most general aspects of the project to the most specific and detailed tasks in the project. This will become Level 3 on your WBS and is generally called a WBS Entry.

For example, suppose you are writing a technical manual, a good decomposition would be to break the manual into its smallest components – chapters. The Chapter 1, Chapter 2, Chapter3 …become the WBS Entries.

Place the post-it notes on top of a wall resembling a pyramid structure (again remember our WBS is a hierarchy) so that the complete project team can visualize the structure. By using post-it-notes you can also easily move the deliverables and WBS Entries around to find a good fit.

Step 3: **Decompose the Components of the Deliverables into Work Packages** Q10 Q11

Ok at this point you've identified the deliverables and broken each deliverable into major components. Let's decompose one step further and now put some action into this step. Use verbs and action names at this step with the goal to decompose the deliverable components into the smallest chunks of work that can be realistically managed by the project manager and completed within the desired timeframe. This level of component breakdown is called the Work Package and is Level 4 on your WBS.

Take the technical manual example stated above, a work package for Chapter 1 might look like: (1) Complete Research (2) Develop Outline, (3) Draft Complete, (4) Revise Approve Draft.

The project manager should reserve the right to decompose the WBS to whatever level of detail he or she requires to effectively plan and manage the project. So how far should you decompose?

Here are a few helpful guidelines:

- The package should be small enough to be able to identify and assign an individual or team of people that will be held accountable for the result
- The package should NOT be so granular that the project team has a hard time identifying the work package as part of the higher deliverable
- Use the 8/80 rule: no work package should take less than 8 hours or longer than 80 hours to complete

Step 4: **Review your WBS to include Any Additional Required Deliverables**

Be sure to include any external deliverable that me be required to complete one of the deliverables identified earlier. For example: (1) Permit Approval from a Building Department or (2) Performance Specification provided by an Outside Consultant.

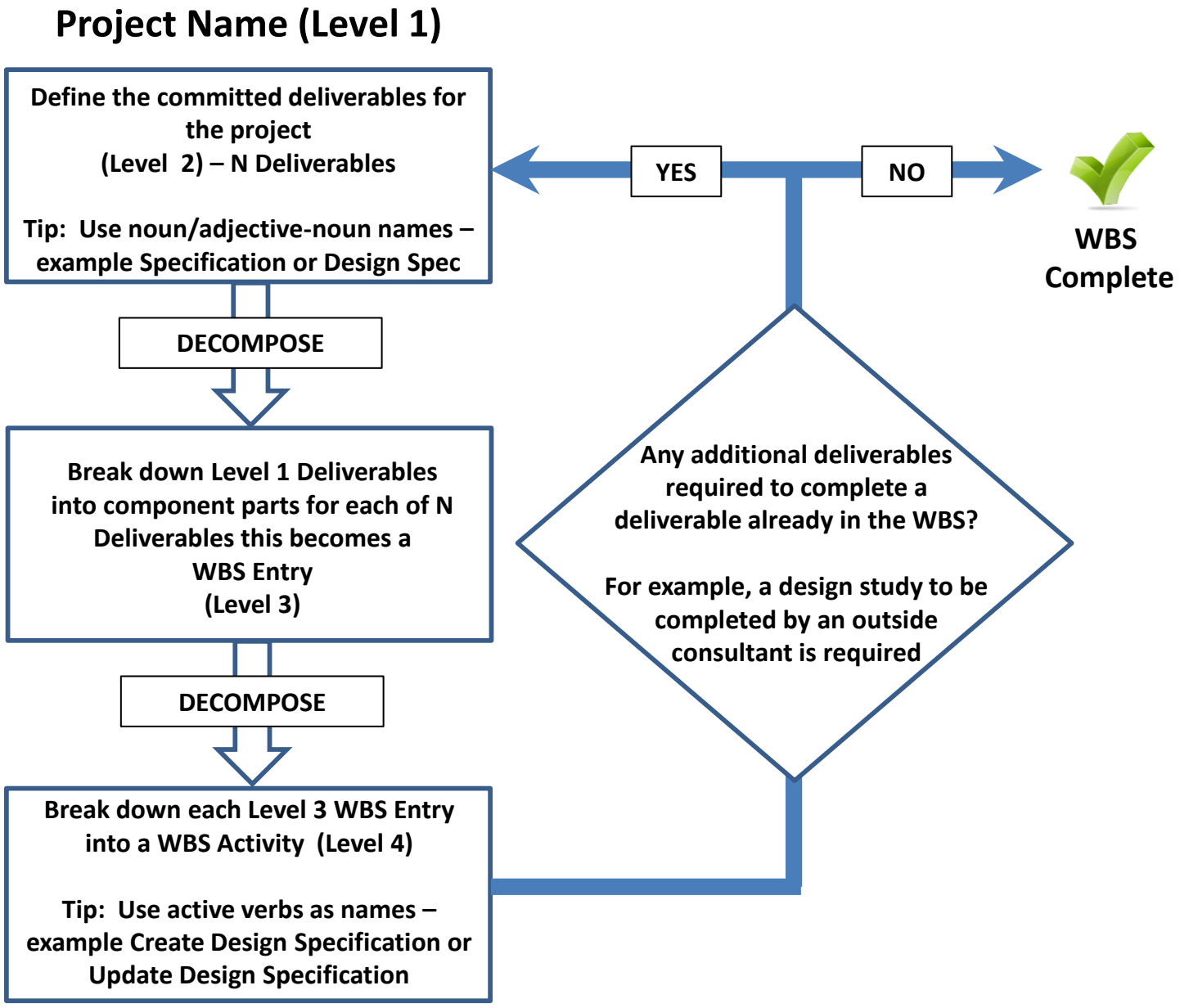
Step 5: **Iterate**

Repeat Steps 1 through 4 until the project manager and the project team feels that the WBS accurately describes 100% of the required project work. Ask yourself and the project team following questions:

- If we produced all of the listed deliverables would we achieve all of the objectives of the project?
- If we complete all of the listed WBS entries for each single deliverable could we successfully complete that deliverable?
- If we complete the Work Packages for each WBS entry would we sufficiently complete the requirements of the WBS Entry?

Be careful not to micromanage your project by making your work packages too detailed. Micromanagement can cause frustration and low morale among the project team members and lead to inefficient work output.

Below is a brief schematic of the Steps in WBS Development



5. Your WBS – A Graphical View Q12

Since your WBS is a hierarchy and represents a top-down view of the project and represents 100% of the project outcome a graphical representation of your WBS will be most effective. Two ways to graphically represent your WBS are (1) the Outline View and (2) the Organization Chart View.

Here a few helpful hints when preparing your graphical view of your WBS:

- Level 0 of your WBS is the Project itself
- Level 1 is the highest level of your WBS and as you move down the hierarchy the level numbers increases
- Level 1 should represent the Major Deliverables of the project but could also represent Project Phases or Sub-projects of a bigger Program
- Project Management processes, if desired, should be listed in Level 1 (i.e. Project Management)
- At ANY Level you should have 2 or more entries otherwise the level has been decomposed too far and the level itself does not have meaning
- Be sure that the decomposition from a higher level deliverable to a lower level components makes sense (recognized by everyone on the project team as part of the higher deliverable). This hierarchical understanding is call logically distinct
- Again remember the 100% Rule – From the bottom up the sum of the work at the child level must equal 100% of the work represented by the next highest level - the parent. And as you roll up the WBS levels the no listed levels should fall outside of the scope of the project

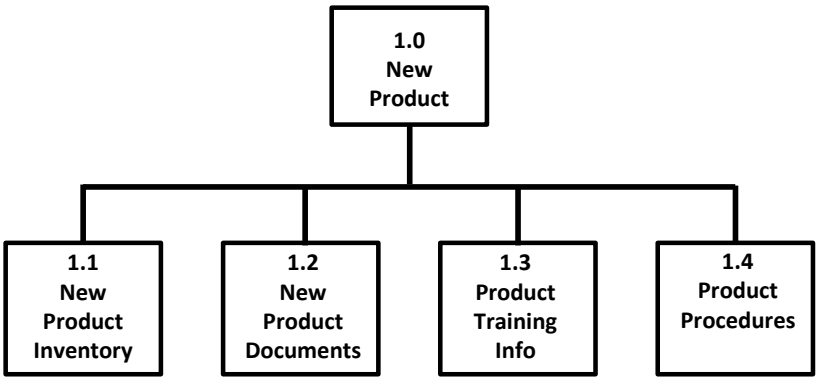
WBS Views

Outline View

1.0 New Product

- 1.1 New Product Inventory
- 1.2 New Product Documents
- 1.3 Product Training Info
- 1.4 Production Procedures

Organization Chart



6. A WBS Example

1. Here's the Scope

I have contracted with a builder to construct a single story house. The house design is complete but will require a building permit and will be responsibility of the contractor. The house should include site prep necessary for installation of a concrete foundation, exterior walls built from concrete block with finished interior walls constructed of drywall. The house should be provided with an asphalt shingle roof. On the interior the house will have 1 bathroom (bath sink & cabinet, bathtub, toilet,), a standard kitchen with a single sink, a suitably sized air conditioning system, and a 100 amp electrical panel with code-required fixtures and outlets throughout the house. The project is small enough that Project Management is not included in the WBS (PMs choice). We will call the project "New House"

2. What are the Deliverables?

After examining the Scope Statement develop the list of deliverables:

• Site Ready • Foundation • Concrete Slab • Exterior Walls	• Roof • Electrical System • Mechanical System (AC) • Plumbing System	• Finished Interior Walls • Kitchen • Bathroom

3. Let's Decompose the Deliverables into components (Remember these are the WBS Entries – if I have 1 for a given deliverable than do not list)

Deliverable	Decomposition Components
Site Ready	Rough Grading
Foundation	Forms
	Rebar
	Concrete
Concrete Slab	Soil
	Wire Reinforcement
	Concrete
Exterior Walls	Concrete Block
	Rebar Reinforcement
	Concrete
Roof	Trusses
	Roof Decking
	Shingles
	Fascia

Deliverable	Decomposition Components
Electrical System	Main Electrical Panel
	Fixtures
	Outlets
Mechanical System	AC System
	Ductwork
Plumbing System	Bathroom
	Kitchen
Finished Interior Walls	Finished Drywall
Kitchen	Cabinets
	Sink
Bathroom	Cabinets
	Sink
	Bathtub
	Toilet

4. Let's create an outline view of the WBS with WBS Entries

Note: Start with the project name at the highest level, add deliverables from above and then add the Decomposition components - aka WBS Entry - for each deliverable)

1.0 New House

- 1.1 ***Site Ready***
  - 1.1.1 Rough Grading
- 1.2 ***Foundation***
  - 1.2.1 Forms
  - 1.2.2 Rebar
  - 1.2.3 Concrete
- 1.3 ***Concrete Slab***
  - 1.3.1 Soil
  - 1.3.2 Wire Reinforcement
  - 1.3.3 Concrete
- 1.4 ***Exterior Walls***
  - 1.4.1 Concrete Block
  - 1.4.2 Rebar Reinforcement
  - 1.4.3 Concrete
- 1.5 ***Roof***
  - 1.5.1 Trusses
  - 1.5.2 Roof Decking
  - 1.5.3 Shingles
  - 1.5.4 Fascia
- 1.6 ***Electrical System***
  - 1.6.1 Main Electrical Panel
  - 1.6.2 Fixtures
  - 1.6.3 Outlets
- 1.7 ***Mechanical System***
  - 1.7.1 AC System
  - 1.7.2 Ductwork
- 1.8 ***Plumbing System***
  - 1.8.1 Bathroom
  - 1.8.2 Kitchen
- 1.9 ***Finished Interior Walls***
  - 1.9.1 Finished Drywall
- 1.10 ***Kitchen***
  - 1.10.1 Cabinets
  - 1.10.2 Sink
- 1.11 ***Bathroom***
  - 1.11.1 Cabinets
  - 1.11.2 Sink
  - 1.11.3 Bathtub
  - 1.11.4 Toilet

Wait! The contractor has to get a permit before we can start anything!! Better add another deliverable to the top of the WBS.

"Site Ready" has only 1 component, let's delete the WBS entry and roll it back up

"Interior Walls" also has only 1 component, again let's delete the WBS entry and roll it back up

<< Revised and Corrected Outline View of the WBS with WBS Entries >>

1.0 New House

- 1.1 ***Building Permit***
- 1.2 ***Site Ready***
- 1.3 ***Foundation***
  - 1.3.1 Forms
  - 1.3.2 Rebar
  - 1.3.3 Concrete
- 1.4 ***Concrete Slab***
  - 1.4.1 Soil
  - 1.4.2 Wire Reinforcement
  - 1.4.3 Concrete
- 1.5 ***Exterior Walls***
  - 1.5.1 Concrete Block
  - 1.5.2 Rebar Reinforcement
  - 1.5.3 Concrete
- 1.6 ***Roof***
  - 1.6.1 Trusses
  - 1.6.2 Roof Decking
  - 1.6.3 Shingles
  - 1.6.4 Fascia
- 1.7 ***Electrical System***
  - 1.7.1 Main Electrical Panel
  - 1.7.2 Fixtures
  - 1.7.3 Outlets
- 1.8 ***Mechanical System***
  - 1.8.1 AC System
  - 1.8.2 Ductwork
- 1.9 ***Plumbing System***
  - 1.9.1 Bathroom
  - 1.9.2 Kitchen
- 1.10 ***Finished Interior Walls***
- 1.11 ***Kitchen***
  - 1.11.1 Cabinets
  - 1.11.2 Sink
- 1.12 ***Bathroom***
  - 1.12.1 Cabinets
  - 1.12.2 Sink
  - 1.12.3 Bathtub
  - 1.12.4 Toilet

5. From the latest WBS (with WBS Entries) Let's Decompose further into Activities – See the Table Below (Be sure to use Verbs for activities)

Deliverable	Decomposition Components	Decomposition Activities
Site Ready	Rough Grading	Rough Grade the Site
Foundation	Forms	Layout Forms
		Install Forms
	Rebar	Procure Rebar
		Install Rebar
	Concrete	Pour Concrete
Concrete Slab	Soil	Procure Clean Fill
		Compact Fill
	Wire Reinforcement	Procure Wire Reinforcement
		Install Wire Reinforcement
	Concrete	Pour Concrete
Exterior Walls	Concrete Block	Procure Concrete Block
		Install Concrete Block
	Rebar Reinforcement	Procure Rebar Reinforcement
		Install Rebar Reinforcement
	Concrete	Pour Concrete
Roof	Trusses	Procure Truss material
		Fabricate Trusses
		Install Trusses
	Roof Decking	Procure Roof Decking
		Install Roof Decking
	Shingles	Procure Shingles
		Install Shingles
	Fascia	Procure Fascia
		Install Fascia
Electrical System	Main Electrical Panel	100A Panel
	Fixtures	Design Fixture Layout Diagram
		Install Fixtures
	Outlets	Design Outlet Layout Diagram
		Install Outlets
Mechanical System	AC System	Design AC Layout Diagram
		Install AC
	Duct Work	Install Duct Work
Plumbing System	Bathroom	Install Rough Bathroom Plumbing
	Kitchen	Install Rough Kitchen Plumbing
Finished Interior Walls	Finished Drywall	Install and Finish the Drywall
Kitchen	Cabinets	Design Kitchen Layout
		Procure Kitchen Cabinets
		Install Kitchen Cabinets
	Sink	Install Sink
Bathroom	Cabinets	Design Bathroom Layout
		Procure Bathroom Vanity
		Install Bathroom Vanity
	Sink	Install Sink
	Bathtub	Install Bathtub
	Toilet	Install Toilet

6. Convert to an Outline View WBS

1.0 New House

1.1 ***Site Ready***
- 1.1.1 Rough Grading

1.2 ***Foundation***
- 1.2.1 **Forms**
  - 1.2.1.1 Layout Forms
  - 1.2.1.2 Install Forms
- 1.2.2 **Rebar**
  - 1.2.2.1 Procure Rebar
  - 1.2.2.2 Install Rebar
- 1.2.3 **Concrete**

1.3 ***Concrete Slab***
- 1.3.1 **Soil**
  - 1.3.1.1 Procure Clean Fill
  - 1.3.1.2 Compact Fill
- 1.3.2 **Wire Reinforcement**
  - 1.3.2.1 Procure Wire Reinforcement
  - 1.3.2.2 Install Wire Reinforcement
- 1.3.3 **Concrete**

1.4 ***Exterior Walls***
- 1.4.1 **Concrete Block**
  - 1.4.1.1 Procure Concrete Block
  - 1.4.1.2 Install Concrete Block
- 1.4.2 **Rebar Reinforcement**
  - 1.4.2.1 Procure Rebar Reinforcement
  - 1.4.2.2 Install Rebar Reinforcement
- 1.4.3 **Concrete**

1.5 ***Roof***
- 1.5.1 **Trusses**
  - 1.5.1.1 Procure Truss material
  - 1.5.1.2 Fabricate Trusses
  - 1.5.1.3 Install Trusses
- 1.5.2 **Roof Decking**
  - 1.5.2.1 Procure Roof Decking
  - 1.5.2.2 Install Roof Decking
- 1.5.3 **Shingles**
  - 1.5.3.1 Procure Shingles
  - 1.5.3.2 Install Shingles
- 1.5.4 **Fascia**
  - 1.5.4.1 Procure Fascia
  - 1.5.4.2 Install Fascia

1.6 ***Electrical System***
- 1.6.1 **Main Electrical Panel**
- 1.6.2 **Fixtures**
  - 1.6.2.1 Design Fixture Layout Diagram
  - 1.6.2.2 Install Fixtures
- 1.6.3 **Outlets**
  - 1.6.3.1 Design Outlet Layout Diagram
  - 1.6.3.2 Install Outlets

1.7 ***Mechanical System***
- 1.7.1 **AC System**
  - 1.7.1.1 Design AC Layout Diagram
  - 1.7.1.2 Install AC
- 1.7.2 **Ductwork**

1.8 ***Plumbing System***
- 1.8.1 **Bathroom**
- 1.8.2 **Kitchen**

1.9 ***Finished Interior Walls***
- 1.9.1 **Finished Drywall**

1.10 ***Kitchen***
- 1.10.1 **Cabinets**
  - 1.10.1.1 Design Kitchen Layout
  - 1.10.1.2 Procure Kitchen Cabinets
  - 1.10.1.3 Install Kitchen Cabinets
- 1.10.2 Sink

1.11 ***Bathroom***
- 1.11.1 **Cabinets**
  - 1.11.1.1 Design Bathroom Layout
  - 1.11.1.2 Procure Bathroom Vanity
  - 1.11.1.3 Install Bathroom Vanity
- 1.11.2 **Sink**
- 1.11.3 **Bathtub**
- 1.11.4 **Toilet**

7. The WBS Dictionary - Further Refine Your WBS Work Packages

At its lowest level your WBS consists of work packages – smallest chunks of work that can be realistically managed by the project manager and completed within the desired timeframe. Now you need to gather all of the WBS work packages and define them in a support document called a WBS dictionary. The function of the WBS dictionary is to provide a detailed description of the work package specifically for the individual or small group assigned responsibility for a work package. A good WBS dictionary will include the following (for each work package):

- WBS component title and WBS identification code – Unique identifiers
- Responsible Organization/Individual
- Work Detail Narrative – a description of the work process and procedure
- Assumptions
- Approval requirements
- Schedule milestones
- Cost and time estimates
- Resource requirements – how many people, how much equipment or supplies?
- Interdependencies - what work comes before and after the work package

Be sure to have each section of the WBS dictionary created by the person or group responsible for the work package. This reinforces ownership of the work package and will lead to better project control and chances for successful completion.

Since the WBS is best displayed in a graphical view (i.e. outline view or organizational hierarchy) there is a practical limit as to how much information can be detailed in the view. This is why the WBS dictionary is so helpful and should be included with the WBS itself.

A WBS dictionary provides the detailed information that communicates to the entire project team a better understanding of the smallest work elements within the hierarchy of the complete project.

- Stakeholders will better understand what is being accomplished on each level
- Team members will better understand what is expected of them on each level
- PMs will better understand how the project is proceeding on each level

Let's look at the Work package – "Design Kitchen Layout" from our New House Project described above and complete WBS Dictionary. You as PM would repeat this process for each work package the example.

Project: New House

Work Package ID:	1.10.1.1
Work Package Name:	Design Kitchen Layout
Work Package Description:	Complete a full cabinet layout for the new house kitchen including BOM for all cabinets, fillers, and hardware. Design should include upper and lower cabinet layout with inclusion of 1 sink base cabinet.
Assigned To:	ABC Cabinets
Date Assigned:	3/1/12
Approval Requirements:	Final cabinet layout approval required from owner
Assumptions:	Standard Cabinets Provided: raised face panel, maple doors and drawer fronts, self-gliding hardware, stainless knobs
Schedule Milestones:	Kitchen layout complete by 6/1/12
Estimated Cost:	Included in cabinet purchase
Estimated Duration:	7 days
Resource Requirements:	Superintendent - 8 man-hours for internal review and field verification of layout
Interdependencies	Interior finished walls for kitchen complete See Work Package ID 1.9.1

8. WBS Checklist

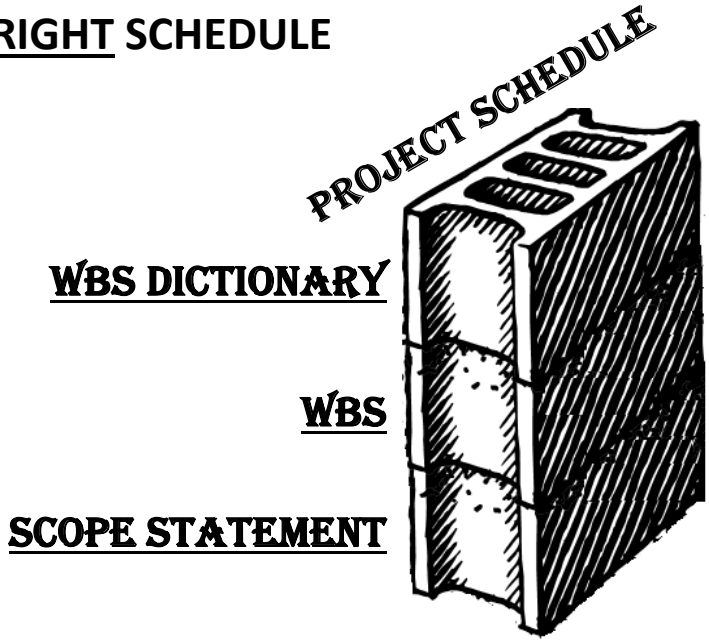
At the end of the WBS process review the following che

Yes / No	Was the WBS created jointly by the project team?
Yes / No	Are Level 2 entries – the deliverables - defined using NOUNs?
Yes / No	Do the deliverables 100% match the work scope? The "what" of the project?
Yes / No	Have external deliverables been considered and included?
Yes / No	Has the WBS been decomposed into work package levels?
Yes / No	Any work packages that cannot be assigned to an individual / small group?
Yes / No	Any work packages that cannot be completed between 8 and 80 hours?
Yes / No	If Project Management is included in the WBS – Is it included in Level 2?
Yes / No	Has a WBS dictionary been created and include work package definitions?
Yes / No	Has the WBS and WBS dictionary been reviewed and approved by the primary stakeholders prior to starting schedule development?

SECTION IV

BUILDING THE RIGHT SCHEDULE

To have a greater chance of achieving project success, and meet the needs of the project stakeholders, you will ultimately need to build a solid project schedule and then respond to input as the project progresses. But you have to take the RIGHT APPROACH to the build. This section will provide you with some tools and techniques that will allow you to reach the RIGHT schedule, one that has a solid foundation and will give the true picture of what time is needed to complete the project.



SO LET's TEST YOUR KNOWLEDGE?

You're assigned Project X. It has only 4 tasks, tasks that per the WBS dictionary have durations of 1, 2, 4, and 5 weeks. Your Project Sponsor asks - How long is the project? **Correct Answer: You really can't tell – But Why?**

- If you had unlimited resources and you could start every task at the same time, the project could be complete in 5 weeks (the longest task)
- Or if you started all of the tasks in a simple sequential order, one after another, the project could be complete in 12 weeks
- But what happens if there are ANY interdependencies between tasks that we missed? Say Task B (2 weeks) requires task C (5 weeks) to be complete before starting – Now the project would require 7 weeks to complete – if path B-C was the critical path – we still just don't know

As we get started in this section you can now see that at the beginning it may be better to define the APPROACH to developing your schedule rather than the ACTION of building the schedule itself. This guide WILL NOT actually build a schedule. This is better suited for the many scheduling tools and project management software packages that are commercially available. This guide WILL, however, help you define successful schedule development processes and ways to improve the content that goes into building the RIGHT schedule.

6 CONSISTENT STEPS TO DEVELOP A SOLID SCHEDULE Q14

Step 1: Defining Scheduled Activities
Step 2: Estimating Durations for each Activity
Step 3: Estimating Required Resources for each Activity
Step 4: Sequencing and Defining Dependencies between Activities
Step 5: Determine the Project Duration
Step 6: Analyze the Scheduled Activities to Improve Project Duration

STEP 1:
DEFINING SCHEDULED ACTIVITIES

1. STARTING WITH THE WBS

At this stage of the project, the planning or "thinking" phases should be complete and it's time to start "doing". So where can we find the project activities? Refer back to the Scope Statement, the WBS, and the WBS Dictionary we discussed in Sections II and III. These are your building blocks to your schedule and from a quick review of you should remember:

- First your Scope Statement defined what the project was supposed to accomplish
- You then decomposed your project scope into bit size chunks of work and created a hierarchical listing called the Work Breakdown Structure (WBS)
- And because your WBS was a hierarchy you can see logical groupings of work including specific deliverables which could be integrated into specific milestones
- Finally from your WBS dictionary you detailed even more information about the lowest level activities in your WBS including interdependencies among the different work packages

2. DEVELOPING THE PROJECT ACTIVITY LIST

So go back to the WBS and WBS dictionary and let's create a detailed listing of the activities described called a Project Activity List. Ultimately, your Project Activity List, when complete, will be a summary document which details all of the activities listed in the WBS dictionary and at a minimum should include:

- The activity ID – (preferably as listed on the WBS)
- Description of the Activity
- Estimated duration of the activity (Including expected start date and end date)
- Dependency of the activity with any other activities (predecessors and successors)
- List any milestones associated with the completion of the activity (Activity with a Duration of 0)

3. PROJECT ACTIVITY LIST (OUR EXAMPLE)

But for this step, Step 1, let's only define the activities and their expected start dates. Take our example above and here's the start of the Project Activity List. Let's fill in what we now know in yellow:

GIVEN - Project X: 4 tasks with descriptions shown below and an expected start date of 1/1/12. The project stakeholders have said the project must be complete by 2/26/12

Example Project Activity List

Activity ID	Activity Description	Immediate Predecessor	Expected Duration, wks	Dependency	Start Date	Milestone
1	Start of Project		0		1/1/12	Yes
A	Activity A description					
B	Activity B description					
C	Activity C description					
D	Activity D description					
2	End of Project		0		2/19/12	Yes

STEP 2:
ESTIMATING DURATIONS FOR EACH ACTIVITY

1. TOO HOT or TOO COLD?

At this point your activity duration estimate is your best sense of how much time is required to ACTUALLY perform an activity. When estimating durations be careful to not be too overly optimistic or unrealistically shorten activity durations because:

(1) It will appear that you are meeting your schedule targets and you will miss the opportunity to make adjustments to get the project back on track
(2) If the project team finds the duration estimates to be unrealistic, they may not continue to work on task

On the other hand it is important not to be too pessimistic and make the estimated durations too long. Longer estimates may lead stakeholders to expect more features or higher quality from the project or worse yet lead to cancellation of a project because it is perceived you cannot reach the desired project goals.

2. HOW TO IMPROVE DURATION ESTIMATES

The fact is your duration estimates are going to come from people and each person has his or her own experiences that will influence that estimate. Here are some ways to improve your duration estimates:

A. Clearly define the project activities

We discussed this is Section III – if your scope is unclear your estimates will be inaccurate. Take time as you move into the schedule development stage to re-review your WBS and WBS dictionary with the project team and the stakeholders. Make sure the activities are defined to enough of a granular level that there is a clear start and end point.

B. Use Your History

Information from historically similar projects is an excellent source for estimating activity durations. However, be careful to make sure that the projects are truly similar and that the original resources and processes are similar (i.e. availability of the same technical resources – computers, software programs; and the same caliber of human resources – use of technical experts or higher skilled workers)

C. Qualify Your Estimators and the True Workers

Those that are providing information on any activity's duration must have prior knowledge of the work involved. And while expert knowledge is very helpful be careful to assess the capability of the project team that will be actually expected to do the work – a less experienced team will more than likely take longer to complete the work.

Be aware: the experts and heavy hitters PROPOSED for a project are not always the same people that end up ASSIGNED full time to the project. As project manager make sure you assess your activity duration estimates against the skills of your final team lineup.

D. Be Sure Qualify the Risks and Assumptions

We will talk more in depth about risks in Section VII but for estimating durations just remember to document, in writing, assumptions and risk impacts.

E. Be Sure to Recognize Human Nature

Your duration estimates can go awry because humans are making those judgments. And until machines takeover we will bias our estimates in one way or another – High or Low. Here's Why?

<u>You estimate HIGH because you are cautious:</u>

- You need some freedom, some room to maneuver
- To protect yourself against some uncertainty
- To be sure you can keep your commitment
- You lack knowledge about the work
- You're not confident in your ability to do the work
- You in general have a pessimistic outlook about the project

Temper pessimistic HIGH estimates by assuring the team the risks and assumptions in the estimate will be documented to support their commitment.

<u>You estimate LOW because you are confident:</u>

- You look forward to a challenging goal
- You like exposure to uncertainty
- You know you will look good in keeping your commitment
- You're over confident in your knowledge about the work
- You're over confident in your ability to do the work
- You in general have an optimistic outlook about the project

Temper overconfidence and LOW estimates by reviewing relevant project history. Ask the team - Can you back up what you say with history?

F. Eliminate "Fudge" Factors

Eliminate the "just to be safe" measures that plague many duration estimates. Rather than adding say a 25% "fudge" factor on your estimate – detail the assumptions or risks associated with the estimate.

Did you Know? Fudge in "Fudge Factor" can be traced back to the 1570s as an extension of the word "fadge" – to make suit, fit.
Source: Online Etymology Dictionary

G. Get Statistical!

How about trying some statistical methods to improve your duration estimates? Consider a network modeling technique developed in the 1950's by the Department of Defense for use on the US Navy's Polaris project called the Program Evaluation and Review Technique (PERT). While PERT is mainly a network model that can be used to graphically represent activities and milestones, PERT also provides a statistical analysis technique for determining the probability of an activity's duration.

Called the PERT Formula, for each activity you determine an expected value of a Beta distribution from 3 different duration times to determine the Expected Value:

Time Estimate	Description
Optimistic Time	Generally this is the shortest expected time in which an activity can be completed – there is approximately a 1% chance that this activity will be completed in this time
Most Likely Time (different from Expected Value)	This is the time that the activity has the highest probability of being completed within
Pessimistic Time	This is the longest time that the activity may require to be completed - there is approximately a 1% chance that the activity will be longer than this time

Following a Beta Distribution the Expected Value is calculated from the equation:

Expected Value = (Optimistic Time + 4 x Most Likely Time + Pessimistic Time) / 6

EXAMPLE: Task 1 has been estimated to have 3 probable times for completion: Q16

Most Likely time: 9 weeks
Optimistic Time: 7 weeks
Pessimistic Time: 12 weeks

Expected Value = (7 + 4 x 9 + 12) / 6 = 9.16 weeks

Using the PERT formula is a good way to work around "Human Nature we discussed above. By asking for a range of optimistic and pessimistic estimates you can calculate an expected value.

3. PROJECT ACTIVITY LIST (OUR EXAMPLE)

OK Now in Step 2, let's estimate durations for activities and we'll add the results to the build out of the Project Activity List. Again let's add what we know and highlight in yellow.

GIVEN - Project X: 6 tasks, estimated durations for each task were originally estimated as shown in the "Most Likely Duration" column below. Using the PERT Formula technique the Project team was asked to re-think the duration estimates in terms of optimistic and pessimistic values. The results including the calculated expected value are as follows:

Activity ID	Optimistic Duration	Most Likely Duration	Pessimistic Duration	Expected Value (calculated)
A	3.5	4	5	4.1
B	1.5	2	3	2.1
C	4	5	7	5.2
D	1	1	2	1.2

(** all values in weeks)

NOTE: For sake of simplicity we are going to round down and use the original likely durations

Example Project Activity List - REVISED

Activity ID	Activity Description	Immediate Predecessor	Expected Duration, wks	Dependency	Start Date	Milestone
1	Start of Project		0		1/1/12	Yes
A	Activity A description		4			
B	Activity B description		2			
C	Activity C description		5			
D	Activity D description		1			
2	End of Project		0		2/19/12	Yes

STEP 3:
ESTIMATING REQUIRED RESOURCES FOR EACH ACTIVITY

1. SHOW ME THE MONEY

Every project, even the 6 task project we kicked off at the beginning of this section, requires resources. And resources just don't mean people resources – it could include equipment, materials, software, hardware and on and on. Remember back in Section 1 – Project Management Basics we said: All projects have a beginning and an end and MUST have a budget and requires a COMMITMENT of resources.

Again using your WBS and the WBS dictionary let's consider what types of resources are needed for each activity.

General Estimating Tips:

- Make sure people familiar with the activity, make the estimates
- Base estimates on Normal Conditions and an Normal level of available resources
- Be sure to use consistent time units (i.e. all weeks or days or hours)
- Treat each task as an independent unit – do not aggregate activities
- Do not include contingencies

2. RESOURCE ESTIMATING TECHNIQUES

There are three good tools / techniques you can use to get better estimates of the resources for your activities – (1) Alternatives Analysis, (2) Industry Data and (3) Bottom-Up Estimating. Each of these three techniques will be discussed below.

A. Alternatives Analysis

An Alternatives Analysis is an analytical comparison of the different methods you could employ to meet the requirements of each activity. The objective is to determine best project value between alternatives.

For example: A WBS activity has been identified as "Print sales booklet"

Alternative 1: Print "in-house" expected cost is $100, 4 week delivery
Alternative 2: Outsource Printing expected cost is $125, 2 week delivery

By using your Alternatives Analysis technique the project team could decide if the extra costs of outsourcing are worth the schedule compression

B. Industry Data

Perhaps trade groups, specific industry databases or guidelines are available that could provide useful estimate information.

C. Bottom-Up Estimating

Bottom-up Up estimating is the most time consuming estimating process but also the most accurate. In this technique all of the costs of individual tasks are estimated for each type of resource requires (human, physical, materials, supplies etc). The total costs are summed together to derive the complete activity cost.

Advantages: high level of accuracy, project team will have confidence in the estimate leading to higher success rates of completion

Disadvantages: Time consuming and requires a significant man-hour effort and since this is expected to be of high accuracy, the estimators could end up "padding" the activity budget so as to not fall short

While it is important to ensure you have enough resources, to establish a good project schedule baseline you need to assume that there are NO RESOURCE LIMITATIONS. Remember we are trying to get to the RIGHT SCHEDULE – to establish the right amount of time to complete the project.

STEP 4:
SEQUENCING AND DEFINING DEPENDENCIES BETWEEN ACTIVITIES

1. INTRODUCTION

OK, Now that the schedule activities have been clearly defined and we've even established the durations for each activity it's time to sequence the activities into a logical order and check for dependencies between activities. In the following sections we'll show you some techniques to use to help sequence and define activity dependencies and introduce you to a useful diagramming technique for illustration.

2. TECHNIQUES TO USE

A. Precedence Relationships

One of the best ways to sequence your activities is to use common sense with your goal being to find the precedence between activities. If you built the WBS and WBS dictionary using the techniques described in Section III - SHORING UP THE SCHEDULE – you certainly would have used subject matter experts to develop the detailed activities. These same experts are going to know the logical sequence of events. For example – WBS calls for painting a house with 2 activities: (1) apply prime-coat and (2) apply top-coat. If you had never painted a house before you may not know the proper sequence: prime and then top-coat. But for expert painters, this sequence would be obvious.

Begin by analyzing your activities in terms of its reference to the closest activity. Precedence relationships to consider are:

1. Predecessor Activities
   Activities that must be completed before another activity can begin

2. Successor Activities
   Activities that must follow another activity in some type of sequence

3. Parallel Activities
   Activities that can be performed at the same time as another activity

B. Determine Dependencies

Q17

It's also important to determine the relationships between all of your activities. Perhaps one activity is dependent on the completion of another. Following is a checklist of questions to ask for each of your activities in relation to the others:

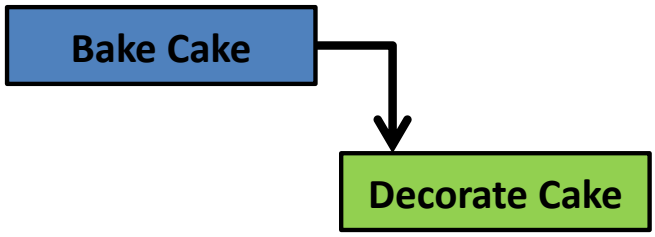
Any Mandatory Dependencies? (Sometimes called Hard Logic)
The nature of the work itself determines the logical order of activities. Typically any activity that has a phyical limitation - Example: rough sand before you paint – it's phyically too late to rough sand after painting

Any Discretionary Dependencies? (Sometimes called Soft Logic)
These are typically "Best Practices" or organizational procedures based on past experience. But you have the discretion to follow the procedure or not. Example: Best painting practices may suggest to tape off window openings before painting – you can decide to if you wish.

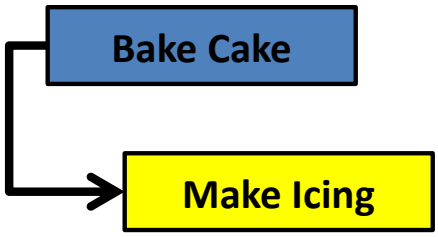
Any External Dependencies?
These are external to the project and can effect the sequence of project activities. Remember our House Building Project in Section III – we needed approval from the local building department in order begin the building process. This is a good example of an external dependency.

Any Factors that Affect Predecessors?
From above we know we need to determine predecessor and successor activities in order to determine when an associated activity can begin. But we need to consider one level deeper and look for relationships that can effect predecessors. Types of relationships are listed below including how the relationship would be depicted on common Project management software programs such as Microsoft Project:

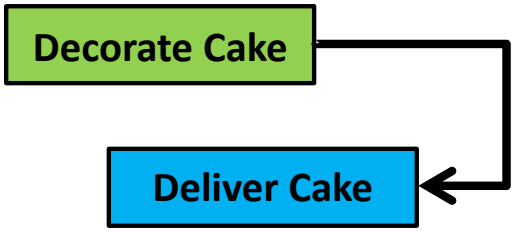
1. Finish to Start Relationships: (most common)
   Implies a logical sequence (completion of Task A to start of Task B)



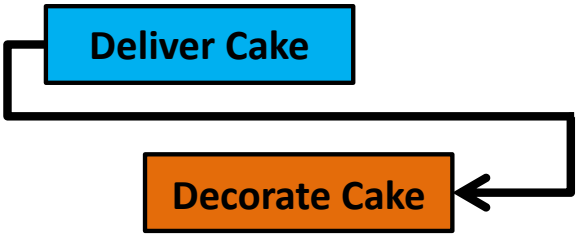
2. Start to Start Relationships:
   Parallel activities where 2 tasks can start at the same time. Note: the tasks DO NOT have to finish at the same time (i.e. tasks that have different durations)



3. Finish to Finish Relationships:
   Another realtionship between parallel activities where 2 tasks can have different starts but 1 can't finish until the other is completed. This does not require that both tasks be completed at the same time.



4. Start to Finish Relationships: (least common)
   Parallel activities where the predecessor must start before the successor task can finish. Example: Say you are baking a cake for a customer, you can start the billing process once you start baking the cake but you cannot finalize the bill until the cake is done.



Any Lead or Lag Dependencies?

When looking at activity relationships, you also need to consider Leads and Lags.

- Leads are allowable time ahead of the start of a specific activity. For example, in our painting example we are going to allow areas of the house to be primed before all of the scraping to be complete. (Not all of the house needs scraping) This is a lead to the "Prime House" activity

- Lags are required time necessary between the start of a specific activity. Again back to our painting example we are going to have to allow 2 days of dry time between the finish of the primer coat and application of the top-coat. This woulld be a lag to the "Top-coat House" activity

Keep an eye out for Start to Start activity relationships – these are one type of parallel activity that can be very useful to shorten a project schedule. Any activity with a Lead may also be helpful.

3. PROJECT ACTIVITY LIST (OUR EXAMPLE)

OK Now in this Step, let's consider some dependencies. Again let's add what we know and highlight in yellow.

GIVEN - Project X:
Activity A and Activity C have Start to Start relationships from the project start – Milestone 1
Activity B has a Finish to Start relationship with C
Activity B has a Finish to Start relationship with A
Activity D has a Finish to Start relationship with C
Activity D and Activity B have Finish to Finish relationships to the project end – Milestone 2
There NO Leads or Lags identified with any of the tasks in this project

Example Project Activity List - REVISED

Activity ID	Activity Description	Immediate Predecessor	Expected Duration, wks	Dependency	Start Date	Milestone
1	Start of Project	-	0	-	1/1/12	Yes
A	Activity A description	Project Start	4	Project Start		
B	Activity B description	A & C	2	F-S (A) & F-S (C)		
C	Activity C description	Project Start	5	Project Start		
D	Activity D description	C	1	F-S (C)		
2	End of Project	B & D	0	F-F (B) & F-F (D)	2/19/12	Yes

STEP 5:
DETERMINE THE PROJECT DURATION

1. INTRODUCTION

At this stage you have everything you need to start building a baseline schedule to determine the overall duration of the project without any optimization. In most cases you would plug the inputs from your newly created Project Activity List into a software program such as Microsoft Project and your baseline schedule would be generated automatically. But in this case we are going to go behind the scenes to show the details. And to begin we are going to introduce 2 ways to graphically illustrate your schedule: (1) the Gannt Chart and (2) the Network Diagram.

2. GANNT CHARTS

A Gantt chart is a very simple method of showing the project schedule in a graphical form. The Gantt Chart was invented by Henry L. Gantt in 1917 and today is the most widely used method to present an illustrative view of the overall project timeline and the sequential order of the project activities.

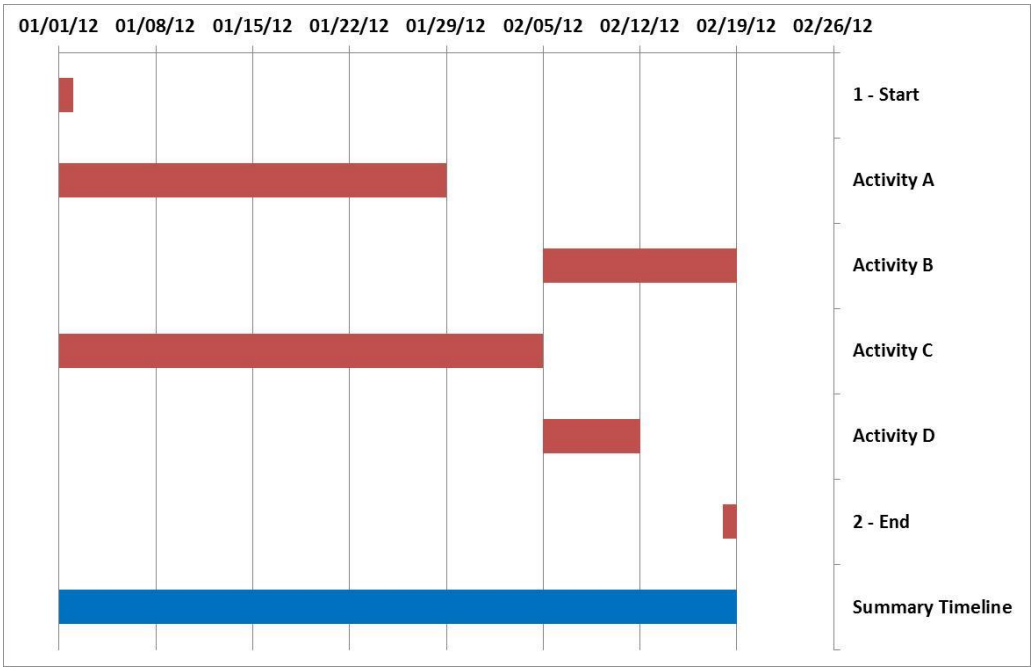
In its simplest form the Gantt Chart depicts the project schedule as a calendar along the horizontal axis and the list of project activities along the vertical axis. Each task is represented by a bar or a rectangle and each bar is positioned in the chart to begin over, and end at, the date of the calendar on the x axis. Therefore, the duration of each activity is depicted as, and proportional to, the length of the bar.

The Gantt chart is very easy to use and helpful for depicting a simple schedule because it is easy to see how schedule tasks line up with each other (along the date axis). In addition, by drawing a vertical line over the date axis for today, it can be easily seen which activities are complete, which are ahead of schedule or behind schedule, or how soon activities are scheduled to begin or finish.

The Gannt Chart can be used in conjunction with a Resource Histogram to see the simultaneous utilization of resources (Again left out from this discussion for simplicity). Also we will be specifically leaving off the Gannt Chart the logical interdependencies between the predecessor and successor activities for additional simplicity. Note: you will want to show the start dates of each activity (which is in fact determined by logical interdependence – just don't depict it on the graph). Activities and their interdependence will be discussed on the Network Diagram in the next step.

The primary goal in this step is to present a high level graphical view of the project schedule and that is why we are using the Gantt Chart without showing the INTERDEPENDENCIES. Use this first pass look to share with the project team and the primary stakeholders to develop an understanding of the sequential timeline. Take the time now to get team buy in and help all team members understand the project expectations. **WARNING:** If you get push back at this stage – you can only anticipate more as the detailed schedule is developed.

Example Simple Gantt Chart – Our Project X



3. NETWORK DIAGRAMS

A. The Basics

We now want to illustrate the interdependencies between activities in better detail than we did with the Gantt Chart so let's look at another illustrative approach called the Network Diagram. The network diagram is useful in depicting the order in which activities are to be completed. Components parts of the Network Diagram are:

- milestones – a major project occurrence; Ex. Foundation Design Complete
- activities – a component of work to be completed during the life of a project, activities take resources and time to complete, best to describe activities as verbs, for example "Design the Foundation"
- duration – amount of time an activity takes to be completed; the duration of an activity can be affected by the amount of people available to work on an activity as well as the capacity of non-people resources (i.e. machine time)

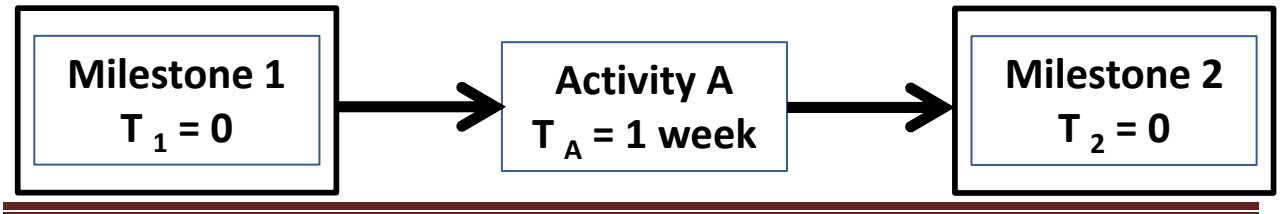
B. General Rules to Remember

- Once you complete an activity and reach a milestone, you can proceed to the next activity or milestone as indicated by the direction of the arrow
- Before you can start the next activity or reach a milestone, you must complete all of the activities and reach all milestones with arrows pointing to the activity you want to start or milestone you want to reach.
- The boxes in the network diagram represent Activities and Milestones. Note: the Milestones are highlighted as a double box and have a duration of 0.
- You can have more than one path from one milestone to another

Here is a simple Network Diagram example:

Network Diagram - EXAMPLE 1

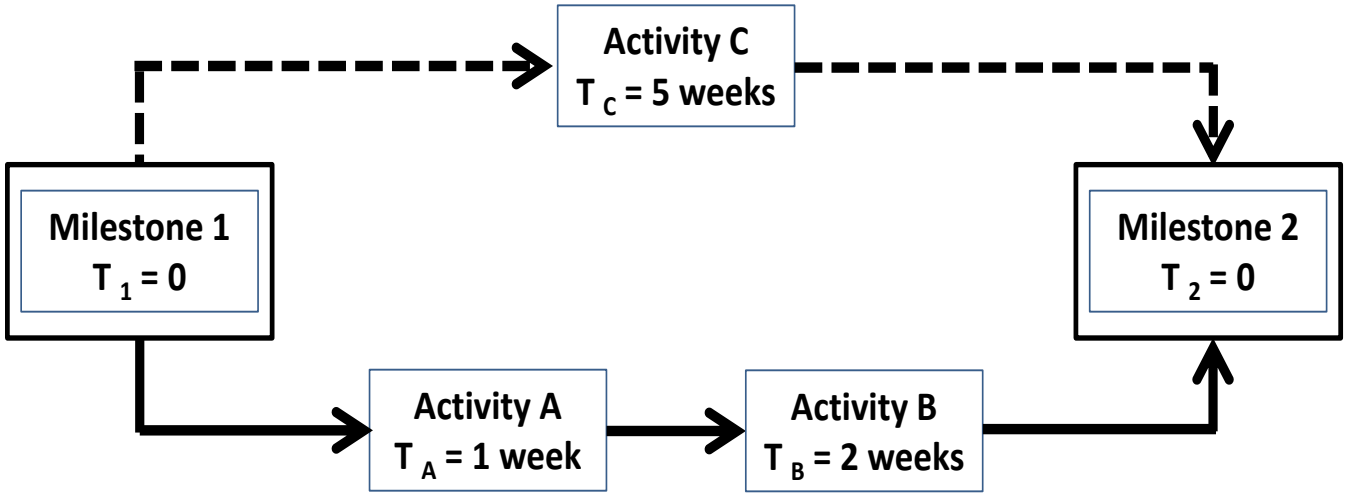
Below is an example of a simplified Network Diagram consisting of a Start Milestone (1), 1 Activities (A) and an ending Milestone (2)



Let's Look at a Multiple Path Example:

Network Diagram - EXAMPLE 2

Below is an example of a Network Diagram consisting of 2 Paths, a Start Milestone (1), 3 activities (A,B,C) and an ending Milestone (2).



Key Takeaways:

- From Milestone 1 (Start) you can take either of 2 paths: Path A-B OR Path C
- Activities A & C are independent of each other so you can start both at the same time OR you can delay starting one or the other (Start to Start Relationship)
- You can start working on Activity B only after you have completed activity A – This is a forcing or requiring relationship – Finish to Start
- Path C (Activity C) is the longest path to finish the project (dashed line)

C. Getting to the Critical Path

You can gain a lot of detailed information from your Network Diagram. But the single most important piece of information illustrated is your project's Critical Path. The Critical Path is the longest path in your Network Diagram to get to project completion and also is the shortest time in which the project can be completed. Identification of the Critical path is important because any change in duration of a task along the critical path will affect the project schedule.

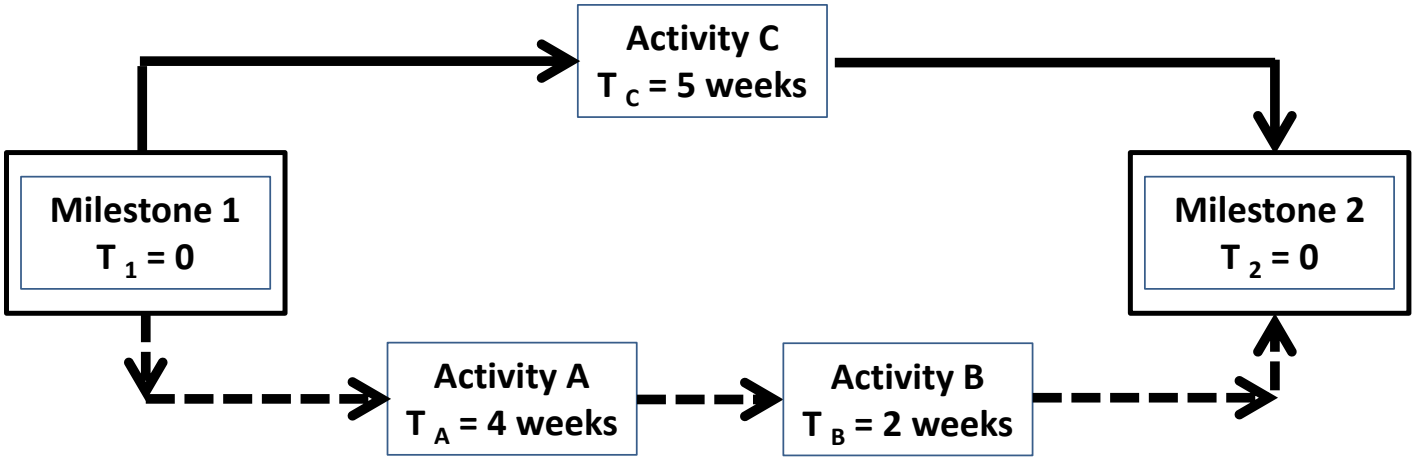
Some other things to consider from your Network Diagram relating to the Critical Path are:

- Closely monitor all critical path activities because even a minor delay in a critical path activity will delay the project
- You can have more than 1 critical path (if each path has the same duration)
- Your critical path can change as a project progresses. For example if the activities in a critical path are completed in a shorter period, a non-critical path could now become the critical path. Conversely, if events in a non-critical path become delayed and the new duration of the activities becomes greater than the original critical path, a non-critical path could now become the critical path.

Let's Look at Impacts of Effects on the Critical Path:

Network Diagram - EXAMPLE 3

Consider Example 2 above, we see that Path C is what we now know as the Critical Path. However, after 1 week into the project there has been found to be a problem with a machine used in Activity A and the expected duration of Activity A is extended to 4 weeks. Path A-B, which was a non-critical path is extended to 6 weeks and now becomes the Critical Path.



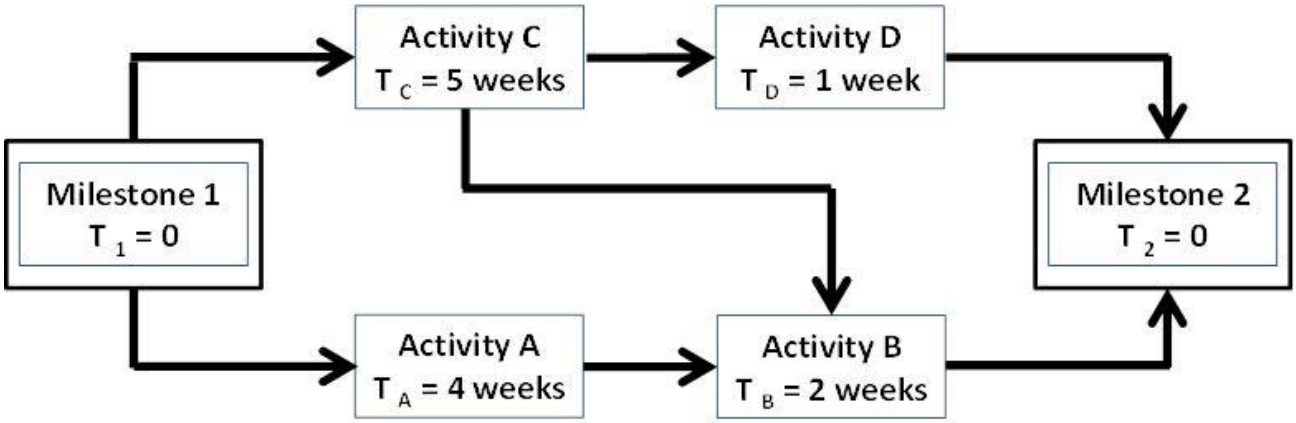
D. Other Non-Critical Path Information

There's still more you can gain from studying your Network Diagram that's closely related to the Critical Path:

- The Non-Critical Path: The sequences of activities that can be delayed and yet still finish in the shortest time – this can quickly become the critical path!
- Slack time or float: The maximum amount of time you can delay an activity and still finish in the shortest time without impacting the Critical Path
- Early start date: The earliest date you can START an activity
- Early finish date: The earliest date you can FINISH an activity
- Late Start Date: The latest date that you can START an activity and still finish in the shortest time
- Late Finish Date: The latest date that you can FINISH an activity and still finish in the shortest time

4. NETWORK DIAGRAM (OUR EXAMPLE)

Let's now draw the Network Diagram for Project X and highlight the dates we now can figure from the Network Diagram. (Highlights in Yellow)



Activity ID	Activity Description	Immediate Predecessor	Expected Duration, wks	Dependency	Start Date	Milestone
1	Start of Project	-	0	-	1/1/12	Yes
A	Activity A description	Project Start	4	Project Start	1/1/12	
B	Activity B description	A & C	2	F-S (A) & F-S (C)	2/5/12	
C	Activity C description	Project Start	5	Project Start	1/1/12	
D	Activity D description	C	1	F-S (C)	2/5/12	
2	End of Project	B & D	0	F-F (B) & F-F (D)	2/19/12	Yes

STEP 6:
ANALYZE THE SCHEDULED ACTIVITIES TO IMPROVE THE PROJECT DURATION

1. GETTING STARTED

In the final step of our scheduling process, we will analyze the project's network diagram in order to identity all critical paths, non-critical paths, and slack time in the non-critical paths. This analysis, called the Critical Path Method, will help the Project Manager to decide which project activities need monitoring and how often to monitor. The Critical Path analysis also provides a means to get back on track if the project meets unexpected delays. We're going to look at our Network Diagram and separate the Critical Path Method into 3 PASSES to analyze the project schedule.

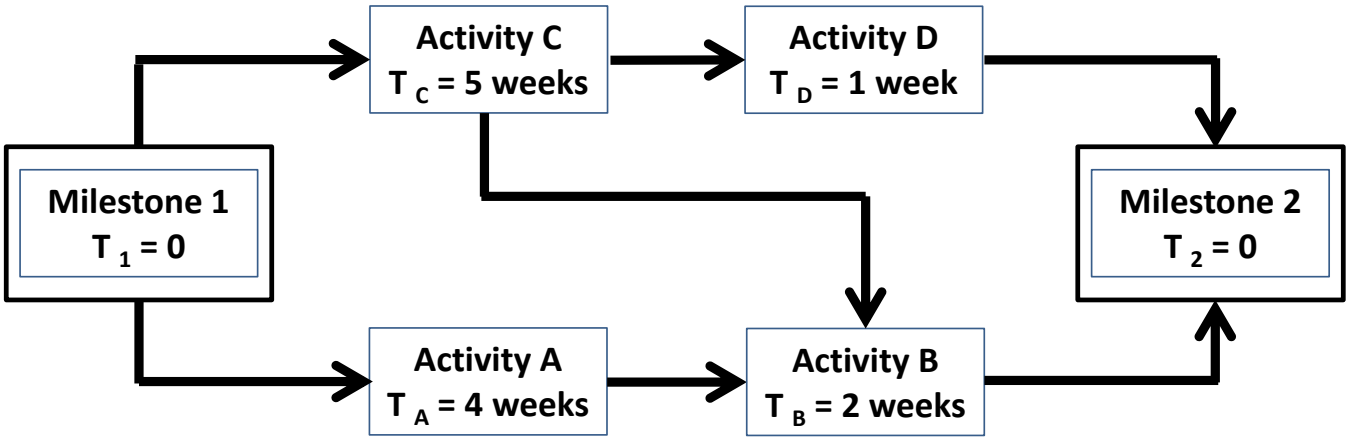
A. Forward Pass: Start-to-finish analysis of the schedule to see how long each path will take in the Network Diagram

B. Backward Pass: Finish-to-Start analysis of the schedule in order to determine how much of a delay each activity can afford along its path in order to finish the project within the critical path

C. Combined Pass: Combined analysis of the Forward and Backward Passes used to calculate early and late start dates and the early and late finish dates for each activity (activity slack)

2. FORWARD PASS

Let's start the forward analysis of our Network Diagram for Project X – The Forward Pass



Step 1: **Look at each path on the Network Diagram and calculate it's duration**

Step #	Path Description	Duration, weeks
1	A - B	6
2	C - D	6
3	C – B	7

Step 2: **Look FORWARD with each activity for each Path: (1) determine start relationships and (2) finish relationships**

PATH A - B

Activity No.	Start Relationship	Finish Relationship
A	The earliest start is when the project begins	The earliest finish is at the end of 4 weeks after the project begins
B	Activities A and C must be complete before you can start Activity B. So, The earliest start is at the end of Activity C at 5 weeks after the project begins	The earliest finish is at the end of 7 weeks after the project begins

PATH C - D

Activity No.	Start Relationship	Finish Relationship
C	The earliest start is when the project begins	The earliest finish is at the end of 5 weeks after the project begins
D	The earliest start is at the end of 5 weeks after the project begins	The earliest finish is at the end of 6 weeks after the project begins

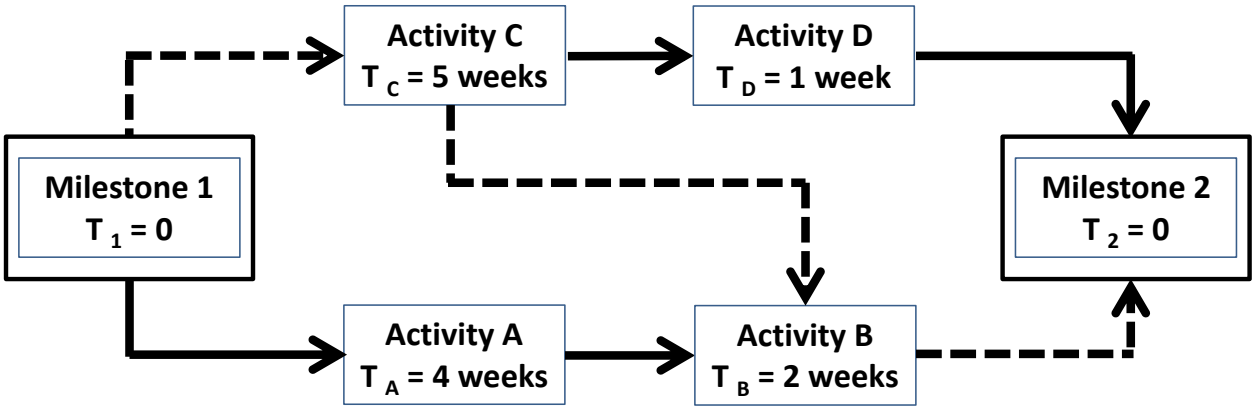
PATH C - B

Activity No.	Start Relationship	Finish Relationship
C	The earliest start is when the project begins	The earliest finish is at the end of 5 weeks after the project begins
B	The earliest start is at the end of 5 weeks after the project begins	The earliest finish is at the end of 7 weeks after the project begins

Step 3: **For each path determine critical path or non-critical path**

Step #	Path Description	Duration, weeks	Critical or Non-Critical Path
1	A – B	6	Non-Critical
2	C – D	6	Non-Critical
3	C – B	7	Critical

The critical path is shown as a dashed line



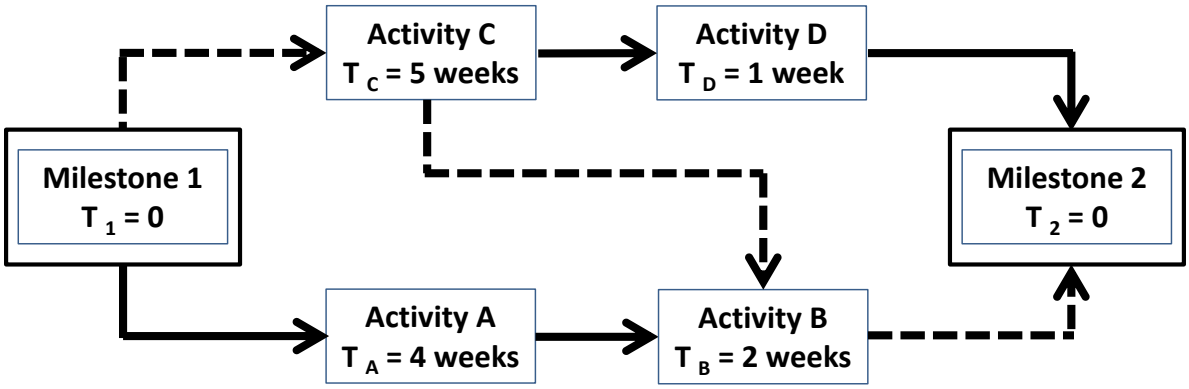
3. BACKWARD PASS

Let's start the backward analysis of Project X – The Backward Pass. With the Backward Pass we can determine Slack time - The amount of allowable time delay that will not impact the duration of the project. And if we look back we know that the critical path is the longest path in the project schedule so any activities or milestones that fall within the critical path have 0 slack time. (Remember, we certainly do not want any delays in the critical path)

But in reality unexpected things happen, either resource conflicts or unplanned delays, and you may not be able to start all of the project activities at their earliest start times. The Backward Pass is going to tell you how much delay each activity has. So let's go!

Again let's refer to the paths in Project X's Network Diagram and ask this question:

How late can I start an activity in the Non-Critical Path and not become the Critical Path?



PATH B – A

Activity No.	Duration	Required Latest Start	Slack Time
B	5 weeks	Beginning Week 6 to be complete by end of week 7 (If Activity B starts at the beginning of week 7 the project is late)	No slack – critical path
A	4 weeks	Beginning Week 2 to be complete by end of week 2	1 week

PATH D - C

Activity No.	Duration	Required Latest Start	Slack Time
D	1 week	Beginning Week 7 to be complete by end of week 7	1 week
C	5 weeks	At beginning of project (If Activity C starts at the beginning of week 2 the project is late)	No slack – critical path

PATH B - C

Activity No.	Duration	Required Latest Start	Slack Time
C	5 weeks	At beginning of project (If Activity C starts at the beginning of week 2 the project is late)	No slack – critical path
B	2 weeks	Beginning Week 6 to be complete by end of week 7 (If Activity B starts at the beginning of week 7 the project is late)	No slack – critical path

4. COMBINED PASS

OK we've now finished the forward and backward passes so let's combine the results in the COMBINED PASS in order to construct the early and late start dates and the early and late finish dates and note them on the network diagram. At this point we want to actually calculate the slack for each activity and the project by either:

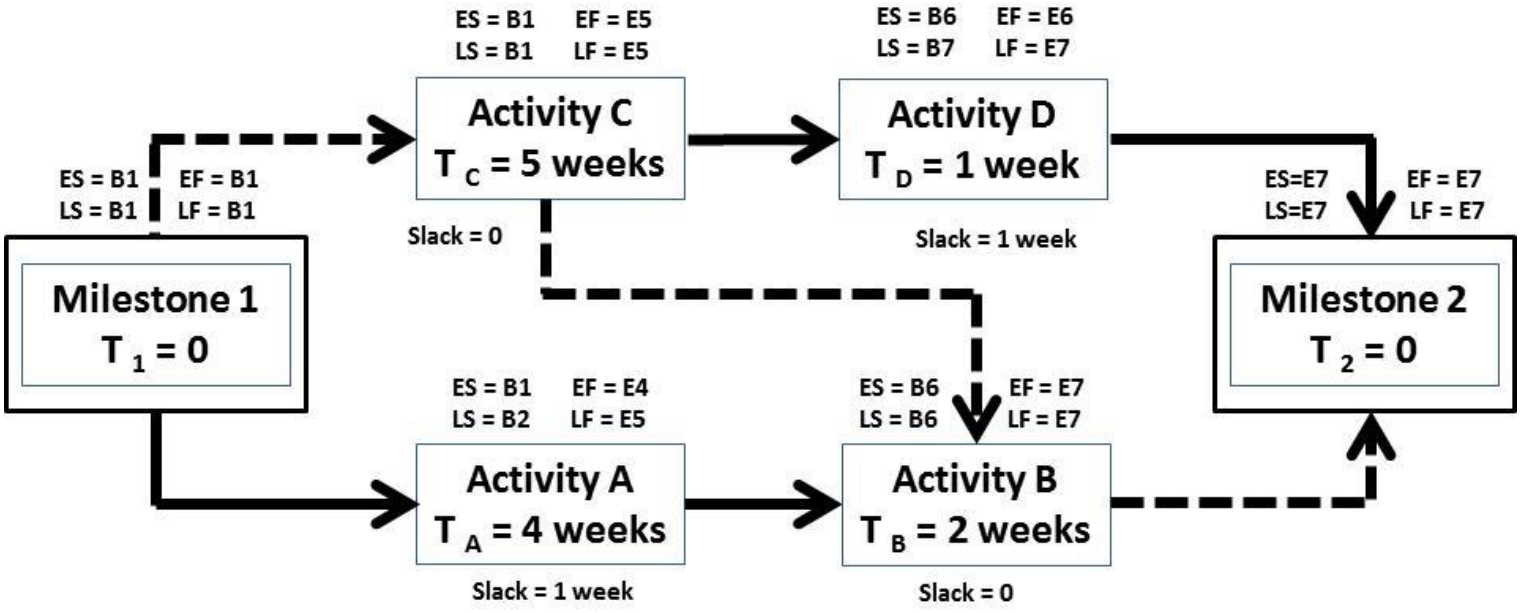
- Subtracting the early start date from the latest allowable start date - or -
- Subtracting the early finish date from the latest allowable finish date

Look again at Project X

Summarize what we know from the project statements (look at the beginning) and the results of finding the critical path:

So Let's breakdown each path and activity and map the slack in each activity starting with the Critical Path

Put it all together into the Project X - Network Diagram



Tabulate the Activities: (How we populated the diagram!)

Activity No.	Activity Duration, Weeks	Early Start (ES), Week # (Beginning or Ending)	Late Start (LS), Week # (Beginning or Ending)	Early Finish (EF), Week # (Beginning or Ending)	Late Finish (LF), Week # (Beginning or Ending)	Slack, weeks
Milestone 1 (Project Start)	0	ES = B1	LS=B1	EF = B1	LF = B1	-----
C	5	ES = B1	LS=B1	EF = E5	LF = E5	0 – Critical Path
Explanation:		The earliest we can start is right after project authorization 1/1/12	CB is critical path at 7 weeks and with 7 weeks available – we cannot delay the start of C	From Early Start B1 we would be complete in 5 weeks	From late Start B1 we would be complete in 5 weeks	ES – LS = 0 or EF - LF = 0
B	2	ES = B6	LS=B6	EF = E7	LF = E7	0 – Critical Path
Explanation:		B is in critical path and a successor to C – so an early start of B is the early finish of C	B is in critical path and a successor to C – so a late start of B is the late finish of C	From Early Start B6 we would be complete in 2 weeks	From late Start B6 we would be complete in 2 weeks – this is the end of the project	ES – LS = 0 or EF - LF = 0
D	1	ES = B6	LS=B7	EF = E6	LF = E7	1
Explanation:		D is a successor to C – so an early start of D is the early finish of C	D (non-critical path) needs to be complete by end of project – a late start of D is 1 week before end	From Early Start B6 we would be complete in 1 week	From late Start B7 we would be complete in 1 week	ES – LS = 1 or EF - LF = 1
A	4	ES = B1	LS=B2	EF = E4	LF = E5	1
Explanation:		The earliest we can start is right after project authorization 1/1/12	A is a predecessor to B, B is in critical path – so we can start no later than 4 weeks before the late start of B	From Early Start B1 we would be complete in 4 weeks	From late Start B2 we would be complete in 4 weeks	ES – LS = 1 or EF - LF = 1
Milestone 2 (Project End)	0	ES = E7	LS=E7	EF = E7	LF = E7	-----

CONCLUSION

Remember back to the first question on Project X – How long is the project going to take? Well now we can answer with confidence – 7 weeks … if we complete all of the tasks as planned! From this section you can see that even a 4 task project takes a lot of effort to plan and establish a baseline schedule. On your projects you more than likely will use some form of scheduling software which will do the "heavy lifting" but you should now understand how the results are derived. For example, Microsoft Project can automate the processes of entering tasks, assigning relationships, building your project schedule, and even defining the critical path but remember – garbage in = garbage out.

In conclusion, by understanding how your schedule is built and how the critical path will effect your project outcome your will be better able to choose which project activities you should monitor and how often. In addition, by understanding slack in your schedule you can keep non-critical activities from becoming critical.

SECTION V

CALLING ALL "COSTS"

Projects with unlimited budgets just don't exist, so it's your job as the Project Manager to identify ALL of the project costs upfront and monitor them as the project progresses. Again refer to Section I – Project Management Basics - where by definition we stated a project has to have definite timeline and a definite budget. So let's consider the limited budget and why accurately estimating a project cost upfront is important. An accurate project estimate will:

- Allow stakeholders early in the project lifecycle to evaluate the anticipated project benefits against vs the expected costs in order to determine if the project makes sense
-
- Allow project management and the stakeholders to determine if funds necessary to support and complete the project are available

1. IDENTIFYING ALL COSTS

A project budget is required that will provide a detailed, time-phased estimate of all resource costs required for a project. Project budgets are typically developed in stages starting with an initial rough estimate to a final approved project budget. Your budget should include all costs including direct and indirect costs. Direct costs are costs for resources that are solely used on your project. Indirect costs are costs for resources that may be used on multiple projects but cannot be directly identified or charged against individual projects (i.e. company overhead and general administrative costs).

Examples of Direct Costs and Indirect Costs Include:

Cost Description	Cost Type	Example
Project Team member salaries	Direct	Salary for labor hours worked
Project specific materials and supplies needed	Direct	Unique computer software required for a project
Travel expenses related to the project	Direct	Flight costs to attend onsite project meetings
Project specific Sub-contract or consulting work	Direct	Cost for design expert
Employee benefits	Indirect	Annual sick leave, vacation
Rent	Indirect	Office space cost for the company
Computers	Indirect	General computers used throughout the company
Management and Administrative Salaries	Indirect	Portion of the salary for organizational managers

In the earliest stages project stakeholders may not have fully considered the "all-in" costs (direct and indirect costs) and may discover that there are not enough funds to carry the project forward. While disappointing to stop a project at this point it is better than the disruption that occurs as you monitor the project progress and the actual costs are realized later.

2. STAGES OF THE PROJECT BUDGET

Again at the start of a project high accuracy project budgets are not available and stakeholders have to make decisions in light of insufficient information as to the viability of a project or that the full funding level is available. So in order to support these important project decisions the project manager can develop and refine a project budget in three stages in providing the best available information to the stakeholders in a timely basis.

Stage 1: Rough Order of a Magnitude Estimate (ROM)

The Rough Order of a Magnitude Estimate is an initial estimate of cost based on a general sense of the expected project work. This is estimate is compiled without the support of detailed data but can be compiled by considering the costs of similar projects. Subject matter

experts or consultants are best used on this level of effort estimate and it is important to understand that the typical ROM estimate will have an accuracy of about plus or minus 50%. Typical characteristics of a ROM estimate are:

- Expect a Variance of Variance of -50% to +50%
- "Ballpark" estimate used for decisions to move forward
- Top down estimation – start with the expected cost of the project and then use ratios for allocation to sub-parts (i.e. 30% for preliminary design, 50% for detailed design, 20% for production)
- Use of expert knowledge and experience is critical
- Low level effort – typically requiring 40 to 80 hours to complete over 1 to 4 weeks usually only utilizing 1 to 3 people

Stage 2: Detailed Budget Estimate

In the Detailed Budget estimate stage by now the WBS and detailed work packages should have been identified. From these work packages costs estimates can be by developed by determining the amount of personnel and non-personnel resources that are required using a Top-down or Bottom-up approach. Direct labor costs can be estimated by number of man-hours required against actual hourly labor costs or average salaries. and non-direct costs can be estimated. Direct cost for material, equipment, travel, and non-personnel resources are estimated. Finally indirect costs should be included as a percentage of man-hour estimates or average salaries. The level of effort put into the budget estimate can be considered medium / high dependent on the desired variance.

Expected Variance of -10% to +25%	**Expected Variance of -5% to +10%**
Known as "Budget Estimate"	Known as "Definitive Estimate"
Use top down approach	Use Bottom up approach
Medium Effort to complete • 80 to 480 hours required • 2 to 6 months to complete • 4 to 10 people utilized	High Effort to complete • 480 to 2000 hours required • 6 to 12 months to complete • 11 to 20 people utilized

Stage 3: Approved Budget

In this final stage the project budget, with the expected variance, has to be approved by the project stakeholders.

3. REFINING THE PROJECT BUDGET AFTER APPROVAL

As a project moves through its lifecycle and the work actually begins be aware of some common occurrences that often will require changes in the approved project budget:

- The personnel you have assigned to the project have less experience than what you expected in the personnel selection process. Consequently activities may require additional time, resources or expert help to accomplish the task
- Actual prices of subcontracted services, equipment, and direct expenses are higher than estimated
- Non-personnel resources (i.e. computers, specialized equipment) are no longer available as planned requiring you to acquire outside help or higher cost alternatives
- The stakeholders desire different project results than those originally approved

Don't underestimate the impact of indirect costs (overhead and general and administrative costs) in your project budget. As your project progresses escalation in direct labor rates could impact your expected variance greater than you expect.

For example say you have direct labor costs of $100,000 and your finance department uses a weighted labor rate of 40% based on labor rates. You experience a 10% increase in direct labor rates so the combined impact when including indirect costs becomes 14% (10% + 10% x .4).

SECTION VI

MANAGING RISK

Your goal as the project manager is to plan and monitor your project to meet the needs of the stakeholders and be on-time and within budget. But there is always a possibility that something unexpected may happen that could cause you to miss your targets. This possibility is called Risk and exists to some degree in every project because predicting the future with 100% certainty is not possible.

So let's consider some attributes of risk:

- Project risks are greater the longer a project lasts
- Project risks are greater the longer the period is between when you prepare you project plan and when the work is finally started (i.e. approval delays increase risk)
- Project risks are greater with less experienced teams or with teams that have never worked on similar projects
- Project risks are greater if you are using newer technology on the project (i.e. computer software systems) primarily due to the learning curve of new systems
- Project risk can be POSITIVE or NEGATIVE

    a. Negative risks (threats) can have a detrimental effect on the project objectives (i.e. causing a budget increase or missing an deadline)
    b. Positive risks (opportunities) can have a potentially beneficial effect on the project objectives

1. RISK MANAGEMENT

Q21

We know risks exist so we need to employ a process to identify risk, assess the potential consequence of the risk, and then develop a plan to mitigate or minimize any negative impacts. This process is called Risk Management. Here are steps to follow in Risk Management:

Step No.	Description
1. Identify all risks	Attempt to determine the aspects of your project environment or plan that may change
2. Assess the potential effects of the change on the project	What happens to the project objectives – schedule, cost, stakeholder expectation
3. Develop a plan to mitigate the effect of the change	How can we protect the project objectives?
4. Specifically monitor the project risks identified	Ongoing monitoring is required of previously known risks (are they still viable, is the risk increasing of decreasing) and new risks that are identified in the progress of the project
5. Communicate the risks to all stakeholders	Continually inform stakeholders – from project inception to completion

2. IDENTIFYING RISK FACTORS

You should now recognize that Risk is the ***possibility*** that something unexpected may happen that could cause you to miss your targets. But how do you identify the risks? To help identify risk consider looking for risk factors which are variables that can increase your chances of the possibility of the risk occurring. For example, in medical terms, smoking increases your chances of developing colon cancer. Therefore, smoking is a risk factor for colon cancer. In project management terms, payment issues with a client would be a risk factor for assuring project funding is in place for the same client on a new project. The risk factor itself does not cause the project to miss its goals however there is a greater chance of this happening. "Where there's smoke there's fire" Think of risk factors as your smoke. Some examples of risk factors to look for and the project stage they may be found in are listed as follows:

Project Stage	Risk Factor
Project Initiation	The project is for a new client
	You've had problems with an existing client
	The project does not have a primary project stakeholder or champion
	Not all of the project stakeholders are clearly identified
	The stakeholders show tepid interest in the project
	The project is very large and
	The project will require a large variety of expert skills / unique knowledge
	The project will require resources from several different departments within the organization
	Required background info and organizational plans are not in writing
	No funding analysis or feasibility analysis has been completed
	There has been no clear budget or source of funds allocated to the project
Project Planning	The project plan is not in writing and parts are missing
	No one person has been assigned the responsibility to manage the project
	Parts of the project plan are not approved by some/all of the stakeholders
	Members of the project team are new or inexperienced
	There was insufficient discussion and support for developing roles and responsibilities for team members
	The project success depends on the critical role of 1 or more people
	Work packages lack sufficient detail or not all team members participated in the development the work packages for which they were assigned
	Not all Project activities have been assigned to a specific individual or 2 or more people are assigned responsibility for the same project activity
	Time estimates for project activities are developed from a pre-established project end date
	No historical or expert knowledge is used in developing activity durations
	No identification of type, timing, or amount of non-personnel resources

Project Stage	Risk Factor
Executing the Work	There are no project procedures for resolving conflict or reaching required decisions
	The needs and expectations of the stakeholders change
	Ongoing Communication and progress reporting is inconsistent
	Key stakeholder(s) leave the project and/or new stakeholders are assigned
	Key team member(s) leave the project and/or new team members are assigned
	The change order process is not formally followed and changes approved
	Some project activities are using a new procedure or technology
	The project team is new and has never worked together before
	The decision is made to fast-track certain project activities
	The project plan did have a detailed work plan and consider members working on multiple tasks and projects
	Efficiency and productivity estimates are not following plan
Closing the Project	Key deliverables are not in writing
	The project results and deliverables are not approved by the key stakeholders
	Project team members are re-assigned before the project is complete
	Change orders have not been approved

3. ASSIGNING PROBABILITY AND CONSEQUENCES TO RISK

Ok, Let's assess where we are now. We now know what factors to look for to help identify risk and we understand the risk can have an impact on the goals of the project. The final step is to (1) estimate the actual probability of the risk happening and (2) determine what could be the outcome if the risk were to actually occur. Your goal is to determine the Expected Value of the Risk (probability of risk multiplied times the expected measure of the effect).

A. What is the Likelihood of the Risk?

Objective information on the risk (such as previous experience with other projects or similar instances, or past project reports) is the best available information a project manager can rely on to identify the likelihood of risk. But in the absence of objective data, the personal opinion of experts is necessary. If using expert opinion consider the following guidelines:

Expert Opinion Consideration	Discussion
Pre-define the risk scale	• Using Percentages a. 0% represents no chance of occurrence b. 100% is certainty of occurrence • Use Category Ranking (words describing likelihood) a. High, Medium, or Low b. Always, Often, Sometimes, Rarely or Never • Ordinal Ranking (weighting of likelihood against one another) a. Event 1 > Event 2 b. Event 2 > Event 3 c. Event 3 > Event 4 …
Solicit Independent Multiple Opinions	The project team should reach the consensus from the independent expert opinions. Caution: do not allow the independent experts to discuss together as a group as consensus could be reached that may not provide a fair assessment
Pre-qualify that the Project instances are similar	Be sure to validate the project experience of the expert is similar to your project.

B. What is the Consequence if the Risk event occurs?

The magnitude of effects of the risk event should be your primary consideration. Events that can affect the overall project should be considered of higher magnitude impact.

For example, a schedule slip on an activity that IS NOT in the critical path may have a negative effect on reaching intermediate schedule milestones and cause some loss of productivity and minor cost increases for the personnel assigned but has not affected the overall completion of the project. This could be considered a lower magnitude effect.

On the other hand, a schedule slip on an activity that IS in the critical path will absolutely impact overall project completion and will require commitment of additional resources to get the project back on schedule. This risk would be considered a higher magnitude effect.

C. What is the Expected Value of the Risk?

Expected Value of Risk = Probability of Risk Occurrence X Expected Measure of the Effect

Once the Expected Value of the Risk is determined the project team can evaluate and decide if this is an acceptable risk.

Example: A machine is needed for delivery at the project site in 8 weeks. The machine is available from 2 acceptable vendors that the team has experience with. If the machine is late, extra costs for a crane are $200 per week.
Vendor 1 has a machine that costs $1000 has agreed to the delivery of 8 weeks.
Vendor 2 has the same machine that costs $900 but the machine is coming from out of state and cannot be guaranteed for delivery at 8 weeks. The project team had a similar machine delivered last year from Vendor 2 in 8 weeks so they have placed a 75% likelihood that machine will be delivered on time.

Find the expected value of risk if the machine from Vendor 2 is late?

Vendor 2: $100 discount to vendor 1, 85% chance of being on time 15% chance of being late 1 week, $200 per week for crane rental

Expected Value (1 week late) = .25 x ($200) - $100 = -$50

The project team decides to that while Vendor 1 offers a discount for his machine the risk that machine is late balanced against the crane costs cuts in the half that discount. The decision is to buy from Vendor 2.

4. PLANNING TO MANAGE RISK

Recognition is the first step to recovery. So far we have identified the risk factors that helped us identify the risk, we have ranked the probability of the risk occurring and we have quantified the magnitude of the risk. We know need to decide how to act on these risks. Your choices are (1) proactively manage the risk, (2) transfer the risk, or (3) avoid the risk altogether.

A. Managing the Risk

1. MINIMIZE the probability of the risk occurring, for example: say the project team did decide to buy from Vendor 1 in the example above. Actions that could be taken to minimize the chance of being late could include more frequent inspection of the assembly of the machine to ensure it is progressing as planned.

2. Develop CONTINGENCY Plans, for example: again considering buying from Vendor 1 the project team alerts a stand-by trucking company to be available in order to expedite shipping if the machine is shipping late.

B. Transfer the Risk

Consider transferring the risk to a third party, such as an insurance company, or specialty vendor. Transferring risk typically comes with some form of premium payment so consider this in the evaluation. In our machine example discussed earlier, consider adding liquidated damages to the contract for purchase of the machine. Of course the vendor may not agree to the terms or add a premium to his pricing.

C. Avoid the risk altogether

Get the project team together including the project stakeholders to brainstorm solutions or work-arounds to avoid the risky situation altogether. In our machine example, a possible solution is ask the project stakeholders for an extension of the project schedule to avoid the delivery conflict.

6. RISK COMMUNICATION

The most effective project manager is going to communicate early and often. Be sure to have all communications in writing and improve relations with the key stakeholders by

including the following in all discussions about project risks:

- Clearly explain the risks that have been identified, quantify the probability of occurrence and the expected value impact if the risk actually occurs
- Explain how the team is monitoring the risks and has developed contingency plans to minimize the impact of the risk
- Encourage project team members and stakeholders to discuss risks and provide an environment where they are comfortable to share information

SECTION VII

Did You Earn It?

"They make Money the Old-Fashioned Way, They Earn it."

- Tagline from Advertising for the now merged Brokerage Firm - Smith Barney

If your Project Stakeholders were to ask the typical question about how far along you are on your project – what might you say? 25% complete or 50% complete or 75% complete. But do you really know? Have you really EARNED what you say?

Let's say you believe you're 50% complete—is it really 50% or 48% or 56%? The real truth is that any Project Manager doesn't really know for sure with any degree of precision. You may have a general notion but you can't really say with certainty. Earned Value is just the technique that can allow you to answer the question accurately.

WHAT IS EARNED VALUE:

Q23

The general concept behind Earned Value is to have a method to accurately compare where you actually are in the project lifecycle against where you planned to be at the start. Earned Value, at any point in the project enables you to (1) quantify all of the work that has been accomplished so far on a project and (2) quantify all of the work that should have been done on the project. As the Project Manager you can then compare those numbers to determine if you're on schedule, ahead of schedule, or behind schedule; on-budget, under-budget, or over-budget.

The concept of Earned Value started as a financial analysis tool for United States Government programs in the 1960s and today Earned Value Management has become an essential part of project tracking.

Using the Earned Value techniques can help you:

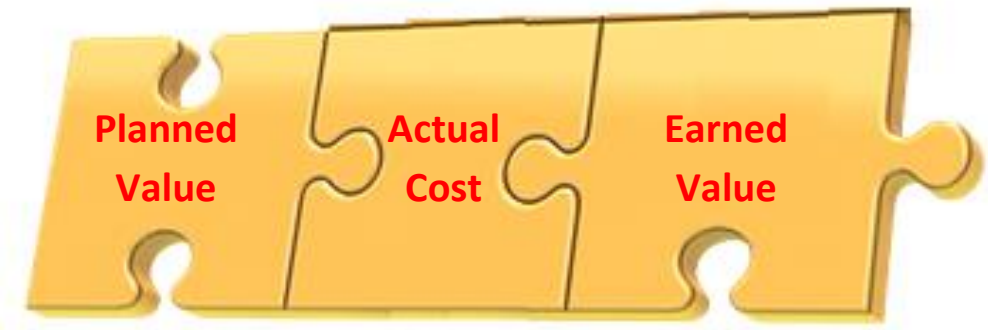
- Track current project status and help better forecast likely future performance
- Answer stakeholder performance questions with better accuracy
- Use statistical techniques to quantify performance
- Improve project planning because the project status is much more measurable

EARNED VALUE METRICS:

Q24

There are three (3) puzzle pieces that fit together to form the picture which is Earned Value:

(1) Planned Value (PM); (2) Actual Cost (AC); and (3) Earned Value (EV)



Planned Value: (PV)

Planned Value (PV) is calculated by adding all the budgeted estimates for all the work that was scheduled to be completed by a given reporting date. The value could be Hours Worked or even dollars spent on a contract or PO.

Example: PV = hours budgeted x hourly rate; PV = 120 hours worked x $20.00 rate

Example: PV = PO completion % x PO amount; PV = 60% x $1000 PO Value

Actual Cost: (AC)

Actual Cost (AC) is calculated by adding up the actual cost for all the work that has been completed by a given reporting date. The cost value could be ACTUAL Hours Worked or even dollars spent on a contract or PO.

Example: AC = actual hours worked x hourly rate; AC = 116 hours worked x $19.48 rate

Example: AC = Widgets delivered x Widget Unit cost; AC = 45 x $124.50 unit cost

Earned Value: (EV)

The Earned Value (EV) component is calculated by adding up the budgeted cost of every activity that has been completed as of the reporting date. This is the basic measure of much the TOTAL project has been BUDGETED to spend to date. This value by itself won't tell you much but when used in the calculations to follow - Earned Value will be helpful in determining a project's status.

EARNED VALUE CALCULATIONS:

So how can we use our three metrics (PV, AC, and EV)?

(1) CALCULATING Schedule Variance: (SV)

Schedule Variance (SV) is going to tell you if you're ahead of schedule or behind schedule. SV is calculated with EV – PV, using days as a measure of performance.

If the Schedule Variance is positive, you have actually completed more work (EV) than you planned to complete (PV) in the given reporting period. If the Schedule Variance is negative, this means you are behind schedule.

You can also look at Schedule Variance in terms of a variance in percentage terms. To calculate a Schedule Variance % (SV%) take your SV from above and divide by the Planned Value. SV% = SV / PV

(2) CALCULATING Cost Variance: (CV)

Cost Variance (CV) is going to tell you how you're project is doing against the budget. Are you under budget or over budget. CV is calculated with EV – AC.

If the Cost Variance is positive, you have budgeted more cost to perform the work than was actually spent during the reporting period. In this case you are fine from a budget perspective. If the Cost Variance is negative, you may be over budget.

Cost Variance, like Schedule Variance can also be viewed in terms of a percentage variance. To calculate a Cost Variance % (CV%) take your CV from above and divide by the Planned Value. CV% = CV / EV

(3) CALCULATING Schedule Performance Index: (SPI)

Schedule Performance Index (SPI) is a calculated ratio of the Earned Value (EV) and Panned Value (PV) and is calculated as: EV / PV.

This index is going to show you the relationship between the budgeted cost of work ACTUALLY performed and the cost of the work that was SCHEDULED to be performed in the reporting period picked. This is known as the "Run Rate" of the project. If the calculated SPI is greater than 1.0 – you are getting more done (actual) than you had planned (PV) and vice versa.

(4) CALCULATING Cost Performance Index: (CPI)

Cost Performance Index (CPI) is a calculated ratio of the Earned Value (EV) and Actual Cost (AC) and is calculated as: EV / AC.

This index is going to show you the relationship between the BUDGETED cost of work ACTUALLY performed and the ACTUAL cost of the work that was performed in the reporting period picked. This is known as the "Burn Rate" of the project. If the calculated CPI is greater than 1.0 – you are getting more done (actual work) for each dollar spent compared to what you had initially estimated and vice versa.

(5) CALCULATING To Complete Cost Performance Indicator: (TCPI)

The To Complete Cost Performance Indicator (TCPI) is a calculated index that shows the efficiency of resources that should be used to complete the remainder of a project. TCPI is calculated as:

$$TCPI = (\text{Total Project Budget} - EV) \ / \ (\text{Total Project Budget} - AC)$$

A value of above 1.0 means the project team has to work very efficiently – utilization is stringent. A value of below 1.0 means the project team has some slack to work less efficiently – utilization is lenient.

(6) CALCULATING To Complete Schedule Performance Indicator: (TSPI)

The To Complete Schedule Performance Indicator (TSPI) is a calculated index that shows the efficiency of utilization for the remainder of a project. TSPI is calculated as:

TSPI = (Total Project Budget – EV) / (Total Project Budget – PV)

A value of below 1.0 means the project team can be more lenient in utilizing the remaining time allocated to the project. A value of above 1.0 means the project team has to work harder in utilizing the remaining time on the project.

EARNED VALUE CALCULATION EXAMPLE:

Consider a project that has exactly 1 task. The Task was originally estimated to take 8 hours. At this point the task has taken 11 hours and it is estimated to take 1 additional hour to complete the task (project). The hourly rate is $100.

- PV = 8 x $100 = $800
- AC = 11 x $100 = $1100
- % Actual Complete = AC / (New Budget) = $1100/$1200 = 91.7%
- EV = Baseline Cost x % Complete = $800 * 91.7% = $734
- CV = EV-AC = $734 -$1100 = - $366
- CPI = EV / AC = $734 / $1100 = 66%

In this case with a CPI less than 1.0; the Project is over budget

<<< End Of Course – Part 1>>>