Earned Value Management Tutorial
Module 3: Project Scheduling

Prepared by:

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Welcome to Module 3. The objective of this module is to introduce you to Project Scheduling.

The Topics that will be addressed in this Module include:

- Define Planning vs. Scheduling

- Define and Illustrate Basic Scheduling Concepts

- Define Logic Relationships and Critical Path

- Define and Illustrate Different Schedule Formats

Let's quickly review what has been covered in the previous modules.

- In Module 1 we introduced you to earned value and the requirements for properly implementing an earned value management system (EVMS).

- In Module 2 we discussed
    - the first steps in the planning process
    - development of the work breakdown structure (WBS)
    - organizational breakdown structure (OBS)
    - the integration of WBS and OBS in creating the responsibility assignment matrix (RAM)

- The next step in this process is to develop the project schedule. So the first question we need to ask is what is scheduling?

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There are multiple ways of defining scheduling. Scheduling is:

…Forming a network of activities and event relationships that portrays the sequential relations between the tasks in a project…

…Planned completion of a project based on the logical arrangement of activities, resources…

…Placing the project and its activities in a workable sequenced timetable…

…A detailed outline of activities/tasks with respect to time…

While scheduling is all of these things, the main thing to remember is that

scheduling is the development of planned dates
for performing project activities and meeting milestones.

By looking at the aforementioned definitions of scheduling, do you see a difference between planning and scheduling? Let's take a look on the next page.

"I keep six honest serving men (they taught me all I knew); their names are What and Why and When and How and Where and Who."

    --- Rudyard Kipling

Planning involves making decisions with the objective of influencing the future. Another way to consider planning is as the "thinking" phase. Defining activities, their logical sequence, and their relationship to each other are all planning functions. In planning you answer the following questions:

What will be performed?

- This question is answered by determining the final project product necessary for achieving project success. This is done in the initiation phase before the development of your WBS.

How will it be performed?

- This question is answered by determining the processes, procedures, and methodologies used to complete the project.

Where will it be performed?

- This answer varies for each type of project. For example, if it's a construction project, the "where" will be the physical location of the building or road etc. If the project is a software development project, the answer could be the physical location of the project team or the final location of the project software.

Who will perform the work?

- This question is answered by determining if the work will be contracted or will use in-house resources. Then, the question will be examined in even more detail: if a contractor, what type of contractor, and if company resource, what department and who in each department?

In **what** sequence?

- This question involves determining the order in which activities will be performed to complete the project.

With five main questions answered, only one last question remains: when. This question involves scheduling.

Scheduling determines the timing of operations in the project. The schedule will determine the specific start and completion dates for the project and all project activities. Another way to look at scheduling is to consider it the "action" or "doing it" phase. In scheduling you answer the question:

When will the work be performed?

- Scheduling includes the project start and completion dates, project deliverables and milestones dates, and the start and completion dates for all activities needed to successfully complete the project.

Equipped with an understanding of the difference between planning and scheduling, let's look on the next page at the scheduling requirement needed in an earned value management system (EVMS).

To satisfy the earned value management system (EVMS) criteria, the schedule must:

- Include logical ties for all activities
- Include all key milestones and deliverables
- Reflect the agreed to project baseline
- Integrate with the cost baseline

We will discuss the last two bullet points in Module 4.

On the following pages, we will discuss the process for developing a project schedule, including how to ensure it is logical and how to ensure that it includes all key milestones and deliverables.

Project scheduling in the earned value management system involves a clear, five step process. This process aids managers in determining the project schedule and, eventually, the project schedule baseline. The process steps are:

1. Develop the list of project activities

2. Sequence the list of project activities

3. Determine the relationships between activities

4. Establish the duration for each activity

5. Determine the project duration (start and completion dates)

For the purpose of explaining the process in detail, we will use the smaller BEST Management Books project from Module 2 instead of the ACME House Building project. At the end of the process will look at the outcome of using this process on the ACME House Building project.
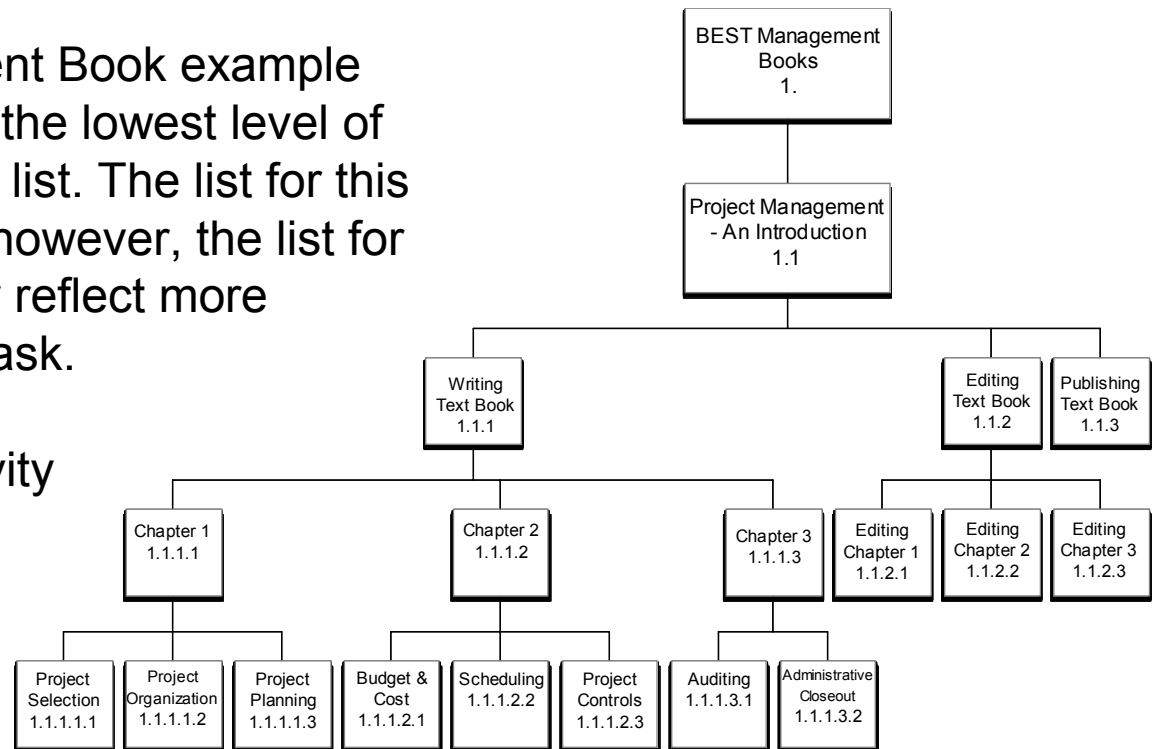
Developing a list of project activities is as simple as it sounds: list all activities that are needed to complete the project. Do not order or rank them yet, as this step comes later. This list needs to be as complete as possible. You can add and subtract activities throughout the process, but the more complete the list is now, the easier the process will be.

Using the BEST Management Book example from Module 2, we will use the lowest level of BEST's WBS as our activity list. The list for this example is relatively short; however, the list for your projects will most likely reflect more detailed activities for each task.

Let's take a look at our activity list on the following page.

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Here is the initial list of activities for the BEST Project Management book. There are two things to remember at this stage of the process.

1. The activity list is not a complete list; additions and subtractions will be made from it.

2. As you develop your list, you may see the need to update the WBS. Remember the WBS is a dynamic tool, revisions may be needed and should be expected as the scheduling of activities progresses.

WBS	Activity List
1.1	Start Development of Project Management Book
1.1.1.1.1	Writing Project Selection section for Chapter 1
1.1.1.1.2	Writing Project Organization section for Chapter 1
1.1.1.1.3	Writing Project Planning section for Chapter 1
1.1.1.2.1	Writing Budget and Cost section for Chapter 2
1.1.1.2.2	Writing Scheduling section for Chapter 2
1.1.1.2.3	Writing Project Controls section for Chapter 2
1.1.1.3.1	Writing Auditing section for Chapter 3
1.1.1.3.2	Writing Administrative Closeout section for Chapter 3
1.1.2.1	Editing Chapter 1
1.1.2.2	Editing Chapter 2
1.1.2.3	Editing Chapter 3
1.1.3	Publishing Project Management Book
1.1	Finished Development of the Project Management Book

For this example, we will assume that this is a complete list of activities, and no revision to the WBS is needed.

With the activity list complete, we need to "sequence" or develop "logic" between activities. To complete this process we need the WBS activities list and a pencil.

A pencil? Why a pencil?

This process requires the project manager, subject matter experts (SME), and other project team members who are familiar with the nature of the specific activities to meet, discuss and develop the sequencing of the project activities. This process is known as "a pencil to paper" process.

Continuing to use our BEST Management book example, we will take a look at this sequencing process on the next page.

1. Start with the WBS…
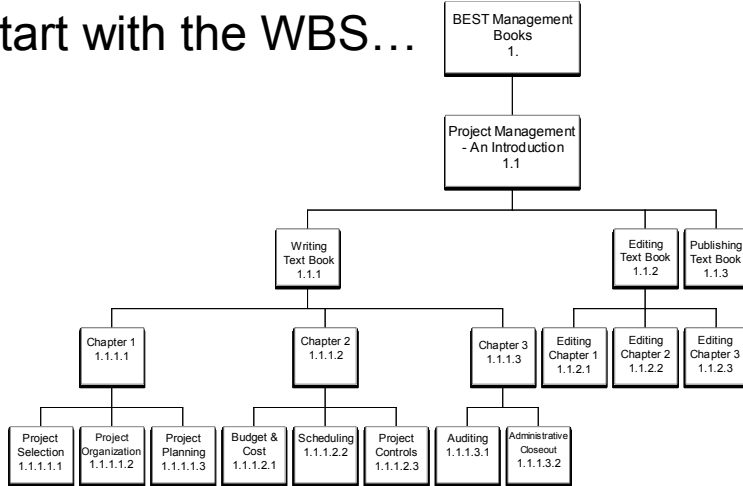
…2. Develop the Activity List….

WBS	Activity List
1.1	Start Development of Project Management Book
1.1.1.1.1	Writing Project Selection section for Chapter 1
1.1.1.1.2	Writing Project Organization section for Chapter 1
1.1.1.1.3	Writing Project Planning section for Chapter 1
1.1.1.2.1	Writing Budget and Cost section for Chapter 2
1.1.1.2.2	Writing Scheduling section for Chapter 2
1.1.1.2.3	Writing Project Controls section for Chapter 2
1.1.1.3.1	Writing Auditing section for Chapter 3
1.1.1.3.2	Writing Administrative Closeout section for Chapter 3
1.1.2.1	Editing Chapter 1
1.1.2.2	Editing Chapter 2
1.1.2.3	Editing Chapter 3
1.1.3	Publishing Project Management Book
1.1	Finished Development of the Project Management Book

3. …Use the WBS and Activity List to develop the project activity sequence or logic…
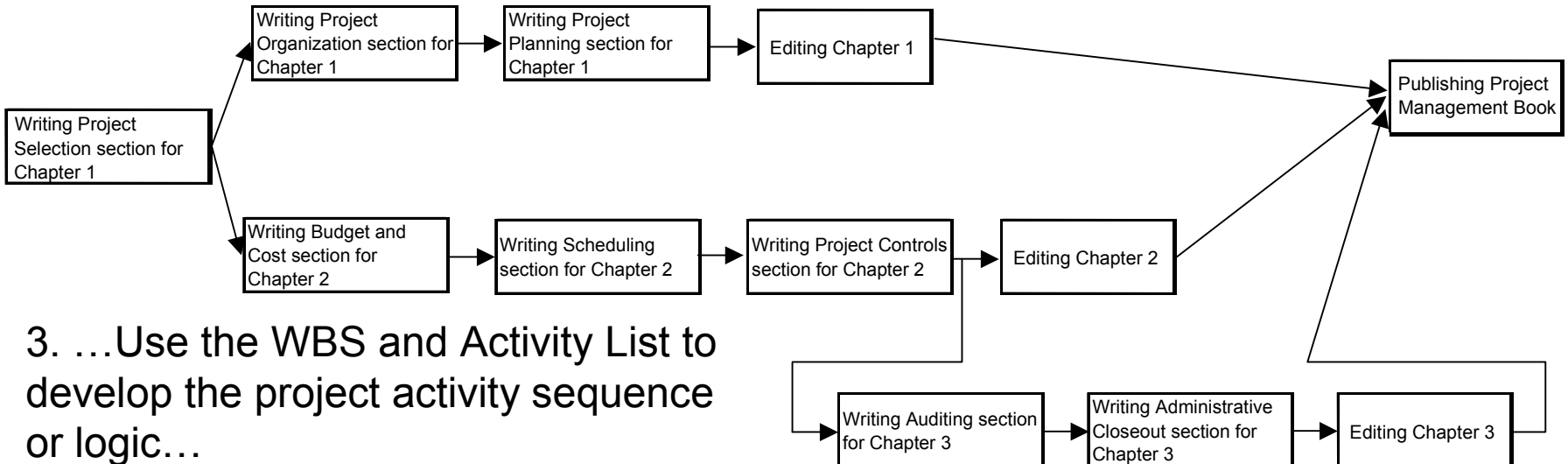
Once the sequence has been established, you need to determine the direct relationship between each activity. But how does sequencing differ from identifying the relationships of tasks and activities?

Sequencing is the order of how things will happen. First, second, third, etc. . .

Identifying direct relationships provides greater understanding to the project tasks and schedule. By identifying the relationships between activities in scheduling, you identify the sequence plus dependencies of tasks. There are 4 types of scheduling dependencies:

> - FS – Finish to Start
> - SS – Start to Start
> - FF – Finish to Finish
> - SF – Start to Finish

- FS – Finish to Start
- SS – Start to Start
- FF – Finish to Finish
- SF – Start to Finish

There are two methods for developing project sequence and relationships:
Precedence Diagramming Method (PDM)
Arrow Diagramming Method (ADM).

We will use PDM in this module but will not explore these scheduling methods in detail.

Let's take a closer look at the first three scheduling dependencies. We will not discuss the last dependence, as it is never used.

The first type of relationship is called Finish to Start (FS). This means that activity "A" must finish before activity "B" can start.

Let's look at this relationship using the BEST Management Books example:

Finish-To-Start

Writing Project Organization section for Chapter 1	→ FS →	Writing the Project Planning section for Chapter 1
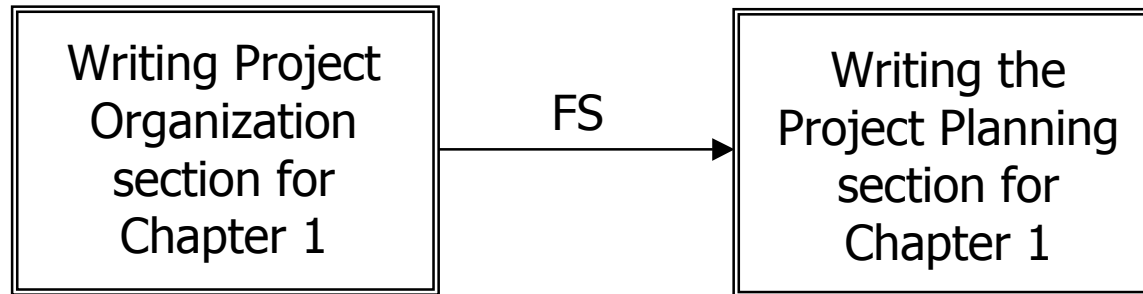
You must **"Finish"** writing the Project Organization section of Chapter 1 before you can **"Start"** writing the Project Planning section for Chapter 1.

The second type of relationship is Start to Start (SS). This means that activity "B" can start as soon as activity "A" starts.

Let's look at this relationship using the BEST Management Books example:

Start-To-Start
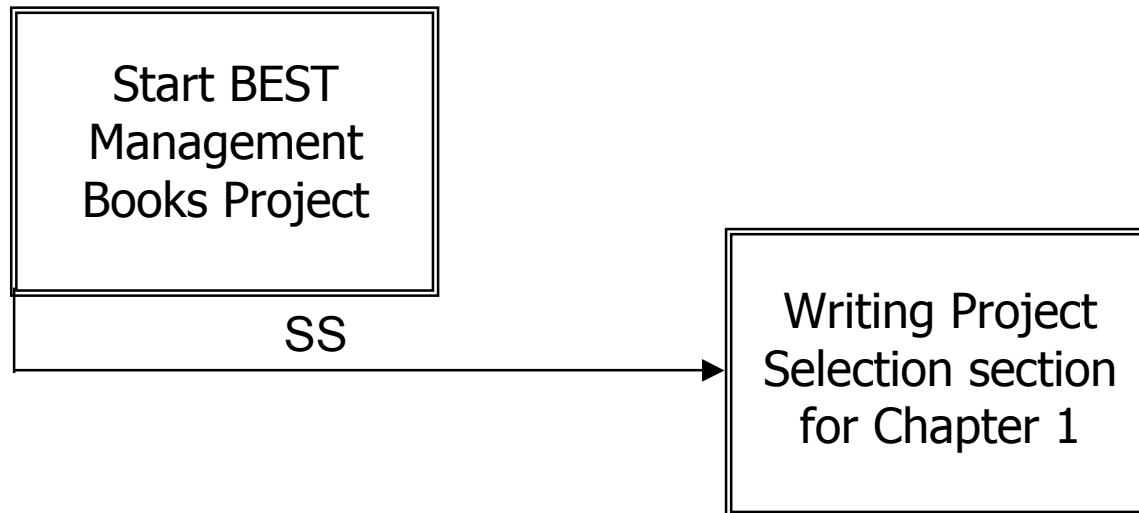
You can **"Start"** writing the Project Selection section for Chapter 1 as soon as you **"Start"** the BEST Management Books Project.

The third type of relationship is Finish to Finish (FF). This means that activity "B" cannot finish until activity "A" finishes.

Let's look at this relationship using the BEST Management Books example:

Finish-To-Finish

Editing Chapter 3	FF	Finish BEST Management Books Project
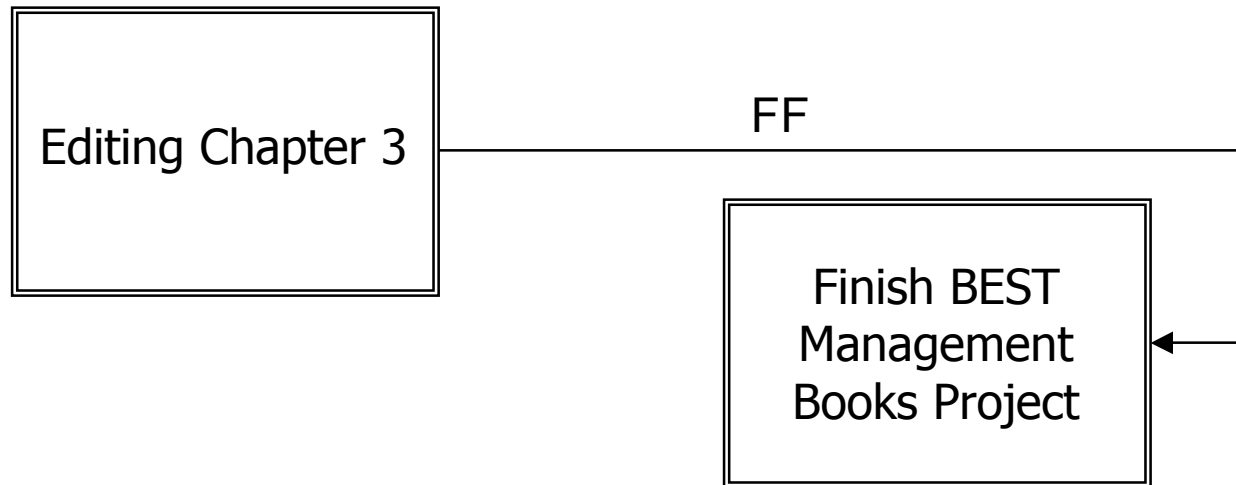
You cannot **"Finish"** the project, Finish BEST Management Book Project, until you **"Finish"** Editing Chapter 3.

Using the relationships we have just described, the BEST Management Books project activities and the logical relationships among them is diagrammed below. This is formally known as a Network Diagram.
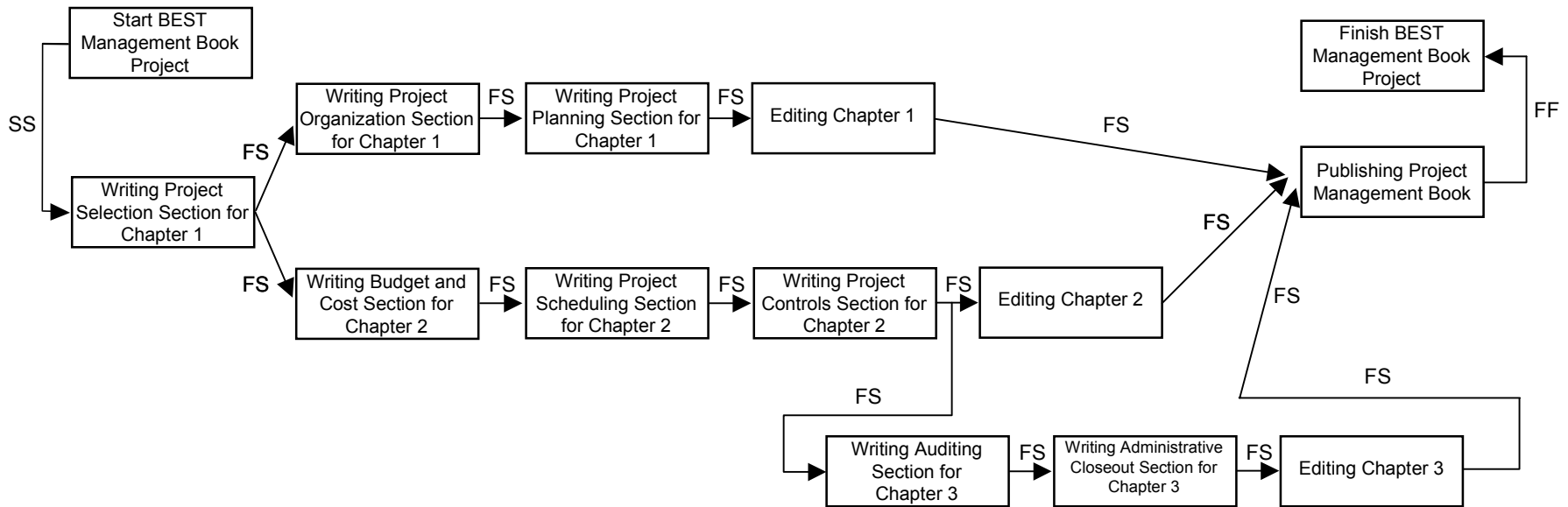
With the relationships defined, we now need to establish the duration for each activity. Let's take a look on the next page.

Now that you have the project network diagram, it is time to determine the duration for each project activity. Once again, just like the sequencing process: you need to enlist the help of the people or group of people familiar with the nature of the project.

Establishing the duration of each project activity involves determining the work periods needed to complete each identified activity. Work periods can be

- hours
- days
- weeks
- months, etc..

Regardless of the exact work period chosen, the period must be consistent for all activities in the schedule. The project manager and team member(s) must decide which work period is right for the project.

Two major duration estimating tools can help project managers estimate the activity duration: the PERT and CPM.

Three time estimates can be applied to any activity:
- Optimistic (O)
- Pessimistic (P)
- Most Likely (M)

PERT uses the distribution's mean to determine individual activity duration. Specifically, the PERT formula is $$(P + 4M + O) / 6$$	Critical Path Method (CPM) requires only a one time estimate per activity. This method uses only a Most Likely time estimate.

Let's consider an example on the next page to understand better.

For the activity "Editing Chapter 1," the following estimates are determined:

- (O) Optimistic estimate = 6 days
- (P) Pessimistic estimate = 18 days
- (M) Most Likely = 9 days

Using PERT, the following estimate is derived: (18 + 36 + 6) / 6 = 10 days.

Using CPM, the estimate is 9 days.

Legend

Time Estimates
- Optimistic (O)
- Pessimistic (P)
- Most Likely (M)

CPM = Most Likely time estimate
PERT = the distribution's mean: (P + 4M + O) / 6

Now let's look at the duration estimate for the activities in the BEST Management Books project. For the purposes of this tutorial, it does not matter which duration estimating method was used.

Here is a list of the activities in the BEST Management Books Project. The durations for each activity have been determined. From looking at the chart, what is the work period chosen by the project manager?

WBS	Activity Description	Duration
1.1	Start Development of Project Management Book	0 wks
1.1.1.1.1	Writing Project Selection section for Chapter 1	8 wks
1.1.1.1.2	Writing Project Organization section for Chapter 1	10 wks
1.1.1.1.3	Writing Project Planning section for Chapter 1	9 wks
1.1.1.2.1	Writing Budget and Cost section for Chapter 2	9 wks
1.1.1.2.2	Writing Scheduling section for Chapter 2	5 wks
1.1.1.2.3	Writing Project Controls section for Chapter 2	7 wks
1.1.1.3.1.	Writing Auditing section for Chapter 3	2 wks
1.1.1.3.2	Writing Administrative Closeout section for Chapter 3	1 wk
1.1.2.1	Editing Chapter 1	8 wks
1.1.2.2	Editing Chapter 2	8 wks
1.1.2.3	Editing Chapter 3	4 wks
1.1.3	Publishing Project Management Book	4 wks
1.1	Finish Development of the Project Management Book	0 wks

The work period is weeks (wks). Remember the selected work period must be consistent for all activities.

At this point, you have covered a good bit of information. Take some time now to review what you have learned before you continue with the module.

So far in this module, we have covered four of the five steps related to project scheduling:

1. Developing the list of project activities
2. Sequencing the list of project activities
3. Determining the relationship between each activity
4. Establishing the duration for each activity

The final step in this process is to determine the project duration (start and completion dates) and the start and finish dates for each individual activity. Take a closer look at this step on the following page.

Usually the project duration and activity start and completion dates are mapped in a typical scheduling software application. The activities are placed in the software tool, and the relationships are identified. The software calculates the dates.

To better understand how the software calculates the dates, we will take a look at the process known as Forward and Backward Pass.

The **Forward Pass** determines the early start (ES) and the early finish (EF) of each activity.	The **Backward Pass** determines the late start (LS) and late finish (LF) of each activity.

Together, these processes give the total project duration, including the start and finish dates for each activity. Additionally, the process will determine the

- **critical path**, which tells you the activities that <u>cannot</u> slip without increasing the total duration of the project or moving the project completion date, and

- **float**, which tells you how much certain activities can slip without impacting the total project duration.

We will look at critical path and float later in the module.

To start this process, let's look at the Forward Pass.

The Forward Pass calculates the earliest date that each activity can start and finish according to the logical sequence of work and the duration of each activity. The Forward Pass yields the project duration.

To start this process, a Project Network Diagram and a chart will help estimate the appropriate dates.

Project Network Diagram

Chart

WBS	Activity	Duration	ES	EF	LS	LF

To begin the Forward Pass process, determine a project start date. Looking at the BEST project, we will use January 1 as the project start date.

The first activity that appears in the Network Diagram is "Start BEST Management Books project." Accordingly, the information appears in the corresponding chart.
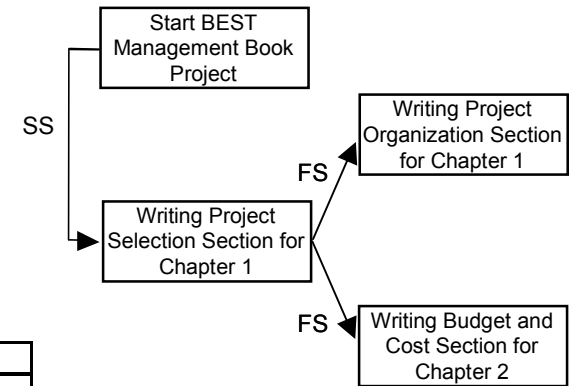
WBS	Activity	Duration	ES	EF	LS	LF
1.1	Start Development of Project Management Book	0 wks	1/1	1/1		

The early start (ES) is 1/1 since this is the First activity and the start date for the project is 1/1. The early finish (EF) for this activity is also 1/1 since it is a milestone and a milestone has no duration.

Using the Network Diagram, the next activity is "Writing Project Selection section of Chapter 1." This activity is start to start (SS) with the previous activity, thus its early start date is 1/1 (see chart). The early finish is determine by the duration of the activity itself. This activity has a duration of 8 weeks, which translates to a early finish date of 2/25.

WBS	Activity	Duration	ES	EF	LS	LF
1.1	Start Development of Project Management Book	0 wks	1/1	1/1		
1.1.1.1.1	Writing Project Selection section for Chapter 1	8 wks	1/1	2/25		

The next activity is "Writing the Project Organizational section of Chapter 1." It is finish to start (FS) with the previous activity. With the FS relationship in mind, what is the early start date for this activity?

Because you must finish writing the Project Selection section before you start writing the Project Organizational section, the early start date for the current activity is 2/26. The early finish is once again calculated by using the duration of the activity, giving you a early completion of 5/6.

WBS	Activity	Duration	ES	EF	LS	LF
1.1	Start Development of Project Management Book	0 wks	1/1	1/1		
1.1.1.1.1	Writing Project Selection section for Chapter 1	8 wks	1/1	2/25		
1.1.1.1.2	Writing Project Organization section for Chapter 1	10 wks	2/26	5/6		

Let's look at one more.

The next activity is "Writing the Budget and Cost section of Chapter 2." It is finish to start (FS). Can you determine the activity that must finish, before this activity can start?

It is finish to start (FS) with Writing the Project Selection section: because you must finish writing the project selection section before you start writing the project budget and cost section (same as Writing Project Selection section), the early start date is also 2/26. The early finish is once again calculated by using the duration of the activity, giving you an early completion of 4/29.

WBS	Activity	Duration	ES	EF	LS	LF
1.1	Start Development of Project Management Book	0 wks	1/1	1/1		
1.1.1.1.1	Writing Project Selection section for Chapter 1	8 wks	1/1	2/25		
1.1.1.1.2	Writing Project Organization section for Chapter 1	10 wks	2/26	5/6		
1.1.1.2.1	Writing Budget and Cost section for Chapter 2	9 wks	2/26	4/29		

This process is used to determine each activity's ES and EF. On the page next is the completed Forward Pass.

By looking at the chart below, can you determine the project duration, start and completion dates?

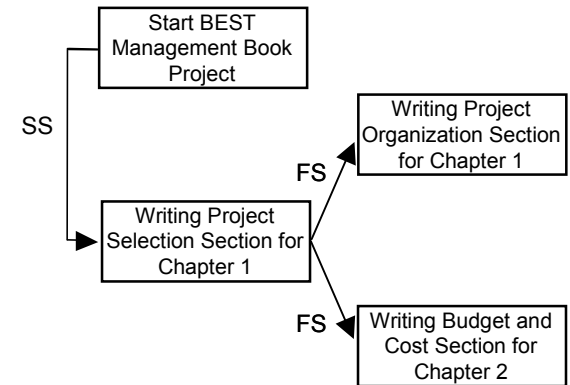| WBS	Activity	Duration	ES	EF	LS	LF
1.1	Start Development of Project Management Book	0 wks	1/1	1/1		
1.1.1.1.1	Writing Project Selection section for Chapter 1	8 wks	1/1	2/25		
1.1.1.1.2	Writing Project Organization section for Chapter 1	10 wks	2/26	5/6		
1.1.1.2.1	Writing Budget and Cost section for Chapter 2	9 wks	2/26	4/29		
1.1.1.1.3	Writing Project Planning section for Chapter 1	9 wks	5/7	7/8		
1.1.1.2.2	Writing Scheduling section for Chapter 2	5 wks	4/30	6/3		
1.1.1.2.3	Writing Project Controls section for Chapter 2	7 wks	6/4	7/22		
1.1.1.3.1.	Writing Auditing section for Chapter 3	2 wks	7/23	8/5		
1.1.1.3.2	Writing Administrative Closeout section for Chapter 3	1 wk	8/6	8/12		
1.1.2.1	Editing Chapter 1	8 wks	7/9	9/2		
1.1.2.2	Editing Chapter 2	8 wks	7/23	9/16		
1.1.2.3	Editing Chapter 3	4 wks	8/13	9/9		
1.1.3	Publishing Project Management Book	4 wks	9/17	10/14		
1.1	Finish Development of the Project Management Book	0 wks	10/14	10/14		

Project Duration: 41 weeks or 205 days.

Project Start: January 1

Project Completion: October 14

With the Forward Pass complete, let's look at the Backward Pass. The Backward Pass calculates the latest date that each activity can start and finish in order to meet the project end date.

Again, using the BEST Management Books example, let's now address the Backward Pass. The chart below contains the Forward Pass information.

Unlike the Forward Pass, which started with the first activity, the Backward Pass will start at the bottom of the chart with the last activity and work backwards.

WBS	Activity	Duration	ES	EF	LS	LF
1.1	Start Development of Project Management Book	0 wks	1/1	1/1		
1.1.1.1.1	Writing Project Selection section for Chapter 1	8 wks	1/1	2/25		
1.1.1.1.2	Writing Project Organization section for Chapter 1	10 wks	2/26	5/6		
1.1.1.2.1	Writing Budget and Cost section for Chapter 2	9 wks	2/26	4/29		
1.1.1.3	Writing Project Planning section for Chapter 1	9 wks	5/7	7/8		
1.1.1.2.2	Writing Scheduling section for Chapter 2	5 wks	4/30	6/3		
1.1.1.2.3	Writing Project Controls section for Chapter 2	7 wks	6/4	7/22		
1.1.1.3.1.	Writing Auditing section for Chapter 3	2 wks	7/23	8/5		
1.1.1.3.2	Writing Administrative Closeout section for Chapter 3	1 wk	8/6	8/12		
1.1.2.1	Editing Chapter 1	8 wks	7/9	9/2		
1.1.2.2	Editing Chapter 2	8 wks	7/23	9/16		
1.1.2.3	Editing Chapter 3	4 wks	8/13	9/9		
1.1.3	Publishing Project Management Book	4 wks	9/17	10/14		
1.1	Finish Development of the Project Management Book	0 wks	10/14	10/14		

Start at the end and go backwards

The process works the same as the Forward Pass but in the opposite direction. Once again using the Network Diagram, the last activity is "Finish the Development of the Project Management Book" (see below). The late finish (LF) and the late start (LS) will be the same as the early start (ES) and early finish (EF) since it is the final activity.

WBS	Activity	Duration	ES	EF	LS	LF
1.1	Start Development of Project Management Book	0 wks	1/1	1/1		
1.1.1.1.1	Writing Project Selection section for Chapter 1	8 wks	1/1	2/25		
1.1.1.1.2	Writing Project Organization section for Chapter 1	10 wks	2/26	5/6		
1.1.1.2.1	Writing Budget and Cost section for Chapter 2	9 wks	2/26	4/29		
1.1.1.1.3	Writing Project Planning section for Chapter 1	9 wks	5/7	7/8		
1.1.1.2.2	Writing Scheduling section for Chapter 2	5 wks	4/30	6/3		
1.1.1.2.3	Writing Project Controls section for Chapter 2	7 wks	6/4	7/22		
1.1.1.3.1.	Writing Auditing section for Chapter 3	2 wks	7/23	8/5		
1.1.1.3.2	Writing Administrative Closeout section for Chapter 3	1 wk	8/6	8/12		
1.1.2.1	Editing Chapter 1	8 wks	7/9	9/2		
1.1.2.2	Editing Chapter 2	8 wks	7/23	9/16		
1.1.2.3	Editing Chapter 3	4 wks	8/13	9/9		
1.1.3	Publishing Project Management Book	4 wks	9/17	10/14	9/17	10/14
1.1	Finish Development of the Project Management Book	0 wks	10/14	10/14	10/14	10/14

The next activity is "Publishing Project Management Book," and it is finish to finish (FF) with the "Finish Development" activity. Thus, the LF and LS are also the same as the ES and EF.

Looking at the Network Diagram on the previous page, you see that there are three activities that have a relationship with Publishing Project Management Book:

- Editing Chapter 1
- Editing Chapter 2
- Editing Chapter 3

Also note that the relationships are all finish to start (FS). With this in mind, what is the LF and LS for each activity?

WBS	Activity	Duration	ES	EF	LS	LF
1.1	Start Development of Project Management Book	0 wks	1/1	1/1		
1.1.1.1.1	Writing Project Selection section for Chapter 1	8 wks	1/1	2/25		
1.1.1.1.2	Writing Project Organization section for Chapter 1	10 wks	2/26	5/6		
1.1.1.2.1	Writing Budget and Cost section for Chapter 2	9 wks	2/26	4/29		
1.1.1.1.3	Writing Project Planning section for Chapter 1	9 wks	5/7	7/8		
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1.1.1.3.2	Writing Administrative Closeout section for Chapter 3	1 wk	8/6	8/12		
1.1.2.1	Editing Chapter 1	8 wks	7/9	9/2	7/23	9/16
1.1.2.2	Editing Chapter 2	8 wks	7/23	9/16	7/23	9/16
1.1.2.3	Editing Chapter 3	4 wks	8/13	9/9	8/20	9/16
1.1.3	Publishing Project Management Book	4 wks	9/17	10/14	9/17	10/14
1.1	Finish Development of the Project Management Book	0 wks	10/14	10/14	10/14	10/14

Because "Publishing Project Management Book" has an LS of 9/17 and all three activities are finish to start (FS), the late finish (LF) for each must be 9/16.

WBS	Activity	Duration	ES	EF	LS	LF
1.1	Start Development of Project Management Book	0 wks	1/1	1/1		
1.1.1.1.1	Writing Project Selection section for Chapter 1	8 wks	1/1	2/25		
1.1.1.1.2	Writing Project Organization section for Chapter 1	10 wks	2/26	5/6		
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1.1.1.3.2	Writing Administrative Closeout section for Chapter 3	1 wk	8/6	8/12		
1.1.2.1	Editing Chapter 1	8 wks	7/9	9/2	7/23	9/16
1.1.2.2	Editing Chapter 2	8 wks	7/23	9/16	7/23	9/16
1.1.2.3	Editing Chapter 3	4 wks	8/13	9/9	8/20	9/16
1.1.3	Publishing Project Management Book	4 wks	9/17	10/14	9/17	10/14
1.1	Finish Development of the Project Management Book	0 wks	10/14	10/14	10/14	10/14

How do you determine the late start (LS) for each activity? Subtract the duration for each activity from LF, as shown in the chart.

Here is the completed list of all the activities, including the early starts (ES), early finishes (FS), late starts (LS) and late finishes (LF). What can you determine about the project from this data?

WBS	Activity	Duration	ES	EF	LS	LF
1.1	Start Development of Project Management Book	0 wks	1/1	1/1	1/1	1/1
1.1.1.1.1	Writing Project Selection section for Chapter 1	8 wks	1/1	2/25	1/1	2/25
1.1.1.1.2	Writing Project Organization section for Chapter 1	10 wks	2/26	5/6	3/12	5/20
1.1.1.2.1	Writing Budget and Cost section for Chapter 2	9 wks	2/26	4/29	2/26	4/29
1.1.1.1.3	Writing Project Planning section for Chapter 1	9 wks	5/7	7/8	5/21	7/22
1.1.1.2.2	Writing Scheduling section for Chapter 2	5 wks	4/30	6/3	4/30	6/3
1.1.1.2.3	Writing Project Controls section for Chapter 2	7 wks	6/4	7/22	6/4	7/22
1.1.1.3.1.	Writing Auditing section for Chapter 3	2 wks	7/23	8/5	7/30	8/12
1.1.1.3.2	Writing Administrative Closeout section for Chapter 3	1 wk	8/6	8/12	8/13	8/19
1.1.2.1	Editing Chapter 1	8 wks	7/9	9/2	7/23	9/16
1.1.2.2	Editing Chapter 2	8 wks	7/23	9/16	7/23	9/16
1.1.2.3	Editing Chapter 3	4 wks	8/13	9/9	8/20	9/16
1.1.3	Publishing Project Management Book	4 wks	9/17	10/14	9/17	10/14
1.1	Finish Development of the Project Management Book	0 wks	10/14	10/14	10/14	10/14

Take a look on the next page.

From the Forward Pass information, we know the Project duration, Project Start, and Completion date.

WBS	Activity	Duration	ES	EF	LS	LF
1.1	Start Development of Project Management Book	0 wks	1/1	1/1	1/1	1/1
1.1.1.1.1	Writing Project Selection section for Chapter 1	8 wks	1/1	2/25	1/1	2/25
1.1.1.1.2	Writing Project Organization section for Chapter 1	10 wks	2/26	5/6	3/12	5/20
1.1.1.2.1	Writing Budget and Cost section for Chapter 2	9 wks	2/26	4/29	2/26	4/29
1.1.1.1.3	Writing Project Planning section for Chapter 1	9 wks	5/7	7/8	5/21	7/22
1.1.1.2.2	Writing Scheduling section for Chapter 2	5 wks	4/30	6/3	4/30	6/3
1.1.1.2.3	Writing Project Controls section for Chapter 2	7 wks	6/4	7/22	6/4	7/22
1.1.1.3.1.	Writing Auditing section for Chapter 3	2 wks	7/23	8/5	7/30	8/12
1.1.1.3.2	Writing Administrative Closeout section for Chapter 3	1 wk	8/6	8/12	8/13	8/19
1.1.2.1	Editing Chapter 1	8 wks	7/9	9/2	7/23	9/16
1.1.2.2	Editing Chapter 2	8 wks	7/23	9/16	7/23	9/16
1.1.2.3	Editing Chapter 3	4 wks	8/13	9/9	8/20	9/16
1.1.3	Publishing Project Management Book	4 wks	9/17	10/14	9/17	10/14
1.1	Finish Development of the Project Management Book	0 wks	10/14	10/14	10/14	10/14

Now it is time to use the information from the Backward Pass to determine the project's critical path.

The Critical Path tells you the activities that <u>cannot</u> slip a day without increasing the total duration of the project or moving the project completion date. The critical path is the longest path of logically related activities through the network which <u>cannot</u> slip without impacting the total project duration.

WBS	Activity	Duration	ES	EF	LS	LF
1.1	Start Development of Project Management Book	0 wks	1/1	1/1	1/1	1/1
1.1.1.1.1	Writing Project Selection section for Chapter 1	8 wks	1/1	2/25	1/1	2/25
1.1.1.1.2	Writing Project Organization section for Chapter 1	10 wks	2/26	5/6	3/12	5/20
1.1.1.2.1	Writing Budget and Cost section for Chapter 2	9 wks	2/26	4/29	2/26	4/29
1.1.1.1.3	Writing Project Planning section for Chapter 1	9 wks	5/7	7/8	5/21	7/22
1.1.1.2.2	Writing Scheduling section for Chapter 2	5 wks	4/30	6/3	4/30	6/3
1.1.1.2.3	Writing Project Controls section for Chapter 2	7 wks	6/4	7/22	6/4	7/22
1.1.1.3.1.	Writing Auditing section for Chapter 3	2 wks	7/23	8/5	7/30	8/12
1.1.1.3.2	Writing Administrative Closeout section for Chapter 3	1 wk	8/6	8/12	8/13	8/19
1.1.2.1	Editing Chapter 1	8 wks	7/9	9/2	7/23	9/16
1.1.2.2	Editing Chapter 2	8 wks	7/23	9/16	7/23	9/16
1.1.2.3	Editing Chapter 3	4 wks	8/13	9/9	8/20	9/16
1.1.3	Publishing Project Management Book	4 wks	9/17	10/14	9/17	10/14
1.1	Finish Development of the Project Management Book	0 wks	10/14	10/14	10/14	10/14

Let's look at calculating the critical path on the following page.

The Critical Path is calculated as follows:

Late Finish date (LF) - Early Finish date (EF)

- If the difference is Zero, then the activity is on the critical path.

- If the result is a number greater the zero, then the activity is not on the critical path and has float.

To better understand critical path, look at the chart. Note a column was added to calculate float and determine the critical path. From reviewing the chart, what activities are on the critical path?

WBS	Activity	Duration	ES	EF	LS	LF	Float
1.1	Start Development of Project Management Book	0 wks	1/1	1/1	1/1	1/1	0
1.1.1.1.1	Writing Project Selection section for Chapter 1	8 wks	1/1	2/25	1/1	2/25	0
1.1.1.1.2	Writing Project Organization section for Chapter 1	10 wks	2/26	5/6	3/12	5/20	14
1.1.1.2.1	Writing Budget and Cost section for Chapter 2	9 wks	2/26	4/29	2/26	4/29	0
1.1.1.1.3	Writing Project Planning section for Chapter 1	9 wks	5/7	7/8	5/21	7/22	14
1.1.1.2.2	Writing Scheduling section for Chapter 2	5 wks	4/30	6/3	4/30	6/3	0
1.1.1.2.3	Writing Project Controls section for Chapter 2	7 wks	6/4	7/22	6/4	7/22	0
1.1.1.3.1.	Writing Auditing section for Chapter 3	2 wks	7/23	8/5	7/30	8/12	7
1.1.1.3.2	Writing Administrative Closeout section for Chapter 3	1 wk	8/6	8/12	8/13	8/19	7
1.1.2.1	Editing Chapter 1	8 wks	7/9	9/2	7/23	9/16	14
1.1.2.2	Editing Chapter 2	8 wks	7/23	9/16	7/23	9/16	0
1.1.2.3	Editing Chapter 3	4 wks	8/13	9/9	8/20	9/16	7
1.1.3	Publishing Project Management Book	4 wks	9/17	10/14	9/17	10/14	0
1.1	Finish Development of the Project Management Book	0 wks	10/14	10/14	10/14	10/14	0

All the activities with zero float are on the Critical Path!!!! But what exactly does this mean? Take a look on the next page.

The Critical Path tells management the activities that are critical or essential in completing the project on time. It is also important for management to look at activities with minor float because any delays in those activities could cause them to be on the critical path.
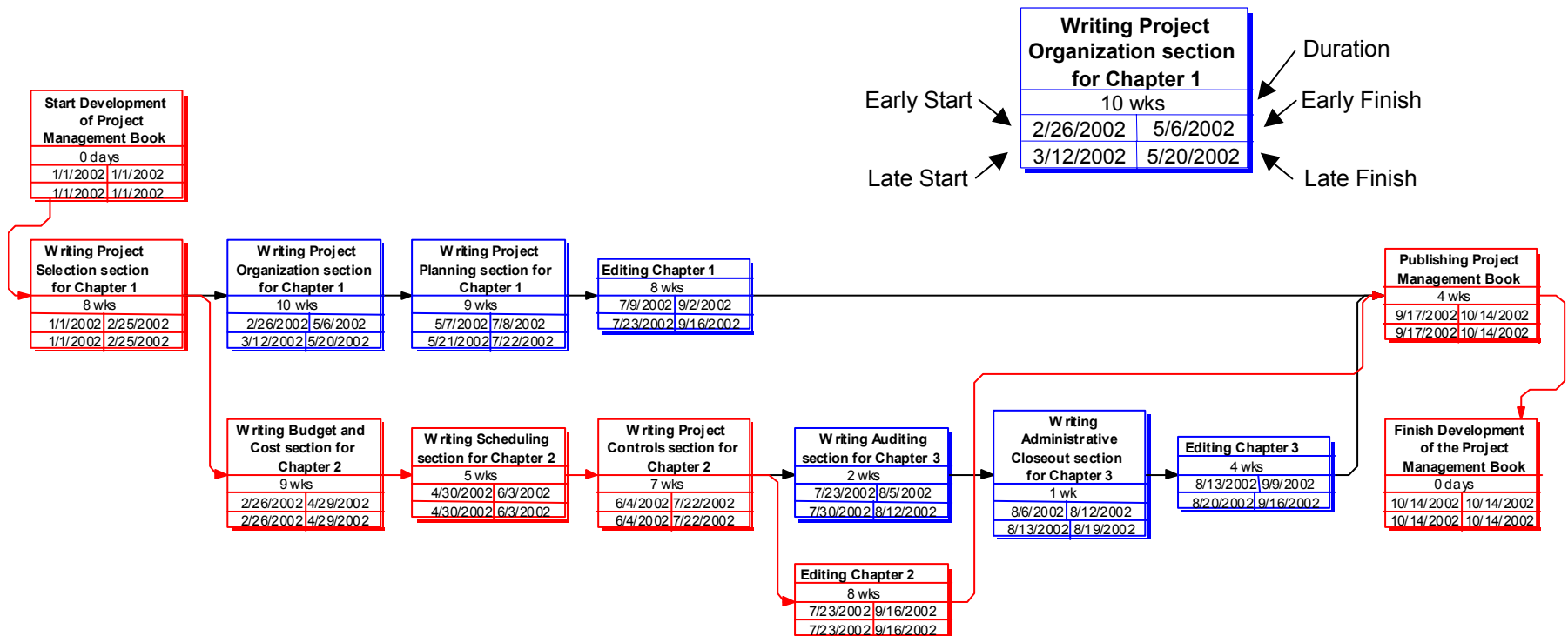
WBS	Activity	Duration	ES	EF	LS	LF	Float
1.1	Start Development of Project Management Book	0 wks	1/1	1/1	1/1	1/1	0
1.1.1.1.1	Writing Project Selection section for Chapter 1	8 wks	1/1	2/25	1/1	2/25	0
1.1.1.1.2	Writing Project Organization section for Chapter 1	10 wks	2/26	5/6	3/12	5/20	14
1.1.1.2.1	Writing Budget and Cost section for Chapter 2	9 wks	2/26	4/29	2/26	4/29	0
1.1.1.1.3	Writing Project Planning section for Chapter 1	9 wks	5/7	7/8	5/21	7/22	14
1.1.1.2.2	Writing Scheduling section for Chapter 2	5 wks	4/30	6/3	4/30	6/3	0
1.1.1.2.3	Writing Project Controls section for Chapter 2	7 wks	6/4	7/22	6/4	7/22	0
1.1.1.3.1.	Writing Auditing section for Chapter 3	2 wks	7/23	8/5	7/30	8/12	7
1.1.1.3.2	Writing Administrative Closeout section for Chapter 3	1 wk	8/6	8/12	8/13	8/19	7
1.1.2.1	Editing Chapter 1	8 wks	7/9	9/2	7/23	9/16	14
1.1.2.2	Editing Chapter 2	8 wks	7/23	9/16	7/23	9/16	0
1.1.2.3	Editing Chapter 3	4 wks	8/13	9/9	8/20	9/16	7
1.1.3	Publishing Project Management Book	4 wks	9/17	10/14	9/17	10/14	0
1.1	Finish Development of the Project Management Book	0 wks	10/14	10/14	10/14	10/14	0

Let's look at the table above in a PERT chart format.

Below is the PERT chart layout of the project. The boxes in red indicate those activities on the critical path. The blue boxes are for all other activities. Notice the information in the boxes, it shows the activity name, duration, early start and finish, and late start and finish. See the legend below for details.

Legend box:

Writing Project Organization section for Chapter 1	
10 wks	
2/26/2002	5/6/2002
3/12/2002	5/20/2002

Early Start → 2/26/2002, Late Start → 3/12/2002, Duration → 10 wks, Early Finish → 5/6/2002, Late Finish → 5/20/2002

Start Development of Project Management Book
0 days	
1/1/2002	1/1/2002
1/1/2002	1/1/2002

Writing Project Selection section for Chapter 1
8 wks	
1/1/2002	2/25/2002
1/1/2002	2/25/2002

Writing Project Organization section for Chapter 1
10 wks	
2/26/2002	5/6/2002
3/12/2002	5/20/2002

Writing Project Planning section for Chapter 1
9 wks	
5/7/2002	7/8/2002
5/21/2002	7/22/2002

Editing Chapter 1
8 wks	
7/9/2002	9/2/2002
7/23/2002	9/16/2002

Publishing Project Management Book
4 wks	
9/17/2002	10/14/2002
9/17/2002	10/14/2002

Writing Budget and Cost section for Chapter 2
9 wks	
2/26/2002	4/29/2002
2/26/2002	4/29/2002

Writing Scheduling section for Chapter 2
5 wks	
4/30/2002	6/3/2002
4/30/2002	6/3/2002

Writing Project Controls section for Chapter 2
7 wks	
6/4/2002	7/22/2002
6/4/2002	7/22/2002

Writing Auditing section for Chapter 3
2 wks	
7/23/2002	8/5/2002
7/30/2002	8/12/2002

Writing Administrative Closeout section for Chapter 3
1 wk	
8/6/2002	8/12/2002
8/13/2002	8/19/2002

Editing Chapter 3
4 wks	
8/13/2002	9/9/2002
8/20/2002	9/16/2002

Finish Development of the Project Management Book
0 days	
10/14/2002	10/14/2002
10/14/2002	10/14/2002

Editing Chapter 2
8 wks	
7/23/2002	9/16/2002
7/23/2002	9/16/2002

Now that we have covered the entire process with the BEST Management project in detail, let's apply it to the ACME House Building project from Module 2. It reveals the following information:

Project Duration:
55 days

Project Start:
1/15

Project Complete:
4/1

WBS	Activity	Duration	ES	EF	LS	LF	Float
1.1	Start House Construction	0 days	1/15	1/15	1/15	1/15	0
1.1.1.1	Pour foundation	6 days	1/15	1/22	1/15	1/22	0
1.1.1.2	Install Patio	6 days	1/23	1/30	3/21	3/28	57
1.1.1.3	Pour stairway	2 days	1/31	2/1	3/29	4/1	59
1.1.1	Concrete Complete	0 days	2/1	2/1	4/1	4/1	59
1.1.2.1	Frame exterior walls	13 days	1/23	2/8	1/23	2/8	0
1.1.2.2	Frame interior walls	7 days	2/11	2/19	2/11	2/19	0
1.1.2.3	Install roofing trusses	4 days	2/20	2/25	2/20	2/25	0
1.1.2	Framing Complete	0 days	2/25	2/25	2/26	2/26	1
1.1.3.1	Install waterlines	7 days	2/20	2/28	2/25	3/5	5
1.1.3.2	Install gas lines	3 days	2/22	2/26	3/1	3/5	7
1.1.3.3	Install B/K fixtures	5 days	3/1	3/7	3/26	4/1	25
1.1.3	Plumbing Complete	0 days	3/7	3/7	4/1	4/1	25
1.1.4.1	Install wiring	5 days	2/20	2/26	2/27	3/5	7
1.1.4.2	Install outlets/switches	3 days	3/22	3/26	3/22	3/26	0
1.1.4.3	Install fixtures	4 days	3/27	4/1	3/27	4/1	0
1.1.4	Electrical Complete	0 days	4/1	4/1	4/1	4/1	0
1.1.5.1	Install drywall	7 days	3/6	3/14	3/6	3/14	0
1.1.5.2	Painting	5 days	3/15	3/21	3/15	3/21	0
1.1.5.3	Install Carpeting	2 days	3/22	3/25	3/29	4/1	7
1.1.5	Interior Complete	0 days	3/25	3/25	4/1	4/1	7
1.1.6.1	Install felt	4 days	2/26	3/1	2/26	3/1	0
1.1.6.2	Install shingles	2 days	3/4	3/5	3/4	3/5	0
1.1.6.3	Install vents	3 days	3/6	3/8	3/12	3/14	6
1.1.6	Roofing Complete	0 days	3/8	3/8	3/15	3/15	7
1.1	House Complete	0 days	4/1	4/1	4/1	4/1	0

As mentioned early in the module, the earned value management system schedule must:

- Include logical ties for all activities
- Include all key milestones and deliverables
- Reflect the agreed to project baseline
- Integrate with the cost baseline

At this point, we have examined the first two bullets; the next step in our process is to reflect the schedule baseline. Take a moment now to familiarize yourself with this step on the next page.

Baseline is the original approved plan that consists of both schedule and cost. The baseline is used as the foundation for measuring project performance. In an Earned Value Management System (EVMS), the schedule and cost baseline are essential.

The Schedule Baseline is the standard that all schedule performance will be measured against. It should be approved by the project manager and other appropriate individuals. Once the project manager approved the project start, logic, relationships and project duration, the schedule is then "baselined" to measure schedule performance.

The final step, integrating with the cost baseline, will be discussed in detail in the next module. For now, take a look at the types of scheduling formats on the next page.
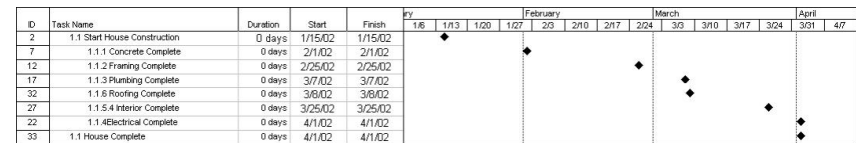
In reporting and displaying your schedule, there are multiple formats that have and can be used. We focus on three major formats:
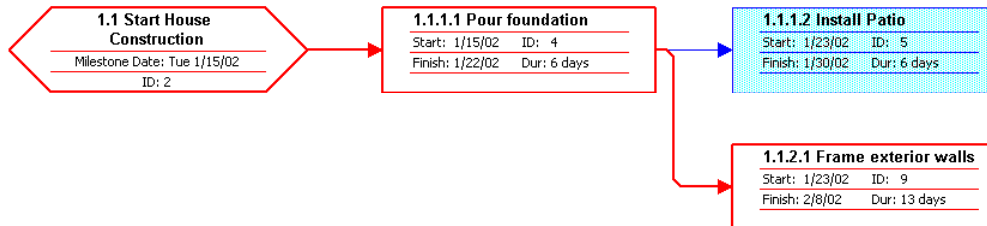
### Gantt or Bar Chart
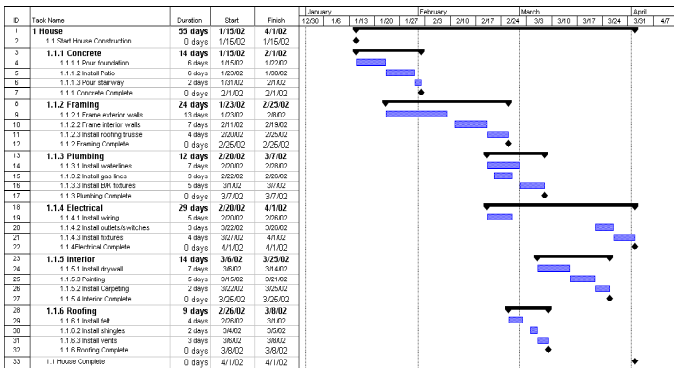
Milestone or Event Charts

Logic or Network Diagram

Gantt or Bar chart shows the activity start and end dates as well as the expected durations. It does not usually show dependencies between tasks. It is a weak planning tool but is good for tracking and reporting progress to the project team. Below is a copy of the Gantt chart for the ACME House Building project.

Prepared by: Booz Allen Hamilton
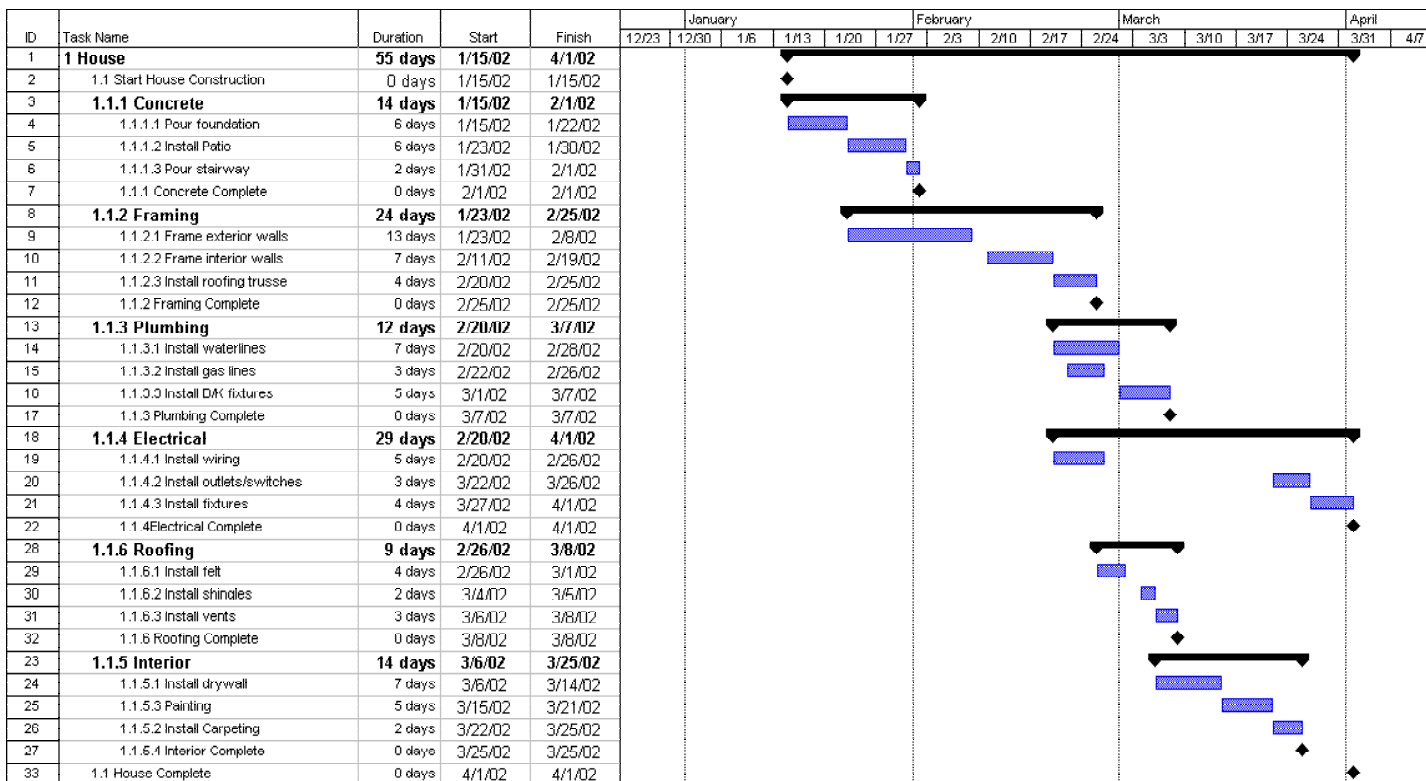
Milestone or Event Charts are a summary-level schedule which identifies the major milestones on a project. It is easy to understand and good for reporting to senior management, but it provides no progress information. Below is a copy of the Milestone chart for the ACME House Building project.

ID	Task Name	Start	Finish	1/6	1/13	1/20	1/27	2/3	2/10	2/17	2/24	3/3	3/10	3/17	3/24	3/31	4/7
2	1.1 Start House Construction	1/15/02	1/15/02		◆												
7	1.1.1 Concrete Complete	2/1/02	2/1/02					◆									
12	1.1.2 Framing Complete	2/25/02	2/25/02								◆						
17	1.1.3 Plumbing Complete	3/7/02	3/7/02										◆				
32	1.1.6 Roofing Complete	3/8/02	3/8/02										◆				
27	1.1.5.4 Interior Complete	3/25/02	3/25/02												◆		
22	1.1.4 Electrical Complete	4/1/02	4/1/02													◆	
33	1.1 House Complete	4/1/02	4/1/02													◆	

The Logic or Network Diagram displays the logic relationships of the project activities. It stresses the logic/interdependencies between activities and is excellent for reviewing project logic. It is not a good reporting format, because the time frame is not clear and can at times be confusing. Below is a partial copy of the Network Diagram for the ACME House Building project.
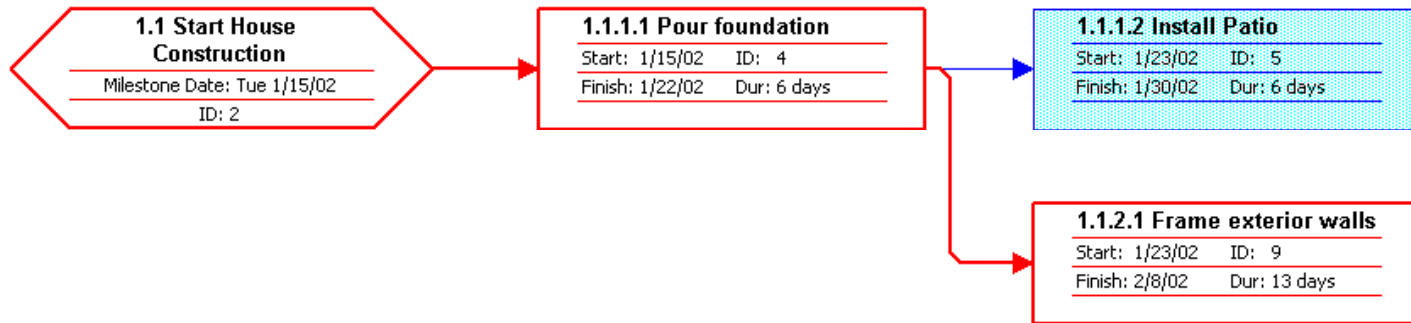
At this point, you have covered all of the content in Module 3. Take some time now to review the major items:

- Planning involves making decisions with the objective of influencing the future. Planning is the "thinking" phase.

- Scheduling is the development of planned dates for performing project activities and meeting milestones. Scheduling is the "doing" phase.

- A clear five step process delineates how to develop a project schedule:
  - Develop a list of project activities
  - Sequence the list of project activities
  - Determine the relationship between each activities
  - Establish the duration for each activity
  - Determine project duration (start and completion dates)

- The Critical Path tells you the activities that can not slip a day without increasing the total duration of the project or moving the project completion date. It is the longest path of logically related activities through the network which cannot slip without impacting the total project duration, termed zero float.

- The Schedule Baseline is what all schedule performance will be measured against. It should be approved by the project manager and other appropriate individuals.

At this point we have examined the basics for developing a project schedule and schedule baseline. The Schedule Baseline is one of the two most important items in an earned value management system (EVMS). In the next module you will examine the other important item in an earned value management system (EVMS): the cost baseline.

If you have a firm grasp of the concepts covered in this module, feel free to progress to the next module. Otherwise, review this module to ensure you have a solid understanding of the basics for developing a project schedule.

This concludes Module 3.