

**Earned Value Management Tutorial
Module 2: Work Breakdown Structure**

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Module 2: Work Breakdown Structure

Welcome to Module 2. The objective of this module is to introduce you to Work Breakdown Structure (WBS) and other supporting documents.

This module will include defining and illustrating the following topics:

- Work Breakdown Structure
- WBS dictionary
- Organizational Breakdown Structure (OBS)
- Responsibility Assignment Matrix (RAM)



What is a Work Breakdown Structure?

Planning a project using earned value management is no different than the initial planning necessary to implement any given project. There are basic items that you need to know and understand as a project manager:

- What makes up my entire project (Scope)?
 - What is the agreed upon work scope and what is additional work?
- What are my start and completion dates (Schedule)?
- How much is the project going to cost (Cost)?

Over the years, it was determined that project managers needed a tool to help capture and control their project scope. This led to the development of a Work Breakdown Structure (WBS).

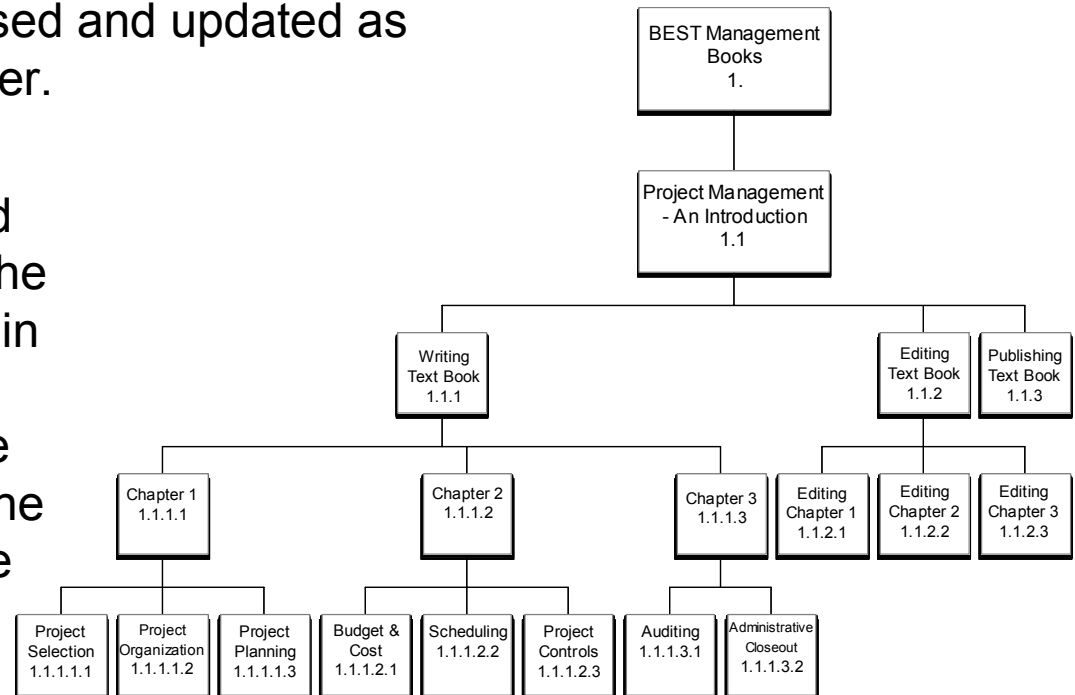
On the following pages we will define and discuss a WBS.



What is a Work Breakdown Structure?

The Work Breakdown Structure (WBS) is a tool that defines a project and groups the project's discrete work elements in a way that helps organize and define the total work scope of the project. A WBS element may be a product, data, a service, or any combination. WBS also provides the necessary framework for detailed cost estimating and control along with providing guidance for schedule development and control. Additionally the WBS is a dynamic tool and can be revised and updated as needed by the project manager.

Each descending level of the WBS represents an increased level of detailed definition of the project work. As you can see in this WBS for developing the BEST Management Book, the work is broken down into all the discrete elements of work, the total sum of which represents all the work and products necessary to produce the book.

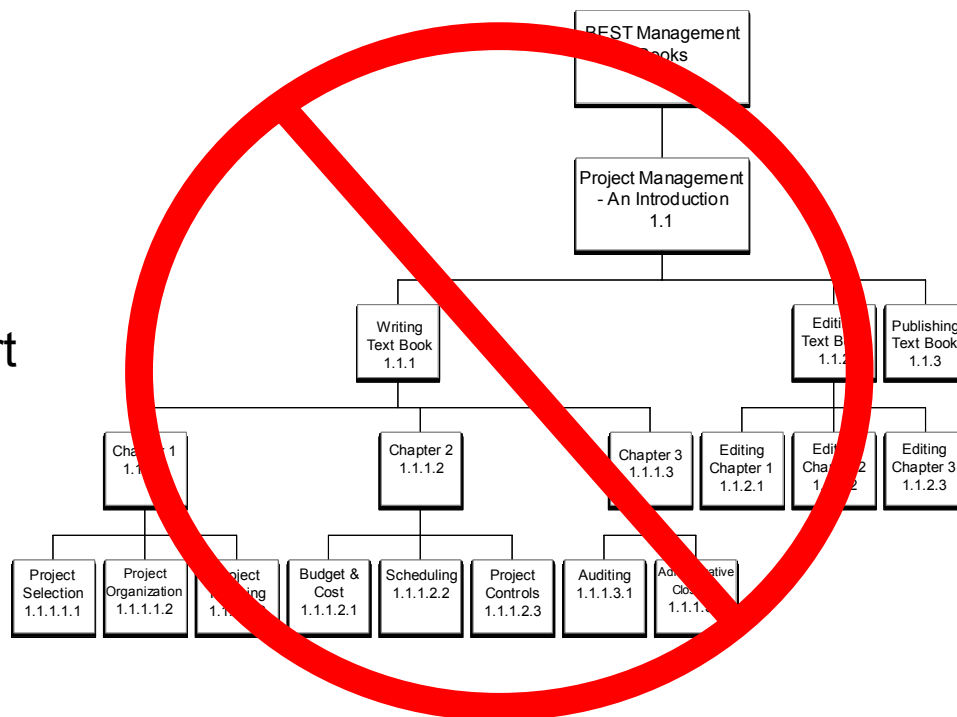




What is a Work Breakdown Structure?

After reviewing the WBS on the previous page, an important point needs to be reviewed. Although a WBS can be depicted so as to look like an organizational chart, it **IS NOT** an organizational chart.

Remember the WBS defines a project and groups the project elements for managing a project. An organizational chart describes the project team that will accomplish the project.





Why is a Work Breakdown Structure needed?

Not all projects have a WBS, and it is true that some of these projects have been successful. So why is a WBS needed? We have already looked at a few reasons, but in review, the WBS:

- Provides a framework for organizing and managing the approved project scope
- Helps ensure you have defined all the work that makes up the project
- Provides a framework for planning and controlling cost and schedule information
- It's better to be deliberate about planning than rely on luck!

Additionally, when you work for a company or organization that has many projects being performed simultaneously, each of the projects is competing for the limited resources available. The WBS enables you to review project details and distinguish one project's needs from others within the company or organization. Why is distinguishing one project from another important? It enables you to identify resource requirements and allocate resources more effectively.

Now let's look at preparing a WBS.



Preparing a WBS

In preparing a WBS there are a number of steps that need to be taken to make sure the WBS developed will help manage your project. Below and on the following pages we will discuss these steps.

1. Identify final project products necessary for achieving project success. The WBS should assist the project manager in developing a clear vision of the end product. You need to answer the following question:
 - What must be delivered to achieve project success?
 - You may need to review the project scope documents for guidance.
2. Identify the major deliverables necessary for project success.
 - These are items that by themselves do not satisfy the project need but combined make up a successful project
 - Examples: a design completion, generator delivery, or acceptance test completion
 - In the DOE, these could be Critical Decisions (see DOE Order 413.3)



Preparing a WBS

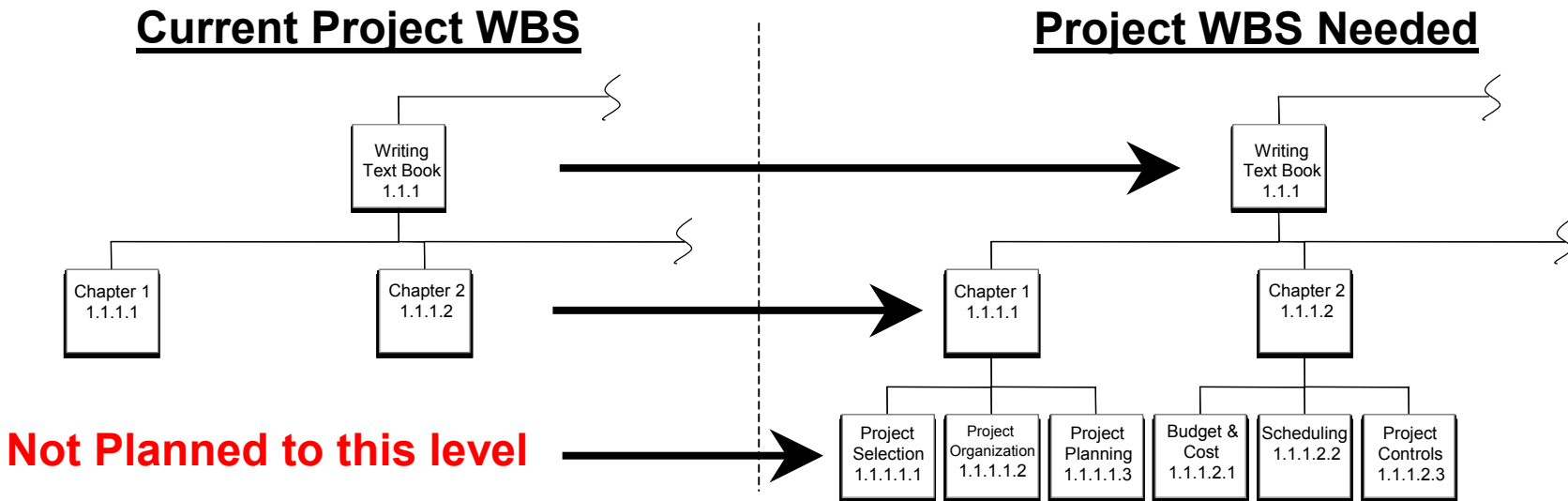
3. Incorporate additional levels of detail until management requirements for managing and controlling the project are met.
 - Remember that each project is different, thus each WBS will be different
 - WBS's from previous projects can be used as templates, but remember that the management philosophy and the level of details may be different from project to project
 - Understand your controlling and reporting requirements
 - Projects have different requirements; make sure you take these into consideration when developing low level details

4. Review and refine the WBS until the stakeholders agree with the level of project planning and reporting.
 - Remember that no matter how detailed a WBS is, there are planning and reporting restrictions a WBS creates. On the following pages, we will look at examples of these restrictions.



Preparing a WBS

Let's use the BEST Management Books' WBS we looked at earlier. Assume that the WBS was only planned down to the chapters level (see graph below, left), but after the first month of work, the stakeholder wants reporting at the subchapter level (see graph below, right). Without restructuring the WBS and changing the other supporting systems, like cost tracking and reporting, it is impossible for the project manager to meet the stakeholder's request.



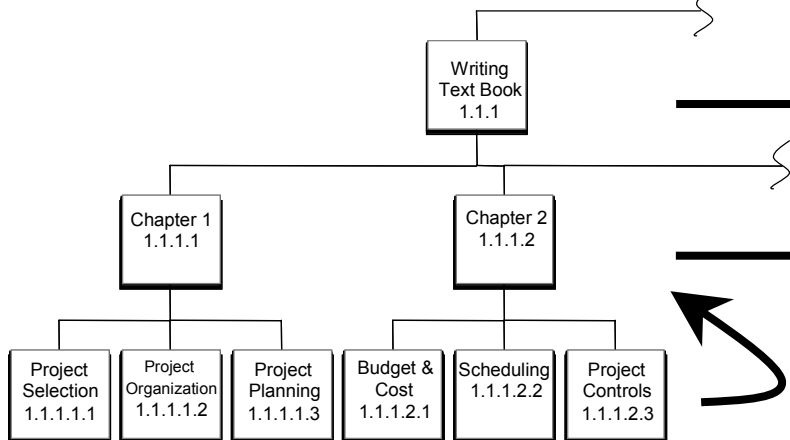


Preparing a WBS

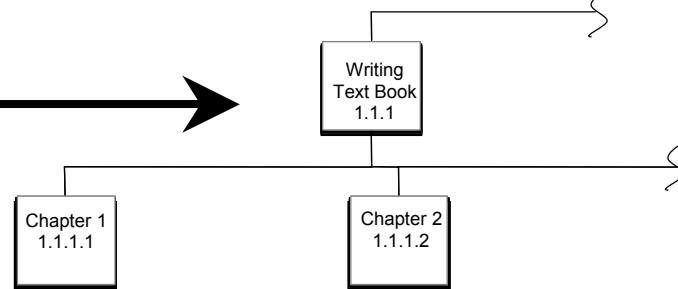
Now let's reverse the situation. Assume WBS was planned down to the subchapter level (see graph below, left), but after the first month of work, the stakeholder wants reporting at the chapter level (see graph below, right). Is there any restructuring needed to the WBS? The answer is "No". Since you planned the work at a level below what is now the stakeholder's requirement, you can "roll-up" and meet the stakeholder's request.

Do you still see a problem with the project WBS? Let's take a look.

Current Project WBS



Project WBS Needed



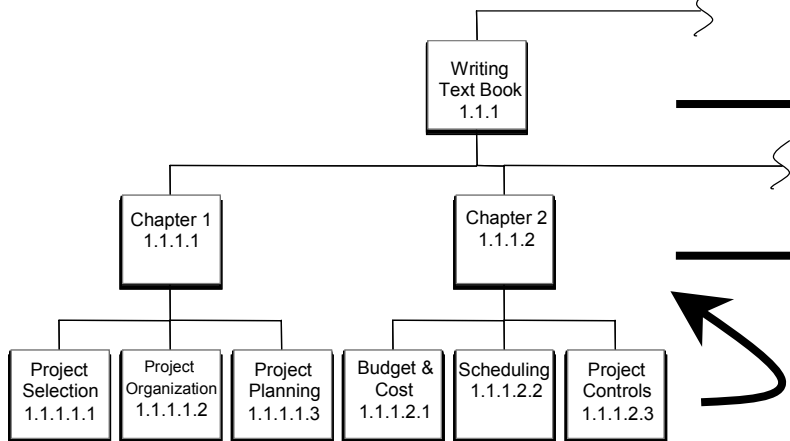


Preparing a WBS

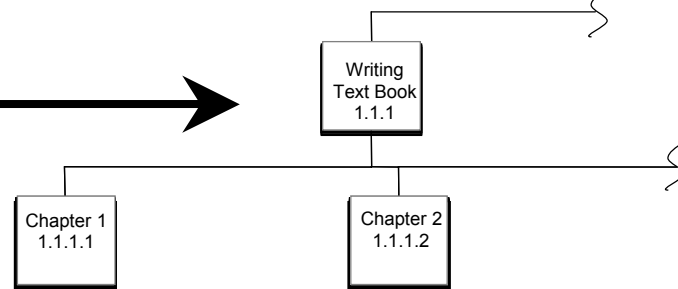
Actually, there is not a problem with the WBS structure, but a problem with the idea of time and cost. The project manager spent time and resources to define the WBS down to a level that he determined was appropriate. The only benefit could be that the project manager wishes to manage the project at the lower level and will roll-up reporting for the stakeholder.

In review, always get stakeholders to agree with the level of project planning and reporting.

Current Project WBS



Project WBS Needed





Preparing a WBS

In developing a WBS, one must realize that there are multiple ways to develop a WBS for any given project. Some ways might be better than others, but the two most important items to remember are that the WBS must contain all approved scope and the Project Manager must develop the WBS to reflect the way he/she intends to manage the project.

Other items to consider when developing a WBS are:

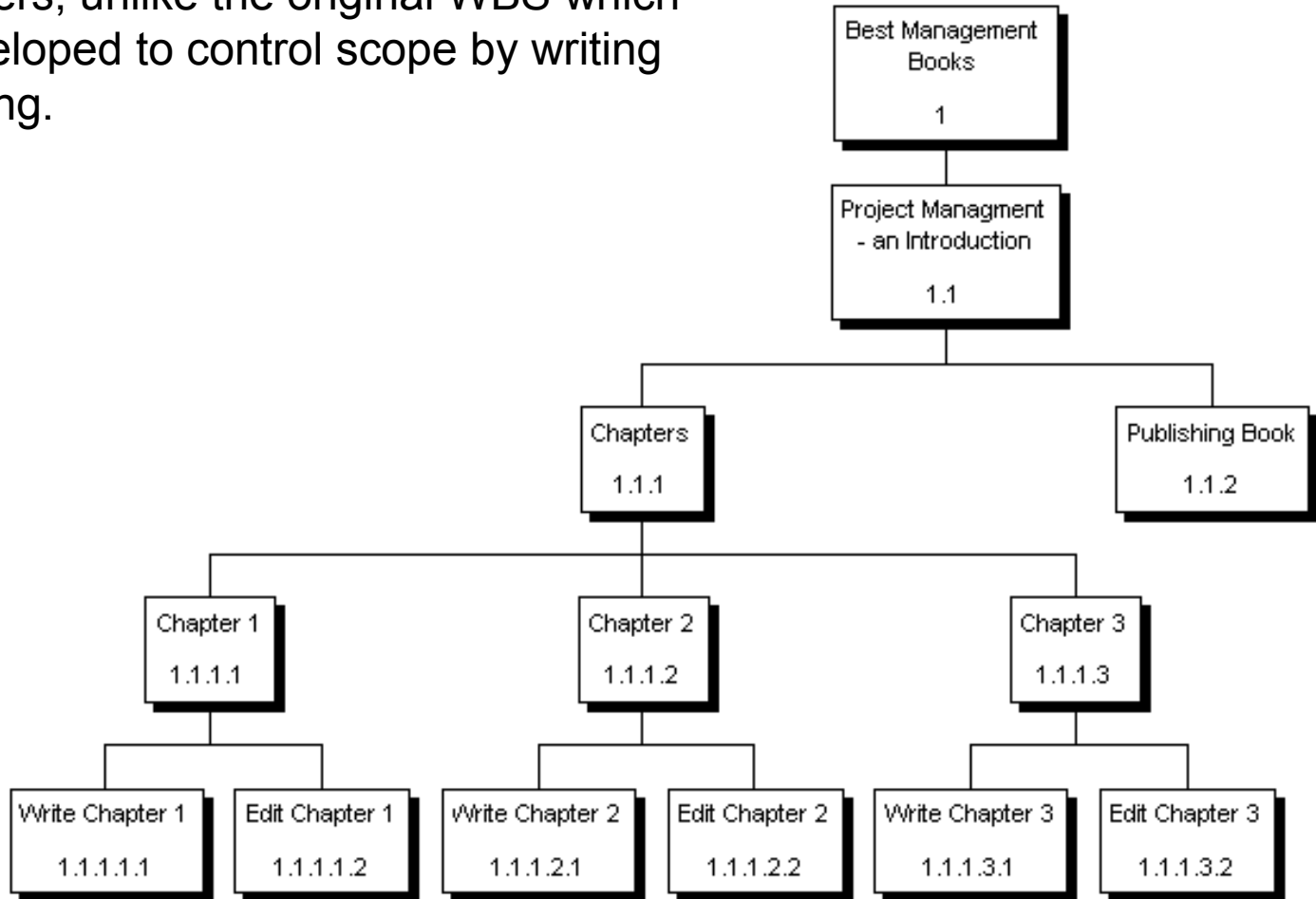
- Reporting requirements
- Size of project
- Resource executing the work (contractors vs. in-house)
- Complexity of the project

On the following two pages are examples of alternative WBS structures for the BEST Management Books project.



Preparing a WBS

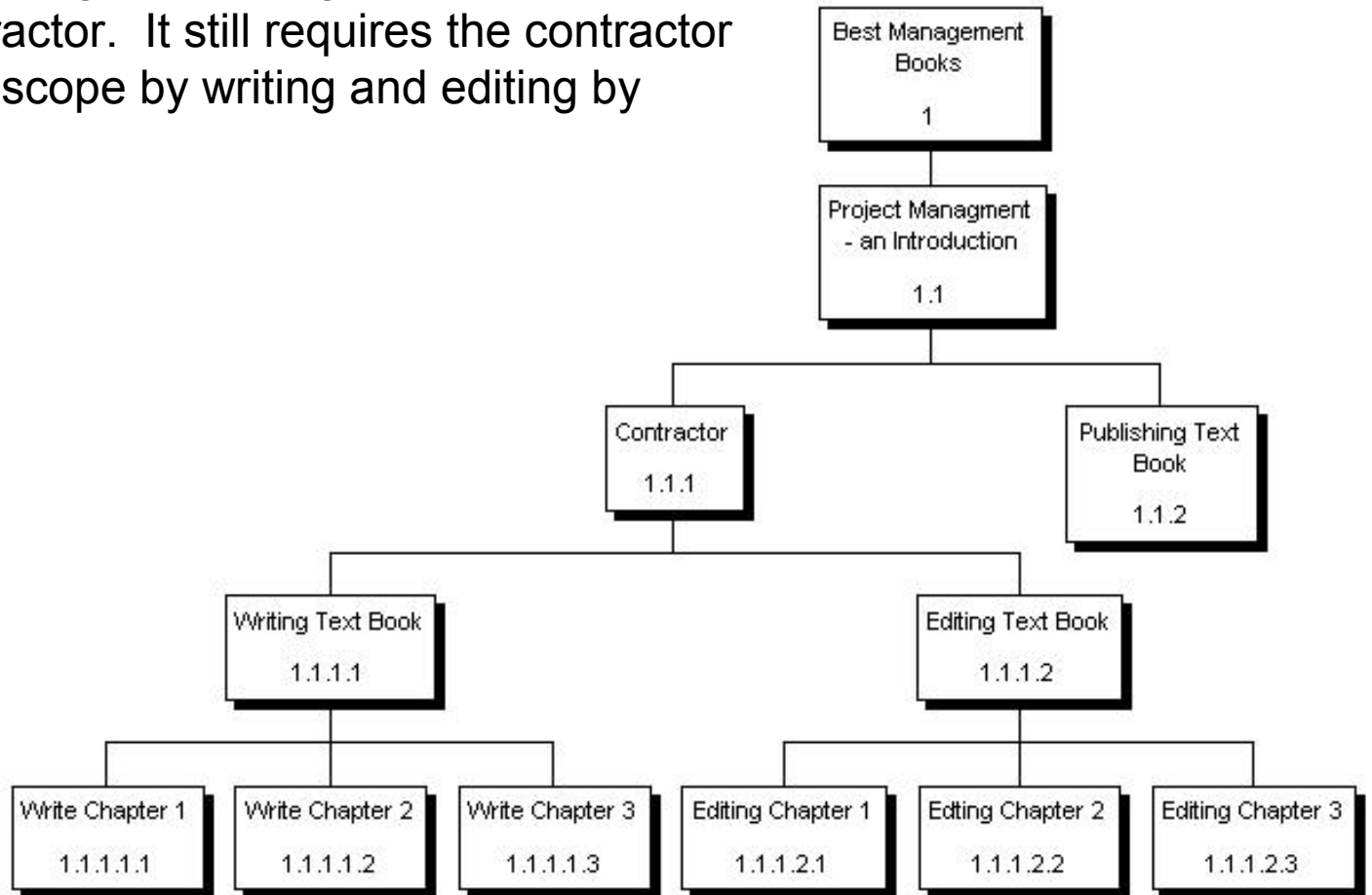
This WBS structure is designed to control scope by chapters, unlike the original WBS which was developed to control scope by writing and editing.





Preparing a WBS

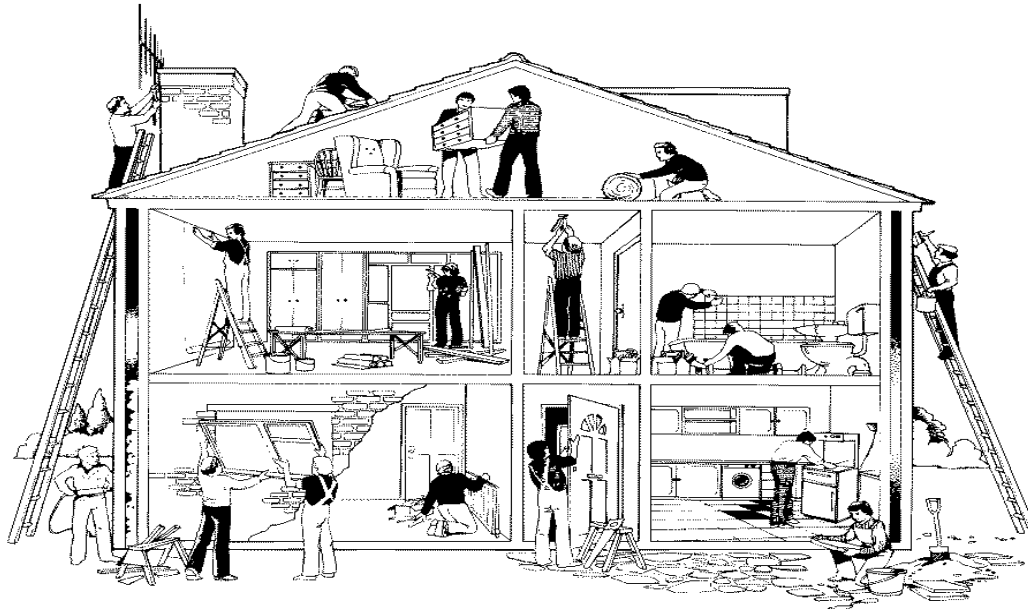
This WBS structure is taking into consideration that the writing and editing will be executed by a contractor. It still requires the contractor to control scope by writing and editing by chapter.





Building a WBS

Armed with the basics of the WBS, it is time to examine them in more detail and to begin to understand how to build one. To do this, let's look at building a WBS for the construction of a single family home. First, take a moment to familiarize yourself with some background information about the construction company, which appears on the next page.





WBS: Structure

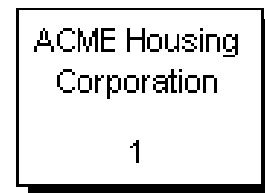
The ACME Housing Corporation, which you own, has been contracted to build its first house. You want to be able to manage your projects effectively and efficiently, so you charge your project managers to develop an appropriate WBS. You decide to manage the project by the individual tasks necessary to complete the house.

You hope that this is the first of many houses that ACME will build, so you start the WBS with ACME in the highest position, or Level 1. Accordingly, Level 1 is given a WBS code of 1. You assign the WBS code of 1 to the highest level because all future projects (houses) will be summarized at Level 1.

NOTE: For ease of explanation, our example will assume the following:

- Design is complete
- All permits issued
- All Material ordered
- Inspection happens

Level 1 →



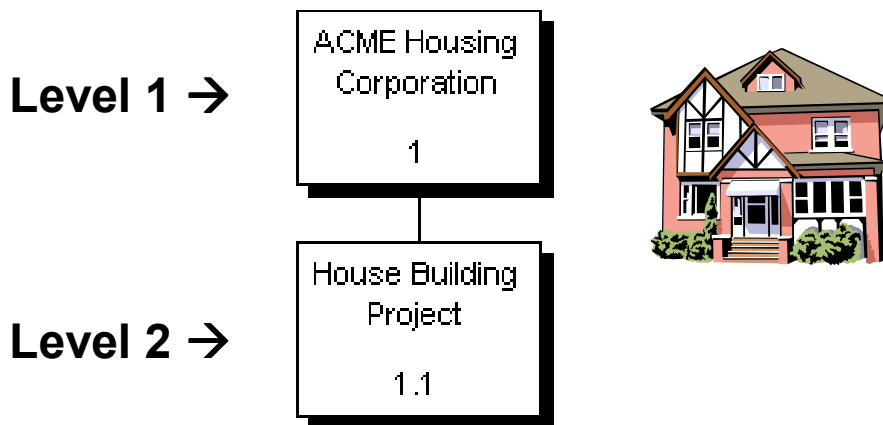


WBS: Structure

With Level 1 established, you can begin to complete the WBS. But what should the next level be?

The logical next level for ACME is the project level. Level 2 is the level for each individual project, or house, that ACME undertakes. As the chart shows below, Level 2 is identified at the project level: House.

Appropriately, the code for Level 2 corresponds to Level 1. In this case, the code is 1.1.

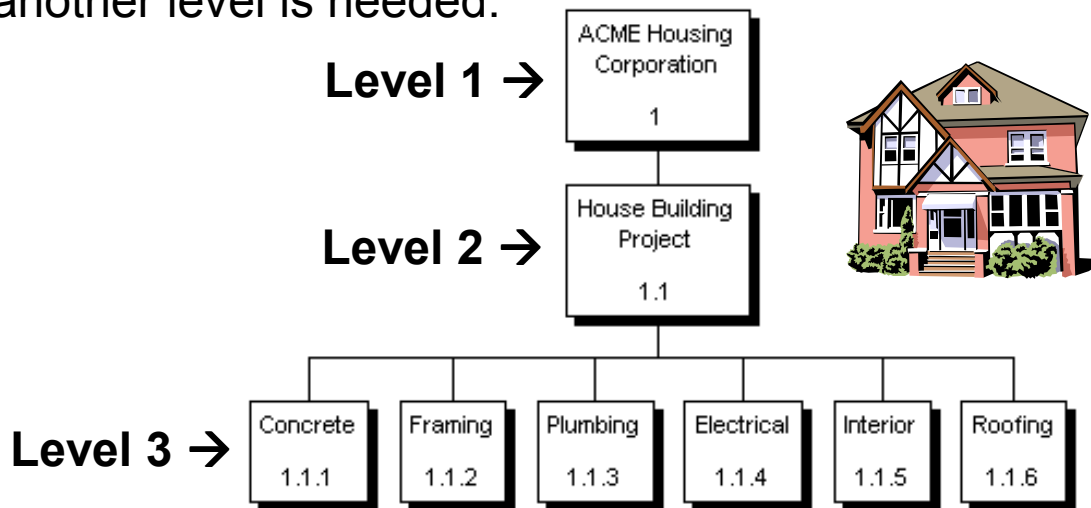




WBS: Structure

Now the WBS for the housing project is complete, right? Actually, no, the WBS is not complete. At this point you determine that you want to divide the work into the major elements needed to build a house. You choose to divide Level 3 into six elements: concrete, framing, plumbing, electrical, interior and roofing. You realize that these are both major deliverables and milestones for managing the project. They also enable you to get to your goal of managing the project by task.

Notice the WBS codes at level 3. Each is unique to the project and starts with the WBS code from the level above (1 → 1.1 → 1.1.1). Now let's look and see if another level is needed.

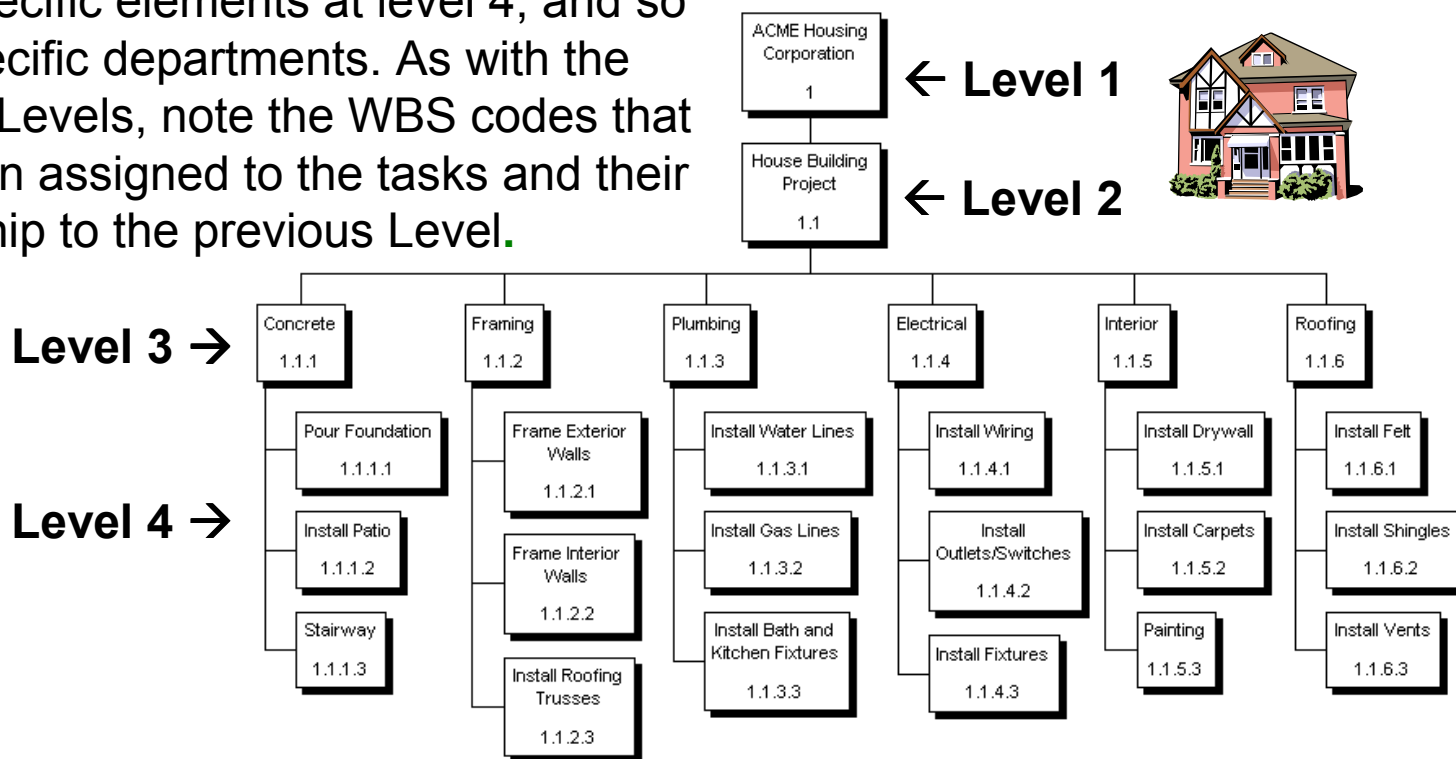




WBS: Structure

The ACME WBS is taking shape, but it does not quite define the project at a level that shows needed tasks for completion. To do this, one more level needs to be included.

Level 4 of the WBS will enable us to manage the project as desired. All of our contractors fit into specific elements at level 4, and so do all specific departments. As with the previous Levels, note the WBS codes that have been assigned to the tasks and their relationship to the previous Level.

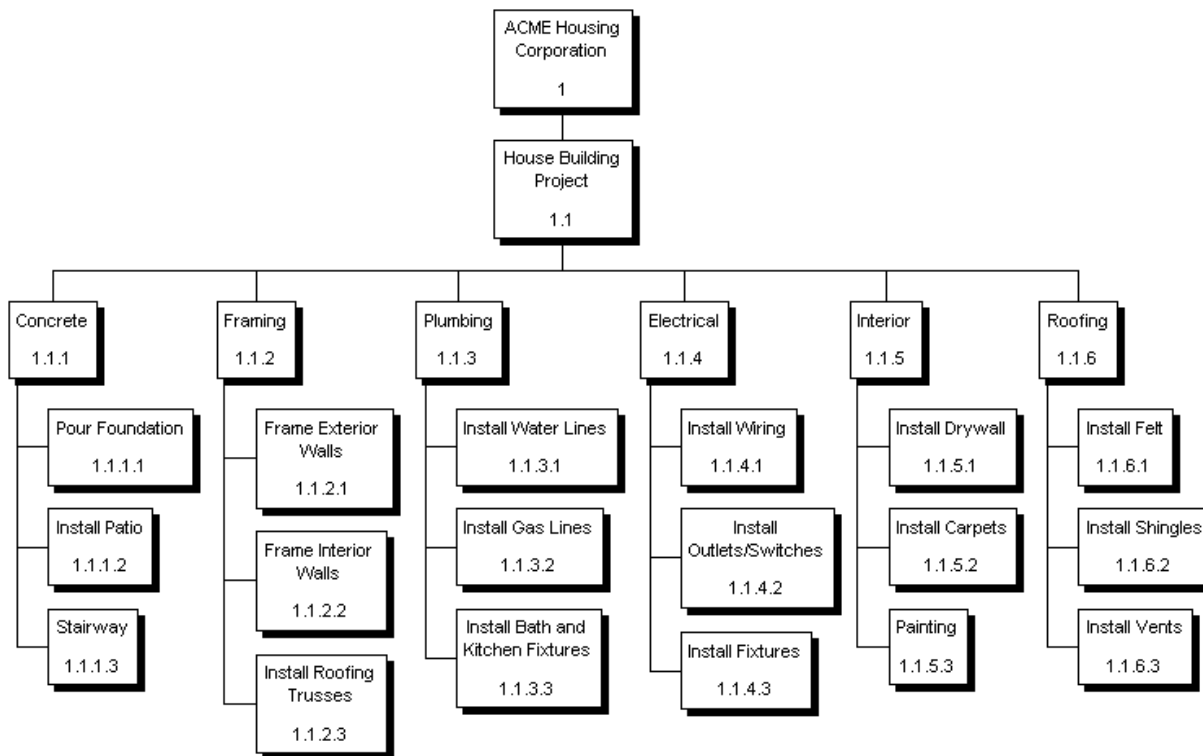




WBS: Structure

What do you think? Is the WBS complete? Does it enable the manager to manage at the task level?

After a review to make sure that only approved scope is included, our WBS is complete. It does include the necessary components to manage the project by task.





Work Breakdown Structure (WBS) Tree

The graphical structure of the WBS is an easy way to identify the project components and relationships of those components; however, the WBS can be displayed in another format as well: the Tree format. Both formats are acceptable. The graphical format is at times easier to understand, but can take up considerable space in a report. The tree is not as easy to understand but is more easily incorporated into a report format.

Note the WBS codes and the structure of the Levels in the Tree format mirror the graphical format. The content has not changed; only the way the content is presented has changed.

1 ACME Housing Corporation

1.1 New Home Construction

1.1.1 Concrete

1.1.1.1 Pour Foundation

1.1.1.2 Install Patio

1.1.1.3 Pour Stairway

1.1.2 Framing

1.1.2.1 Frame Exterior Walls

1.1.2.2 Frame Interior Walls

1.1.2.3 Install Roofing Trusses

1.1.3 Plumbing

1.1.3.1 Install Water Lines

1.1.3.2 Install Gas Lines

1.1.3.3 Install B/K Fixtures

1.1.4 Electrical

1.1.4.1 Install Wiring

1.1.4.2 Install Outlets/Switches

1.1.4.3 Install Fixtures

1.1.5 Interior

1.1.5.1 Install Drywall

1.1.5.2 Install Carpets

1.1.5.3 Painting

1.1.6 Roofing

1.1.6.1 Install Felt

1.1.6.2 Install Shingles

1.1.6.3 Install Vents



WBS and Earned Value

Now that you understand the WBS and how to assemble one, let's examine how it relates to earned value.

In Module 1, we discussed that in implementing earned value, a project manager must have control of the project's "triple constraint" (scope, schedule and cost). Unlike traditional management, which tracks two components (budget and expenditures), earned value considers three and provides a more robust understanding of a project's overall progress and health.

The WBS is the most important item in defining and controlling the project scope. How does it control the scope? If the WBS is not developed correctly and does not capture all the project scope and only the project scope, then the "earned value" system built using the WBS will be inaccurate. The project manager will lose control of the project before it even begins.

Now that you have your WBS, let's take a look on the next page at the other item needed to properly organize your project.



WBS Dictionary

Once the WBS is complete, the WBS dictionary needs to be the next item developed. The WBS dictionary is a narrative documentation of the effort needed to accomplish all work defined in the WBS. The WBS dictionary is developed for the lowest level element in the WBS only.

To better understand how a WBS and a WBS dictionary work, let's compare it to a book and the book's table of contents:

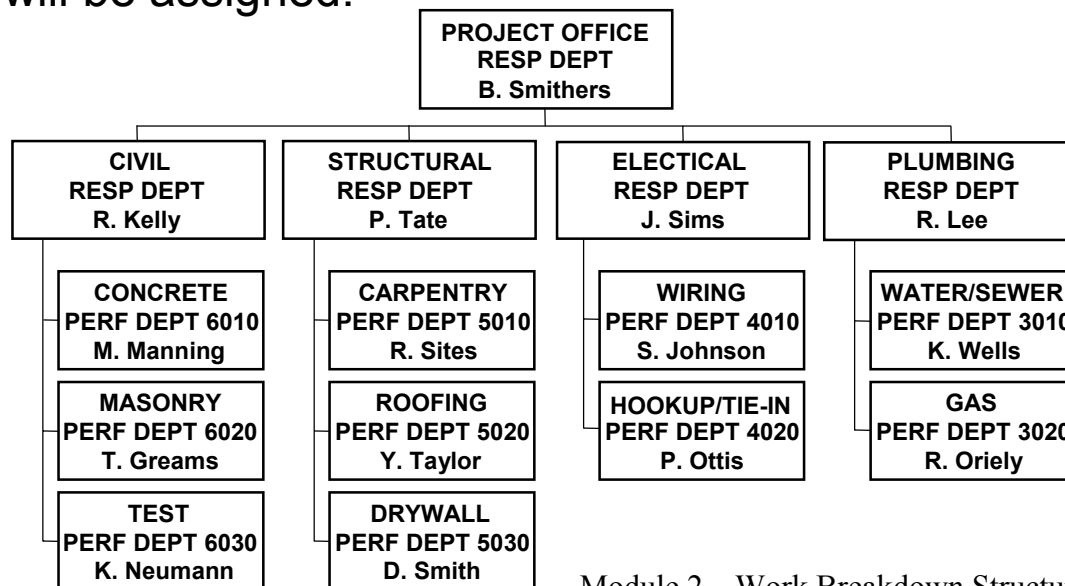
- The WBS is the table of contents for the project. It captures the contents in an organized fashion (chapters, subchapter).
- The WBS dictionary is the book itself. It tells the story. In our case the story is what work will be accomplished and what outputs will be produced in each of the WBS elements. The total of these descriptions is how a house will be built and what is needed to build the house.

The WBS dictionary will often lead to the development of the statements of work (SOW) for the project. SOWs will be discussed in later modules.



Organization Breakdown Structure (OBS)

Now that our WBS is developed, the appropriate resources and responsibilities need to be assigned. The first step in doing this is developing the Organizational Breakdown Structure (OBS) for the project. The OBS indicates the organizational relationships and is used as the framework for assigning work responsibilities. Below is an example of the OBS for the ACME house building project. The OBS is structured by Responsible Department and then by Performing Department at the lowest level. This Performing Department level is where the responsibility and resource needed to accomplish the project will be assigned.

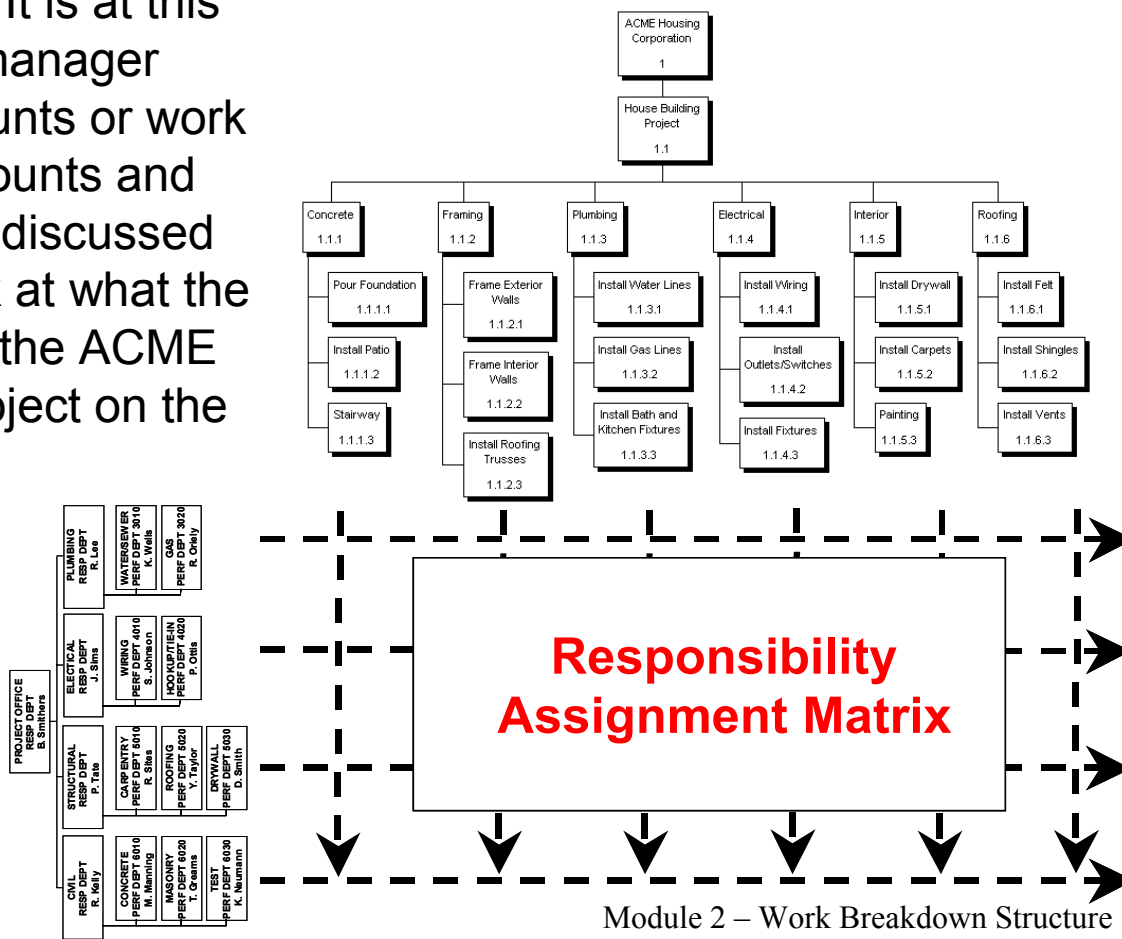


With the relationships and responsibilities defined, the second and final step is to merge the WBS and OBS. Take a look on the next page.



Responsibility Assignment Matrix (RAM)

Merging the WBS and OBS, the project manager creates a Responsibility Assignment Matrix (RAM). The RAM displays the lowest level of both the WBS and the OBS. The integration identifies specific responsibility for specific project tasks. It is at this point that the project manager develops control accounts or work package. Control accounts and work packages will be discussed in Module 4. Lets look at what the RAM may look like on the ACME house construction project on the next page.





Responsibility Assignment Matrix (RAM)

Below is part of the RAM for the ACME housing project.

- The lowest level of the WBS appears across the top
- The lowest level of the OBS appears on the vertical axis

An “X” appears at the intersection of the WBS task and OBS personnel. The “X” defines the specific performing department (from the OBS) assigned to complete a task (from the WBS).

		CONCRETE 1.1.1			FRAMING 1.1.2			PLUMBING 1.1.3		
		Pour Foundation 1.1.1.1	Install Patio 1.1.1.2	Pour Stairway 1.1.1.3	Frame Exterior Walls 1.1.2.1	Frame Interior Walls 1.1.2.2	Install Roofing Trusse 1.1.2.3	Install Water Lines 1.1.3.1	Install Gas Lines 1.1.3.2	Install B/K Fixtures 1.1.3.3
Performing Dept.	Manager									
CONCRETE DEPT 6010	Manning	X	X	X						
MASONRY DEPT 6020	Greams	X								
TEST DEPT 6030	Neumann	X	X	X						
CARPENTRY DEPT 5010	Sites				X	X	X			
ROOFING DEPT 5020	Taylor						X			
DRYWALL DEPT 5030	Smith					X				
WIRING DEPT 4010	Johnson									
HOOKUP/TIE-IN DEPT 4020	Ottis									
WATER/SEWER DEPT 3010	Wells						X		X	
GAS DEPT 3020	Oriely							X	X	



Responsibility Assignment Matrix (RAM)

To better understand the RAM, consider the ACME housing project. The OBS specifies Mr. Sites and the carpentry department as responsible for framing the exterior walls. Therefore, in the RAM, an X appears at the cross-section between the task, framing the exterior walls, and the responsible party, Mr. Sites. Additionally, Mr. Sites is also responsible for framing the interior walls and installing the roofing trusses.

		CONCRETE 1.1.1			FRAMING 1.1.2			PLUMBING 1.1.3		
		Pour Foundation 1.1.1.1	Install Patio 1.1.1.2	Pour Stairway 1.1.1.3	Frame Exterior Walls 1.1.2.1	Frame Interior Walls 1.1.2.2	Install Roofing Trusse 1.1.2.3	Install Water Lines 1.1.3.1	Install Gas Lines 1.1.3.2	Install B/K Fixtures 1.1.3.3
Performing Dept.	Manager									
CONCRETE DEPT 6010	Manning	X	X	X						
MASONRY DEPT 6020	Greams	X								
TEST DEPT 6030	Neumann	X	X	X						
CARPENTRY DEPT 5010	Sites				X	X	X			
ROOFING DEPT 5020	Taylor						X			
DRYWALL DEPT 5030	Smith					X				
WIRING DEPT 4010	Johnson									
HOOKUP/TIE-IN DEPT 4020	Ottis									
WATER/SEWER DEPT 3010	Wells						X		X	
GAS DEPT 3020	Oriely							X	X	



Responsibility Assignment Matrix (RAM)

Alternatively, hours and dollars may be used in the RAM rather than an “X”. Using our ACME House example, the “X” was replaced with the hours needed to complete the task. Now we see that Mr. Sites has 300 hours to frame the exterior walls, 250 hours to frame the interior walls and 175 hours to install the roofing trusses.

		CONCRETE 1.1.1			FRAMING 1.1.2			PLUMBING 1.1.3		
		Pour Foundation 1.1.1.1	Install Patio 1.1.1.2	Pour Stairway 1.1.1.3	Frame Exterior Walls 1.1.2.1	Frame Interior Walls 1.1.2.2	Install Roofing Trusse 1.1.2.3	Install Water Lines 1.1.3.1	Install Gas Lines 1.1.3.2	Install B/K Fixtures 1.1.3.3
Performing Dept.	Manager									
CONCRETE DEPT 6010	Manning	200	125	85						
MASONRY DEPT 6020	Greems	50								
TEST DEPT 6030	Neumann	20	10	5						
CARPENTRY DEPT 5010	Sites				300	250	175			
ROOFING DEPT 5020	Taylor						100			
DRYWALL DEPT 5030	Smith					275				
WIRING DEPT 4010	Johnson									
HOOKUP/TIE-IN DEPT 4020	Ottis									
WATER/SEWER DEPT 3010	Wells							100		15
GAS DEPT 3020	Oriely								125	25



Review of Module 2

Take some time to review the major items of this module:

- The Work Breakdown Structure (WBS) is a tool that defines a project and groups the projects elements in a way that helps organize and define the total work scope of the project
- In preparing a WBS there are a number of steps that need to be taken including:
 - identifying the final project product
 - identifying the major deliverables
 - incorporating the appropriate levels of detail
 - obtaining stakeholder agreement
- WBS Dictionary is a narrative description of the lowest level for each WBS element
- Organizational Breakdown Structure (OBS) indicates the organizational relationships and is used as the framework for assigning work responsibilities
- Responsibility Assignment Matrix (RAM) merges the WBS and OBS to identify the specific responsibility for specific project tasks



Summary of Module 2

At this point we have examined the WBS, OBS and RAM. These items are the start for laying the groundwork for developing an earned value management system (EVMS). In the next module you will examine these item in more detail by looking at the development of the project schedule.

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 WBS, OBS and RAM

This concludes Module 2.