Project Management Institute

Practice Standard for Work Breakdown Structures
Second Edition

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Contents

List of Tables and Figures

Preface to the Second Edition

When the Work Breakdown Structure (WBS) Practice Standard Update Team gathered in April of 2003, the progression of this standard to its current level of advancement could not have been anticipated. To begin the work, the team received the charter for the update process, the original chapters and appendices from the first edition, as well as approximately 450 comments about the content of the document that had been received from readers and project management practitioners since the time of its publication.

While the challenge to update the *Practice Standard for Work Breakdown Structures* initially did not appear particularly difficult, the project team spent a great deal of time planning and developing an appropriate approach. At the time the update was being initiated, the *Practice Standard for Work Breakdown Structures* had achieved widespread popularity across the project management community, and had taken its place beside the *A Guide to the Project Management Body of Knowledge* (*PMBOK® Guide*)—Third Edition as a frequently requested publication available from PMI. Any modifications to this document, therefore, had to be weighed carefully.

With this in mind, the Update Team set in motion a series of discussions, presentations, and interviews designed to surface and accurately illuminate how the WBS is put into play across a broad array of industries today. The resulting conclusions regarding WBS application and practice have now been incorporated into this standard and have been brought together as a "white paper" that accompanies the publication on the *Practice Standard for Work Breakdown Structures*—Second Edition CD-ROM.

From the time the first edition of the *Practice Standard for Work Breakdown Structures* was being developed a little more than five years ago, there has been a vast expansion in rapid electronic access to information through the Internet, CD-ROMS, DVDs, instant messaging, and wireless technology. Knowing that the *WBS Practice Standard* will be delivered into this rapidly evolving communications environment, the Update Team was compelled to consider how this standard would be viewed and used by current and future project management practitioners.

Considering these factors, the Update Team came to understand that what had at first seemed readily achievable was, in fact, considerably more complex and difficult. Team leaders and members alike were convinced the design for the *WBS Practice Standard* would need to reflect not only the progressive application of the WBS in practice today, but must include and incorporate an awareness of the new environment in which it will be used. To ensure this edition met those requirements, the *Practice Standard for Work Breakdown Structures*—Second Edition will now be delivered as a hard copy document as well as a CD-ROM.

Specifically relating to the content of the standard, many of the comments received since the first publication focused on the need for more detail and a broader overall perspective. Many comments included detailed requests for more and varied examples, checklists, job aids, and reference material. The Update Team has taken particular

care to address these comments, while ensuring that material accurately reflects the application of standard practice in the industry. Throughout the standard, the reader will find additional guidance regarding the characteristics that make up a high-quality WBS, as well as considerably more discussion about the use of the WBS in real-life practical situations. Additionally, many of the checklists, sets of questions, and sectional examples have been extracted, reformatted, and placed in the appendices as individual elements that can be used as job aids and guides for developing a WBS.

The *Practice Standard for Work Breakdown Structures*—Second Edition provides guidance in the initial generation, subsequent development, and application of the WBS. The *Practice Standard for Work Breakdown Structures*—Second Edition is not, however, a textbook, and it does not provide specific ''how-to'' instructions. The target audience for this standard includes project managers, project team members, contract personnel, and others who participate or have an interest in any aspect of the management of projects or programs. In using this practice standard, it must be recognized that as projects vary, so can the resulting WBSs. There are, however, certain universal principles that this practice standard addresses.

The *Practice Standard for Work Breakdown Structures*—Second Edition is consistent with the *PMBOK® Guide*—Third Edition. The *Practice Standard for Work Breakdown Structures*—Second Edition also includes information derived from accepted project management industry sources. The Project Management Institute's standards program will periodically update the *Practice Standard for Work Breakdown Structures* as part of the planned evolution of its standards. Your comments are invited.

The *Practice Standard for Work Breakdown Structures*—Second Edition is organized as follows:

Chapter 1	Introduction to the Work Breakdown Structure	Introduces the WBS concept.
Chapter 2	Defining the WBS	Defines the WBS and its characteristics. Defines the benefits derived from using a WBS.
Chapter 3	Importance of the WBS	How the WBS fits with other project management practices.
Chapter 4	Defining WBS Quality	Documents the characteristics of a high-quality WBS. Presents guidelines for determining if the WBS is sufficient for subsequent planning and control.
Chapter 5	Considerations while Creating a WBS	Provides guidance and presents questions that can be asked during the development of a WBS to help ensure that the finished product meets all the needs of the project it will serve.
Appendices A–D		Provides background information on the PMI Standards Program and the *Practice Standard for Work Breakdown Structures*—Second Edition project.

Appendices E–P	Provides documented industry examples to aid the reader in further understanding, creating, and using WBSs. Each appendix represents an approach tailored to a specific purpose, application, or industry. Examples are in different stages of completion and represent the evolutionary development of a WBS. None of the examples should be taken as the *only* suitable WBS for that type of project.
Notes	
Glossary	Provides clarification of key terms that exist in the project management profession, including those that have subtle or variable meanings depending on the organization and industry.

Chapter 1

Introduction to the *Practice Standard for Work Breakdown Structures*—Second Edition

1.1 Overview

Successful project management relies on thorough planning. This begins by defining the project objectives with sufficiently detailed information. The Work Breakdown Structure (WBS) provides the foundation for defining work as it relates to project objectives. The WBS also establishes the framework for managing the work to its completion. The remaining sections of this chapter are as follows:

    1.2 Concept
    1.3 Objectives

1.2 Concept

The WBS is used in projects as follows:

- To define the project's scope of work in terms of deliverables and to further decompose these deliverables into components. Depending upon the decomposition method used, the WBS can also define the project's life cycle as well as the deliverables appropriate to the project, program, or portfolio. This project scope decomposition balances management's need for control with representation of an appropriate level of detail in the WBS.
- To provide the project management team with a framework on which to base project status and progress reports.
- To facilitate communication between the project manager and stakeholders throughout the life of the project. The WBS can be used to communicate information regarding the project scope. In combination with additional data, the WBS is the framework for communicating information that includes, but is not limited to, schedule, risk, performance, dependencies, and budget.
- As a key input to other project management processes and deliverables.
    The WBS articulates the project scope. It is considered as critical input to other project management processes and deliverables such as activity definitions, project

schedule network diagrams, project and program schedules, performance reports, risk analysis and response, control tools, or project organization. Moreover, although the WBS is a key input to these project management processes and deliverables, the WBS is not a substitute for any of these on its own.

For the purposes of this *Practice Standard for Work Breakdown Structures*—Second Edition, a project can be defined as focused internally, externally, or both. Additionally, deliverables for these projects can take the form of products, services, achievement of specific objectives, or attainment of goals.

Internally focused projects can produce deliverables as inputs to other project phases, other individuals, or other organizations within the organization sponsoring the project. Externally focused projects typically produce deliverables for people or organizations outside the organization, such as customers or project sponsors. Many projects produce both internally and externally focused deliverables. Regardless of the focus of the project, a WBS should be prepared in all cases.

Developing a WBS is an essential step during the initial project phases; as soon as the basic scope has been identified, the initial WBS can be created with limited scope information. As additional scope information is developed or made available by more complete analysis of the project work to be performed, the WBS can be updated through the formal change control processes. This updating process is known as ''progressive elaboration.''

This practice standard provides insight into the WBS, its development and its application. It is expected that use of the principles found in this standard will enable the user to prepare a valuable, high-quality WBS and put it to work in the course of managing a project, program, or portfolio.

1.3 Objectives

The primary objectives of the *Practice Standard for Work Breakdown Structures*—Second Edition are (1) to provide a common ground for understanding the concepts and benefits of the WBS and (2) to present a standard application of the WBS as a project management tool. The intent is to encourage consistency in applying this tool and, as a result, to improve project planning and control. The *Practice Standard for Work Breakdown Structures*—Second Edition provides guidance in WBS development, based on the *PMBOK® Guide*—Third Edition, and is used by other PMI standards.

Finally, although the *Practice Standard for Work Breakdown Structures*—Second Edition provides guidance in WBS development, it is not intended to be a tutorial on how to create a WBS.

Chapter 2

Defining the WBS

2.1 Overview

A project is made more manageable by breaking it down into individual components that together are known as a Work Breakdown Structure or WBS. Such a structure defines unique work elements that can be arranged and completed in the order defined by the network diagram: sequentially, in parallel, or in the specific order necessary to accomplish project outcomes. It facilitates other project management processes such as estimating, scheduling, resource allocation, risk analysis, and measurement and control of the project. The WBS represents a clear description of the project's deliverables and scope—the "what" of the project. It is *not* a description of a process or schedule that defines how or when the deliverables will be produced, but rather is specifically limited to describing and detailing the project's outcome or scope. As stated in the *PMBOK® Guide*—Third Edition, "The WBS organizes and defines the total scope of the project. The WBS subdivides the project work into smaller, more manageable pieces of work, with each descending level of the WBS representing an increasingly detailed definition of the project work. The planned work contained in the lowest level WBS components, which are called work packages, can be scheduled, cost estimated, monitored, and controlled."

This chapter will provide more information regarding WBS terms, concepts, the 100% Rule, and an example of a good WBS in action. The remaining sections of this chapter include:

2.2 Common Usage of Terms
2.3 Concept
2.4 The 100% Rule
2.5 WBS for Construction of a Bicycle
2.6 Representations of the WBS
2.7 Summary

2.2 Common Usage of Terms

A WBS, as defined in the *PMBOK® Guide*—Third Edition, is: "A deliverable-oriented hierarchical decomposition of the work to be executed by the project team to accomplish the project objectives and create the required deliverables. It organizes and defines the total scope of the project. Each descending level represents an increasingly

detailed definition of the project work. . . .'' The following terms help clarify this dictionary definition:

Work. Sustained physical or mental effort, exertion, or exercise of skill to overcome obstacles and achieve an objective. Commonly used to refer to a specific activity, duty, function, or assignment often being a part or phase of some larger undertaking; something produced or accomplished by effort, exertion, or exercise of skill. In this context, work refers to work products or deliverables that are the result of effort and not to the effort itself.

Breakdown. Division into parts or categories; separation into simpler substances; decomposition.

Structure. Something arranged in a definite pattern of organization.

These dictionary definitions imply that a WBS has the following characteristics:
- Supports the definition of all work required to achieve an objective, tangible result.
- Is constructed to illustrate and define the hierarchy of deliverables. This hierarchy is organized into ''parent-child'' relationships.
- Has an objective or tangible result that is referred to as a deliverable. In a sense, the WBS can be thought of as a ''deliverable'' breakdown structure.

Additionally, as noted above, the WBS is a deliverable-oriented hierarchical decomposition of the work to be executed by the project team. It can thus be defined in the following terms:

Deliverable. Any unique and verifiable product, result, or capability to perform a service that must be produced to complete a process, phase, or project. Often used more narrowly in reference to an external deliverable, which is a deliverable that is subject to approval by the project sponsor or customer.

Oriented. Aligned or positioned with respect to a point or frame of reference; focused toward the concerns and interests of a specific group.

Hierarchical. Classified according to various criteria into successive levels or layers.

Decomposition. A planning technique that subdivides the project scope and project deliverables into smaller, more manageable components, until the project work associated with accomplishing the project scope and providing the deliverables is defined in sufficient detail to support executing, monitoring, and controlling the work.

These definitions work together to define the overall role of the WBS, that is, to provide a foundation for the development of project schedules, communications, risk management plans, as well as other key project elements.

2.2.1 Definition of Terms

The following definitions represent WBS-related terms as defined by the *PMBOK® Guide*—Third Edition. These terms and others listed in the Glossary of this standard facilitate understanding of the integral role the WBS plays in project management practice. Terms are listed here in alphabetical order.

Activity. A component of work performed during the course of a project.

Apportioned Effort. Effort applied to project work that is not readily divisible into discrete efforts for that work, but which is related in direct proportion to measurable discrete work efforts. Contrast with discrete effort.

Control Account. A management control point where scope, budget (resource plans), actual cost, and schedule are integrated and compared to earned value for performance measurement. Control accounts are placed at selected management points (specific components at selected levels) of the work breakdown structure. Each control account may include one or more work packages, but each work package may be associated with only one control account. Each control account is associated with a specific single organizational component in the organizational breakdown structure (OBS). Previously called a cost account. See also *work package*.

Discrete Effort. Work effort that is separate, distinct, and related to the completion of specific work breakdown structure components and deliverables, and that can be directly planned and measured. Contrast with *apportioned effort*.

Level of Effort (LOE). Support-type activity (e.g., seller or customer liaison, project cost accounting, project management, etc.), which does not produce definitive end products. It is generally characterized by a uniform rate of work performance over a period of time determined by the activities supported.

Task. A term for work whose meaning and placement within a structured plan for project work varies by the application area, industry, and brand of project management software.

Work Breakdown Structure Component. An entry in the work breakdown structure that can be at any level.

Work Package. A deliverable or project work component at the lowest level of each branch of the work breakdown structure. The work package includes the schedule activities and schedule milestones required to complete the work package deliverable or project work component. See also *control account*.

The following definition is included to reflect common usage:

WBS Element. Any single work breakdown structure (WBS) component and its associated WBS attributes contained within an individual work breakdown structure.

2.3 Concept

2.3.1 Overview

The WBS assists project leaders, participants, and stakeholders in the development of a clear vision of the end products or outcomes produced by the project. To be more precise, the WBS provides a clear vision of the work of the project. The WBS divides the project scope into hierarchical, manageable, definable packages of work that balance the control needs of management with an appropriate and effective level of detailed project data. The WBS provides the framework for all deliverables across the project life cycle. The various levels of the WBS also provide support for focusing

communication with stakeholders and aid in clearly identifying accountability to a level of detail necessary for effectively managing and controlling the project.

The upper levels of the WBS typically reflect the major deliverable work areas of the project or major phases in the project's life cycle. These levels also provide logical summary points for assessing team and individual performance, communicating accomplishments, and measuring cost and schedule performance with respect to individual deliverables as well as the overall project.

The content of the upper levels can vary, depending upon the type of project and the industry involved. To avoid confusion and rework, it is often prudent to define the levels of the WBS prior to its construction. The lower WBS elements provide appropriate focus for project management processes such as scope and schedule development, cost estimating and resource allocation, and risk assessment.

Whenever work is logically structured, easily identifiable, and clearly within the capabilities of individuals, project stakeholders can confidently expect that objectives associated with the work can and will be achieved. The use of a WBS helps ensure that the project meets these criteria.

2.3.2 Deliverables

The underlying concept of a *deliverable* is the core of a WBS. The *PMBOK® Guide—Third Edition* defines a deliverable as:

> Any unique and verifiable product, result, or capability to perform a service that must be produced to complete a process, phase, or project. Often used more narrowly in reference to an external deliverable, which is a deliverable that is subject to approval by the project sponsor or customer.

The WBS provides the foundation for integrating the work package and intermediate deliverables with all other aspects of project initiation, planning, execution, monitoring and controlling, and closing.

A deliverable-oriented WBS provides many benefits to the project, including the following:
• Better communication to project sponsors, stakeholders, and team members
• More accurate estimation of tasks, risks, timelines, and costs
• Increased confidence that 100% of the work is identified and included
• A foundation for the control processes within the project.

The deliverable concept and deliverable orientation of the WBS are integral to understanding the proper definition and use of the WBS and the benefits it provides within the larger context of all project management processes.

2.3.3 Design

A well-designed WBS that presents information at the appropriate level of detail and in formats and structures meaningful to those performing the work is an invaluable tool in project management. It provides a graphical representation or textual outline of the project scope. Here are some roles the WBS plays in supporting clarity for project definition:
• Decomposes (or disassembles) the overall project scope into deliverables and supports the definition of the work effort required for effective management

- Clearly and comprehensively defines the scope of the project in terms of deliverables that the project participants and stakeholders can understand
- Supports documentation of the accountability and responsibility for the various deliverables by having a direct relationship among the WBS elements related to the Organizational Breakdown Structure (OBS) identified through the Responsibility Assignment Matrix (RAM)
- Provides a structure for organizing information regarding the project's progress, periodic status, and projected performance for which a project manager is responsible
- Supports tracking of risks to assist the project manager in identifying and implementing responses necessary to achieve desired outcomes.

2.3.4 Management

The WBS supports effective project management in several ways during the life of a project by:
- Separating project deliverables into component parts to ensure the project plan matches the approved project scope and will fulfill the overall objectives of the project
- Supporting the decomposition of project scope into simpler components, providing one of the primary methods for managing complex projects
- Providing a framework for specifying performance objectives
- Providing the basis for integrating and assessing schedule and cost performance
- Supporting the planning and assignment of responsibilities
- Assisting in determining resource requirements such as technical skills, experience and knowledge
- Facilitating the reporting and analysis of project progress and status data, including resource allocations, cost estimates, expenditures, and performance.

2.3.5 Organizational Perspective

The WBS provides the foundation for assigning work to the appropriate organizational units, subcontractors, or individuals. As the work and organizational responsibilities become more clearly defined, individuals, including subcontractors, are assigned responsibility for accomplishing specific WBS elements within defined budgets and schedules.

2.3.6 WBS Levels

The WBS includes all work to be done by the project leaders, stakeholders, and both internal and external participants, such as team members and subcontractors. The WBS provides a clear statement of the objectives and deliverables of the work to be performed. The depth of a WBS is dependent upon the size and complexity of the project and the level of detail needed to plan and manage it. Most work breakdown structures consist of a multi-level hierarchy describing the entire scope to be accomplished by the performing organization; however, the specific number of levels should be appropriate for effectively managing the project in question.

2.4 The 100% Rule

The 100% rule (Haugan, 2002, p 17) is a core characteristic of the WBS. This rule states that the WBS includes 100% of the work defined by the project scope and captures ALL deliverables—internal, external, and interim—in terms of work to be completed, including project management. The 100% rule is one of the most important principles guiding the development, decomposition and evaluation of the WBS. The rule applies at all levels within the hierarchy: the sum of the work at the ''child'' level must equal 100% of the work represented by the ''parent'' and the WBS should not include any work that falls outside the actual scope of the project, that is, it cannot include more than 100% of the work.

It is important to remember that the 100% rule also applies at the activity level. The work represented by the activities in each work package must add up to 100% of the work necessary to complete the work package.

2.5 WBS for Construction of a Bicycle

The scope of a project can be decomposed in multiple ways. Regardless of the manner of decomposition, the sum of the work packages for each different decomposition should add up to the same scope of work. The following sample WBS illustrates key concepts that will be discussed throughout the remaining chapters of this standard.
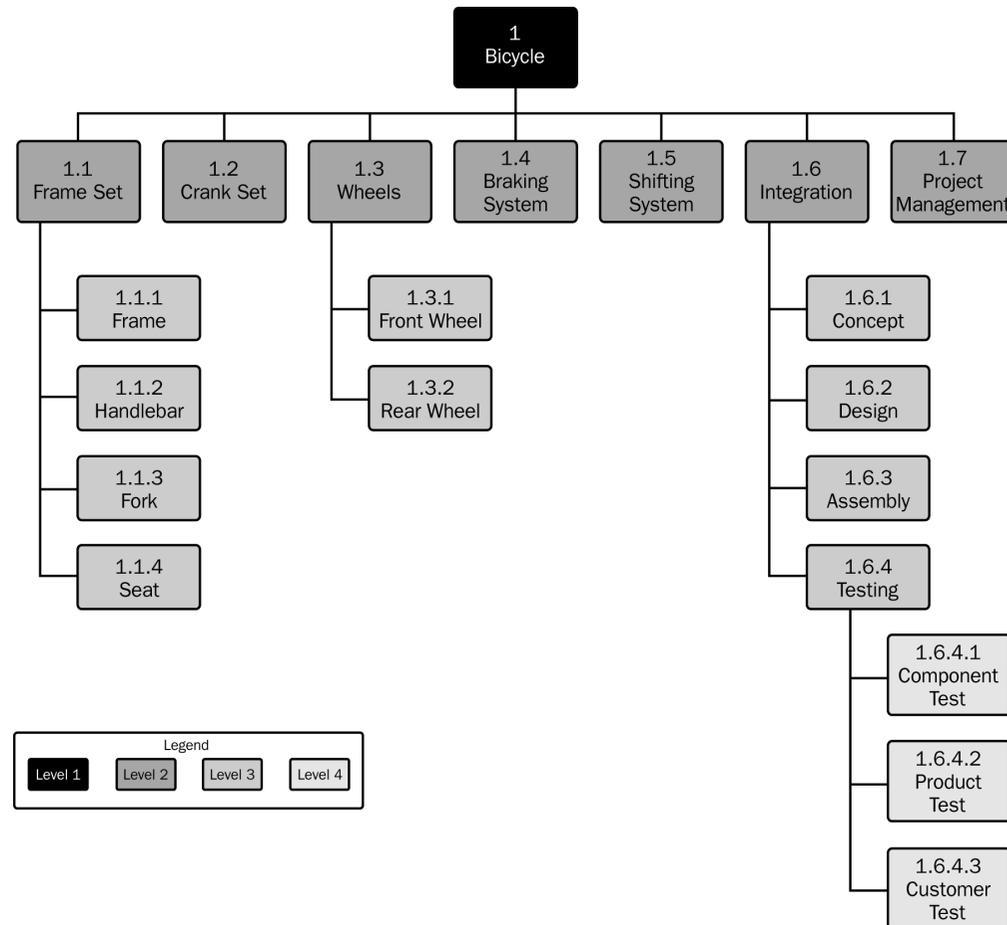
Figure 2-1. WBS Bicycle Example

Figure 2-1 is a sample WBS designed to capture the scope of work required to construct a custom bicycle. To keep the graphic simple, this particular WBS does not differentiate among the many types of bicycles that can be built from similar WBS constructs, for example, a road bicycle, mountain bicycle, racing bicycle, or any other bicycle, but assumes that detailed requirements for a specific type of bicycle would be provided as further decompositions of the illustrated WBS elements.

This particular example was selected for its simplicity to enable the reader to focus on the WBS itself, rather than the multitude of alternatives, options, and components required to define a complex, unique, and perhaps esoteric product. The bicycle is a familiar and common product, an example that easily suggests the processes required to produce the end result.

This illustration shows how concepts and guidance described in later chapters work together to produce a completed bicycle that meets the quality, timeliness, features, and functionality requirements of the project sponsor, which in this case is the purchaser.

Specifically, this WBS illustrates the various levels of a WBS, the numbering scheme, naming convention, relationship of parent and child WBS elements, and the representation of each of these characteristics and principles working together to form a complete WBS. This illustration represents one example of the possible decomposition of the testing elements. It is not intended to be comprehensive or definitive.

The bicycle WBS helps to communicate and reinforce some of the concepts presented. The annotated illustration (Figure 2-2) immediately following shows that all
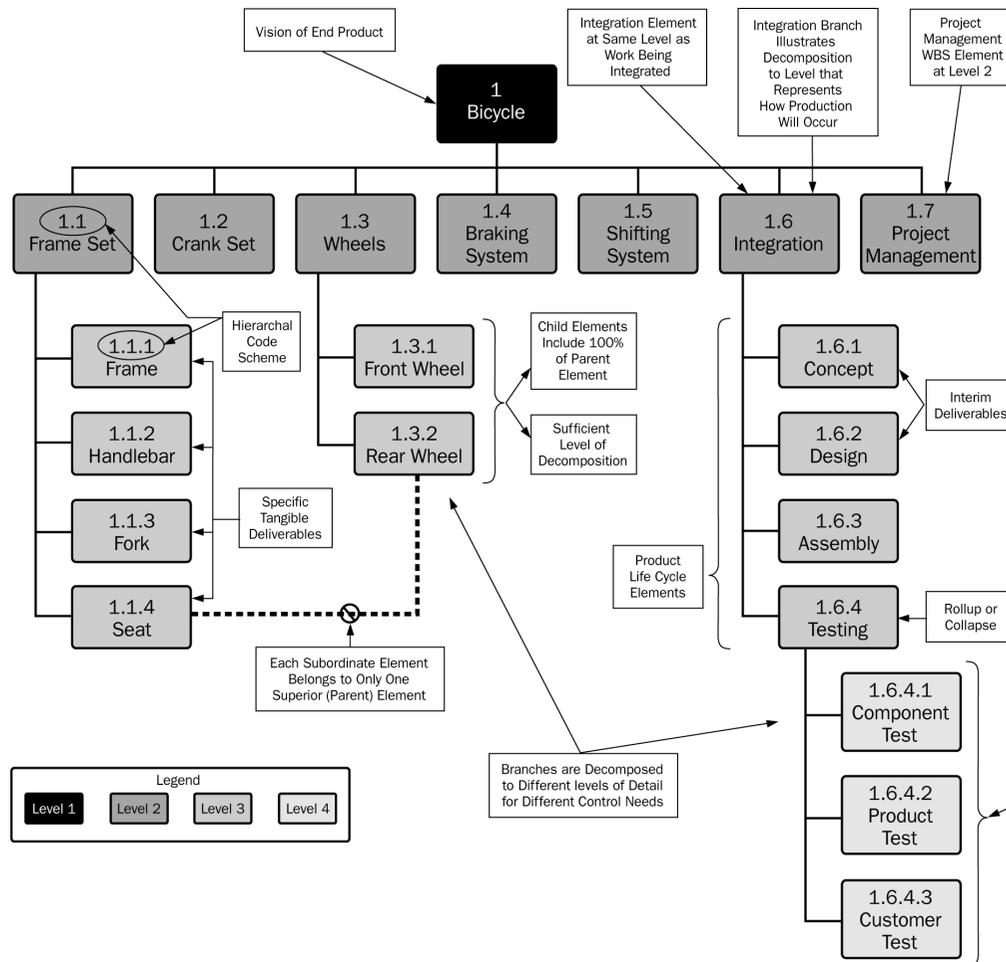
Figure 2-2. Annotated Bicycle Example

WBS elements are not decomposed to the same extent. For example, this hypothetical bicycle WBS does not decompose each Level 2 WBS component further into subelements. While it can be helpful to decompose the entire WBS to the same level for some projects, there are no hard and fast rules dictating that each WBS element is decomposed to the same level. Decomposition is a use-related characteristic that is defined by the context of the project the WBS is developed to support. This concept is presented in detail in Chapter 4, Section 4.2.

Additionally, this example communicates WBS concepts that reflect application in a broad array of industries. The construction of the WBS can remain the same, such as the relationship of the WBS elements, the decomposition level, and the relationship to other WBS elements. The content can be modified to reflect the application of the concept in alternate terms for other industries, projects, or programs. This is illustrated in the decomposed elements that are identified below the Level 2 WBS element for *Integration* (1.6). In Figure 2-2, elements 1.6.4.1–1.6.4.3 are called *Component Test*, *Product Test* and *Customer Test*, respectively. In the next example, Figure 2-3, these
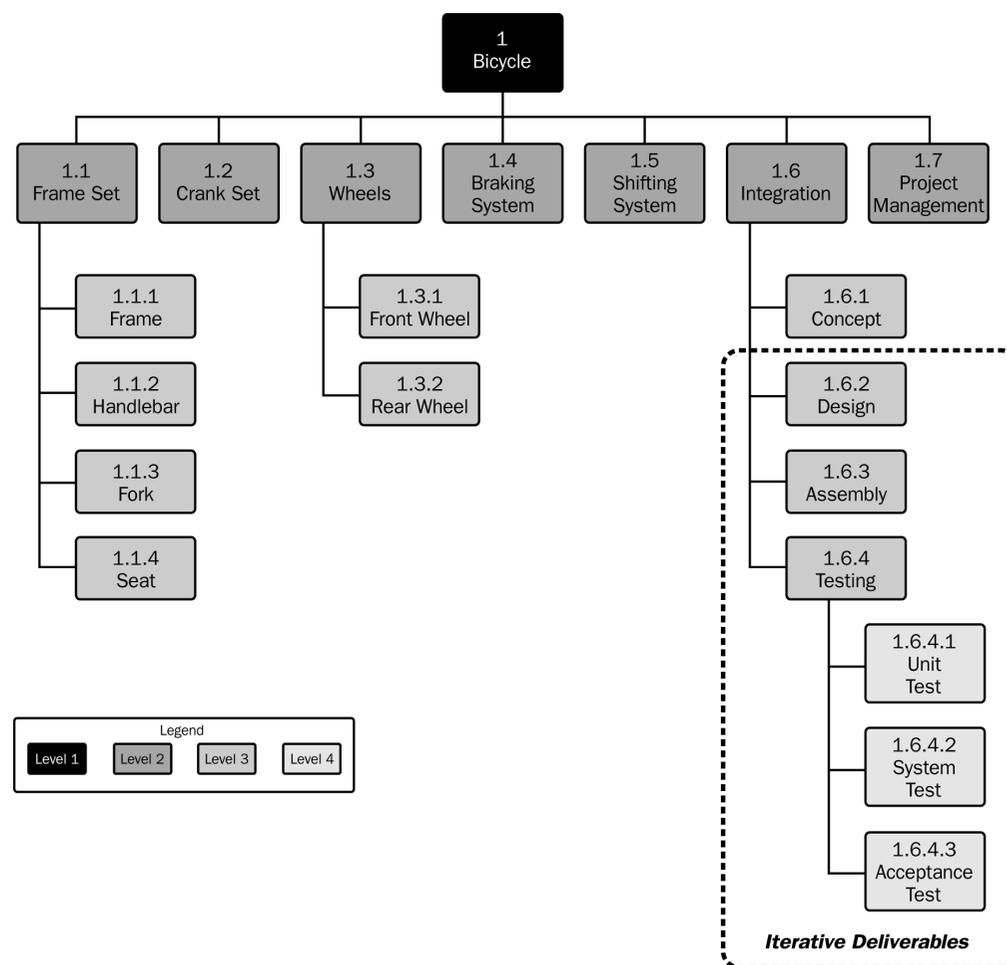
Figure 2-3. WBS Example

same elements are entitled *Unit Test*, *System Test*, and *Acceptance Test*, showing how the concept of testing is represented in various ways using basic WBS elements.

Finally, throughout the standard, the bicycle WBS is repeatedly used as a reference point to clarify and illustrate concepts. To illuminate the concept being discussed, parts of the WBS are extracted, elements are singled out, or sets of decomposed elements are highlighted by placing dotted lines around them. For clarity, these WBS elements are frequently shown in a number of different representations.

2.6 Representations of the WBS

The WBS can be represented in a variety of ways including graphical, textual, or tabular views. Regardless of the representation used, the WBS enables the project team to predict and forecast costs, schedules, resource requirements, and allocations more accurately. Two common methods are the hierarchy diagram and the outline or tabular view as shown in Figure 2-4.

1 Bicycle

1.6 Integration
   1.6.1 Concept
   1.6.2 Design
   1.6.3 Assembly
   1.6.4 Testing
       1.6.4.1 Component Test
       1.6.4.2 Product Test
       1.6.4.3 Customer Test
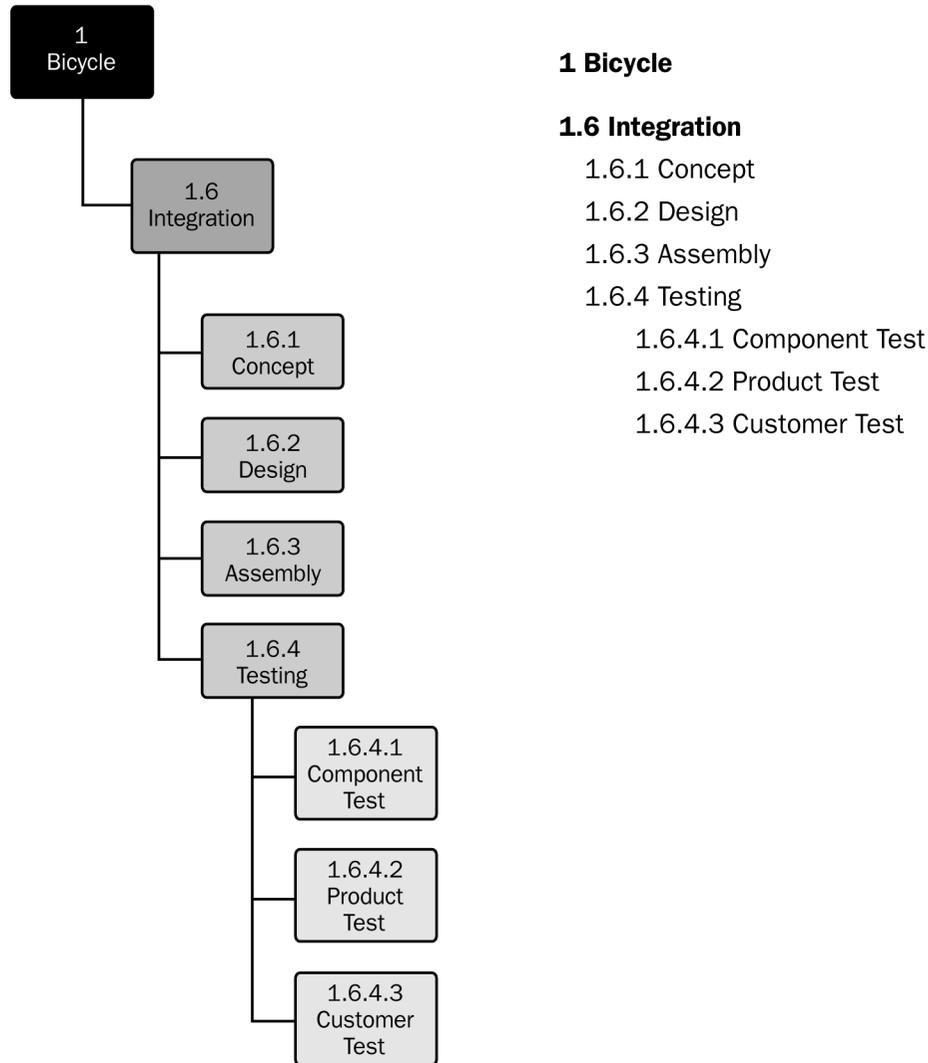
Figure 2-4. WBS Representations Comparison

2.7 Summary

In summary, the WBS:
- Defines the hierarchy of deliverables
- Supports the definition of all work required to achieve an end objective or deliverable(s)
- Provides a graphical representation or textual outline of the project scope

- Provides the framework for all deliverables across the project life cycle
- Provides a vehicle for integrating and assessing schedule and cost performance
- Facilitates assignment of resources
- Facilitates the reporting and analysis of progress and status data
- Provides a framework for specifying performance objectives.

Chapter 3

Importance of the WBS

3.1 Overview

A WBS can not alone ensure project success, but consider that the WBS does the following:
- Defines all the work of the project, and only the work of the project, thereby clarifying the project scope
- Reflects the input from all team members to ensure buy-in
- Provides the baseline for subsequent change control
- Is a primary input to other project management processes—for example, resource planning, cost estimating, schedule development, and risk identification
- Provides the framework for project control, performance monitoring, and the foundation for communication with all stakeholders
- Ensures the work of the project correlates appropriately with the Responsibility Assignment Matrix (RAM) and the Organizational Breakdown Structure (OBS)
- Is referenced in other PMI standards, for example, the *PMBOK® Guide*—Third Edition and *Practice Standard for Earned Value Management* (*EVM*), as an essential planning deliverable supporting key project management functions.

Experienced project managers know that there are many things that can go wrong in projects regardless of how successful the project managers are in the planning and execution of their work. Project failures, however, can often be traced back to a poorly developed or nonexistent WBS.

A poorly constructed WBS can result, among other things, in the following project stumbling blocks and adverse project outcomes:
- Incomplete project definition leading to ongoing project extensions
- Unclear work assignments, goals, objectives, or deliverables
- Scope creep or unmanageable, frequently changing scope
- Budget overrun
- Missed deadlines on scheduled deliverables, or timeline slippage
- Unusable new product or feature
- Failure to deliver on some elements of project scope.

The remainder of this chapter highlights in more detail the important role the WBS plays in project and program management planning:

3.2 Integration with Project Management Processes

The WBS is created in the Create WBS Planning Process (*PMBOK® Guide*—Third Edition). The WBS also plays an integral role in other project management processes. Typical (though not exhaustive) examples are shown in Table 3-1. References in Table 3-1 are to sections in the *PMBOK® Guide*—Third Edition.

Process Group	Importance of WBS in Process
Initiating	● Develop Preliminary Project Scope Statement (Section 4.2) ○ Historical WBS elements can contribute in determining the scope and viability of projects.
Planning	● Scope Planning (Section 5.1) ○ The Scope Planning process documents how the WBS will be created and defined. ● Scope Definition (Section 5.2) ○ The WBS further defines the entire scope of the project. ● Activity Definition (Section 6.1) ○ The WBS is an input source to this process, and is a key component of a project plan. ● Cost Estimating (Section 7.1) ○ The WBS is an input to this process. ● Cost Budgeting (Section 7.2) ○ The WBS is an input to this process. ○ The WBS identifies project deliverables to which costs will be allocated. ● Human Resource Planning (Section 9.1) ○ The WBS is an input source to this process, and is a key component of a project plan. ● Risk Identification (Section 11.2) ○ The WBS identifies project deliverables that must be evaluated for risk events. ● Risk Response Planning (Section 11.4) ○ The WBS might be updated to include work and deliverables required for risk management. ● Plan Purchases and Acquisitions (Section 12.1) ○ The WBS is an input to this process.
Executing	● Information Distribution (Section 10.2) ○ The WBS provides the basis for developing the communications plan and the level of granularity at which project information can be distributed. ○ The WBS helps determine what level of project detail is appropriate to communicate to different stakeholder groups.
Monitoring and Controlling	● Scope Verification (Section 5.4) ○ The WBS facilitates the process of formally accepting completed deliverables. ● Scope Control (Section 5.5) ○ The WBS is an input source to this process, which is a key component of a project plan. ○ It is important to adjust the WBS if project scope is changed so that future changes will be based on an updated, agreed-upon project baseline. ○ A WBS enhances the project manager's ability to assess the impact of scope changes. ● Cost Control (Section 7.3) ○ The creation of the WBS reveals the best point in the hierarchy of deliverables at which to implement cost control.

Table 3-1. Project Management Processes

3.3 Relationship to Other Tools

3.3.1 Project Management Tools

The purpose of the WBS, as a project management tool, is to organize the scope of a project. WBS definition for programs and portfolios can use similar techniques to organize scope. There are many project management tools that use the WBS or its components as input (see Section 5.3 of *PMBOK® Guide*—Third Edition).

.1 **Project Charter.**
The WBS takes the project charter as its starting point. The highest level element in the WBS should represent the project's overall end-point product(s), service(s), or outcomes as described in the project charter. If the project's major products cannot be described during the creation of the WBS, then the project management team should examine the charter to determine if it has been sufficiently defined.

.2 **Project Scope Statement.**
The scope statement for the project is intended to clearly and succinctly describe what the project is and is not intended to accomplish. The high-level elements in the WBS should match, word-for-word, the nouns used to describe the outcomes of the project in the scope statement. If the project management team has difficulty identifying the objects in the scope statement and applying them to the high-level WBS elements, the team should carefully examine the scope statement to determine if it sufficiently captures all project outcomes and deliverables. The WBS Dictionary can also be used to further document and clarify each deliverable (see 3.3.1.6).

.3 **Program and Portfolio WBS.**
The WBS can be used to define scope for projects, programs, and portfolios. For example, program offices are typically established to share tools, techniques, methodologies, and resources in managing one or more collections of related projects as program(s). The project WBS must illustrate a clear understanding of the relationship among highly decomposed work packages within individual projects and program (or higher order) scope definitions. If strategic changes are made, the impact on projects, resources, and budgets can be easily calculated, assuming the project WBS has been constructed correctly in consideration of these higher order factors.

.4 **RBS.**
The Resource Breakdown Structure (RBS) describes the project's resource organization and can be used in conjunction with the WBS to define work package assignments. The link between work packages and the RBS can be used to verify that all members of the project team have been appropriately assigned work packages, and that all work packages have owners.

.5 **OBS.**
The Organizational Breakdown Structure (OBS) is loosely related to the WBS. The OBS depicts the organization hierarchy, allowing the project's work packages to be related to the performing organizational units. This tool reinforces the guideline that each work package should have a single point of responsibility.

The OBS can be a useful tool for project managers in that it clearly demonstrates the hierarchy of people or groups, whereas the WBS is strictly organized by deliverables.

.6 **WBS Dictionary:**
The WBS dictionary is a key document that accompanies the WBS and carries critical project information. The WBS dictionary defines, details, and clarifies the various elements of the WBS to ensure that each component of the WBS is accurately articulated and can be communicated to anyone referencing the WBS. The development of the WBS dictionary often uncovers ambiguity or other errors in the WBS itself, and results in revisions to the WBS. The WBS dictionary contains information about each element of the WBS, including a detailed description of the work, deliverables, activities, and milestones associated with each element. The WBS dictionary might also include an indication of the type and number of resources required and contract control information, such as a charge number or other similar data. Often, a WBS dictionary will include traceability matrices linking the WBS to other scope control documents such as statements of work or requirements documents.

.7 **Project Schedule Network Diagram:**
The network diagram is a sequential arrangement of the work defined by the WBS, and is essential to uncovering project dependencies and risks. The activities within the WBS work packages are arranged to show precedence and order. Developing the network diagram often uncovers problems in the WBS, such as incomplete decomposition, the assignment of too much work in an element, or the assignment of more than one person for an individual WBS element, thus resulting in needed revisions.

.8 **Project Schedule:**
The various elements of the WBS are used as starting points for defining the activities included in the project schedule. Implied dependencies can be recorded in the WBS Dictionary, and the activities as described in the WBS Dictionary are then included as detail in the schedule.

3.3.2 Interrelationships Among Project Management Tools

Because of interrelationships among the WBS and other project management tools, it is important to note that any change in the WBS requires an associated change in the related tools.

Such interrelationships among the WBS and other Project Management processes are described throughout the *PMBOK® Guide*—Third Edition. As an example of these interdependencies, consider the relationship between the WBS and the activity list used for the project schedule as described in Section 6.1.2 of the *PMBOK® Guide*—Third Edition (Activity Definition: Tools and Techniques). Specifically, item 6.1.2.1 (Decomposition) reads:

''The technique of decomposition, as it is applied to activity definition, involves subdividing the project work packages into smaller, more manageable components called schedule activities. The Activity Definition process defines the final outputs as schedule activities rather than as deliverables, as is done in the Create WBS process (Section 5.3).''

"The activity list, WBS, and WBS dictionary can be developed either sequentially or concurrently, with the WBS and WBS dictionary being the basis for development of the final activity list. Each work package within the WBS is decomposed into the schedule activities required to produce the work package deliverables. This activity definition is often performed by the project team members responsible for the work package."

Section 6.2 of the *PMBOK® Guide* (Activity Sequencing) further states:

"Activity sequencing involves identifying and documenting the logical precedence relationships among schedule activities. Schedule activities can be logically sequenced with proper precedence relationships, as well as leads and lags to support later development of a realistic and achievable schedule."

This discussion briefly describes how many project management tools are interrelated, all based upon the foundation of the WBS. The Work Breakdown Structure plays a pivotal role in project and program management in each of the process groups: Initiating, Planning, Executing, Monitoring & Controlling and Closing for which it ensures a consistent definition of the scope of the work to be undertaken.

3.3.3 WBS Development Tools

There are a number of project management tools that can be used to assist a project manager with the development of a WBS. These tools include outlines and organization charts, fishbone and brainstorming techniques, and top down and bottom up development strategies. There are many WBS templates available, and corporate standards can be referenced or copied for quick-starting WBS development. When using generic or corporate WBS templates, it will be important to ensure that the template chosen for the project closely matches the project type (such as a Construction WBS template, an IT Software Development WBS template, a commercial product WBS template, etc.) and is used as a guide or basic structure that is then customized to fit the needs of the specific project being planned. (More information about these tools can be found in Chapter 5 of this standard.)

There are many benefits to using tools to develop a WBS. For example, tools often promote consistency and repeatability in the development of a WBS, especially enterprise productivity tools. WBS tools can also promote and enforce the principles of the WBS standard and can significantly reduce the development effort, simplifying the WBS process, and even promoting reusable WBS products.

3.4 WBS Integration and Use by Other Standards

Scope management is integral to other PMI standards. These include but are not limited to: the *PMBOK® Guide*—Third Edition; *Practice Standard for Earned Value Management* (*EVM*), and *Organizational Project Management Maturity Model* (*OPM3®*). The development of a quality WBS is critical to the successful execution of project management processes, as described in the *PMBOK® Guide*—Third Edition, as well as in the other aforementioned standards.

Standards that take advantage of the WBS typically fall into one of two categories. The first category focuses on using the content output of the WBS as an input. PMI's *Practice Standard for Earned Value Management (EVM)* and upcoming *Practice Standard for Scheduling* fall into this category. Since the content output from a WBS is

predictable and well understood, such standards can build upon or leverage the *Practice Standard for Work Breakdown Structures*—Second Edition.

Other standards incorporate the WBS (as defined by this practice standard) as the preferred tool to develop the scope definition for their role. For example, the *PMBOK® Guide*—Third Edition uses the *Practice Standard for Work Breakdown Structures*—Second Edition to develop the project scope, and OPM3® identifies the WBS as a tool that can be used to develop a program WBS. These standards recognize the *Practice Standard for Work Breakdown Structures*—Second Edition as representing good practice.

The WBS is developed to define carefully what is in the project scope and, by implication, what is out of scope. *The Practice Standard for Scheduling (currently in development)* is based, in part, on an assumption that a high-quality WBS has been developed using good practice, correctly defining project scope. When the project schedule is developed, each high-level (summary) task must correspond to a WBS element. If an activity or task does not have a relationship to a work package within the WBS, then either the WBS does not fully encompass the project scope, or the activity or task is unnecessary.

EVM is a management methodology for integrating scope, schedule, and resources, and for objectively measuring project performance and progress. The data used in EVM are dependent upon WBS elements having been developed using good practice. If WBS elements are not well defined, are too large in scope, are too lengthy in duration, or are in some other manner not appropriately decomposed or developed, it will be difficult to measure the project's earned value. The *Practice Standard for Earned Value Management* relies upon a high-quality WBS as a key input.

The *PMBOK® Guide*—Third Edition, PMI's project management standard, discusses project management practice as a whole. A core element of project management is scope management, and the *PMBOK® Guide* discusses the benefits of using the WBS as a technique to manage and control a project's scope.

The Standard for Program Management describes how collections of related projects are best managed. This standard assumes that the WBS for each relevant project is developed according to good practice and accurately describes the scope for the project.

The Standard for Portfolio Management describes how collections of projects or programs are best managed. This standard assumes that the WBS for each relevant project/program is developed according to good practice and accurately describes the scope for the project.

PMI's OPM3® is an example of a maturity model that can be used to measure and detail an organization's maturity level, as well as provide a clear path to higher levels of maturity. The WBS is important to OPM3®, since OPM3® relies on the benefits of processes aimed at scope management. This standard relies on the development of a quality WBS as a foundation for effective project management.

3.5   Summary

The WBS is an important tool used in the planning and execution of a successful project. Many project cost, schedule, and quality failures can be traced directly to flaws in the development of the project's WBS. It is less likely that a project will be successful without the existence of a quality WBS. In contrast, developing and applying a high quality WBS will significantly increase the likelihood of successful project completion. Chapter 4 will provide insight into the characteristics and components that make up a high-quality WBS.

Chapter 4

Defining WBS Quality

4.1 Overview

What is a quality WBS? The *PMBOK® Guide*—Third Edition (Chapter 8) considers quality to involve the "the degree to which a set of inherent characteristics fulfills requirements." This includes the ideas of conformance to requirements and fitness for use; that is, the ability to satisfy the purpose for which the item (in this case, a WBS) was intended. (See Chapter 3 of this *WBS Practice Standard* for the uses, purpose, and importance of the WBS.) To state that a particular WBS is of high quality, one must agree that the WBS has been created so that it satisfies the purpose for which it was created.

There are two basic principles that govern the quality of a WBS. This chapter will describe these principles and identify the characteristics of a high-quality WBS that flows from each principle. It will illustrate the negative effects of a poorly constructed WBS and it will provide tools for project managers to use in evaluating any specific WBS that is being developed. The remaining sections of this chapter are as follows:

4.2 WBS Quality Principle 1
4.3 WBS Quality Principle 2
4.4 Annotated Example of a High-Quality WBS
4.5 Problem Diagnostic Checklist
4.6 Summary

4.2 WBS Quality Principle 1

A quality WBS is a WBS constructed in such a way that it satisfies all of the requirements for its use in a project.

There are two sub-principles that pertain to satisfying requirements for use of a WBS. These describe core characteristics of every WBS and use-related characteristics that describe a particular WBS based on its individual setting and use.

4.2.1 WBS Quality Sub-Principle 1—Core Characteristics

There is a set of core characteristics that must be present in every WBS, as these characteristics enable the WBS to satisfy project needs that are present in every project.

With respect to core characteristics, a WBS either has them or it does not, and, as such, these characteristics represent the minimum set of specific attributes a WBS must contain. When evaluating or developing a WBS, the absence or presence of these core characteristics will dictate whether or not it is a quality WBS. A WBS with the following core quality characteristics can be said to have core quality:

- Is a deliverable-oriented grouping of project elements
- Defines the scope of the project
- Clarifies the work and communicates project scope to all stakeholders
- Contains 100% of the work defined by the scope
- Captures internal, external, and interim deliverables in terms of work to be completed, including project management
- Is constructed so that each level of decomposition contains 100% of the work in the parent level
- Contains work packages that clearly support the identification of the tasks that must be performed in order to deliver the work package
- Provides a graphical, textual, or tabular breakdown of the project scope
- Contains elements that are defined using nouns and adjectives—not verbs
- Arranges all major and minor deliverables in a hierarchical structure
- Employs a coding scheme for each element that clearly identifies its hierarchical nature when viewed in any format such as a chart or outline
- Has at least two levels with at least one level of decomposition
- Is created by those who will be performing the work
- Is constructed with technical input from knowledgeable subject matter experts (SMEs) and other project stakeholders, such as financial and business managers
- Iteratively evolves along with the progressive elaboration of project scope, up to the point the scope has been baselined
- Is updated in accordance with project change control, thereby allowing for continual improvement, after the project scope has been baselined.

4.2.2 WBS Quality Sub-Principle 2—Use-Related Characteristics

There is an additional set of use-related characteristics that may vary from one WBS to another. These characteristics enable the WBS to be used for purposes that are unique to a specific project, industry or environment, or are applied in a particular way to individual projects.

With respect to use-related characteristics, the quality of a WBS depends on how well the specific content and type of WBS elements meet all the needs for which the WBS has been developed. This statement implies that the more project needs are met by the WBS, the higher its quality. A high-quality WBS is constructed so that it can be used to meet all project requirements, even if a given project does not take advantage of all of the characteristics present.

Use-related characteristics support the application of WBS practice in situational contexts. These can include, and are not limited to the following:

- **Achieves a sufficient level of decomposition.** A WBS is broken down to a level of detail sufficient for managing the work. The appropriate level of detail to enable effective management can differ from organization to organization or project to project.
  - The depth of the WBS correlates with the size and complexity of the project and the level of detail needed to plan and manage it.
  - All deliverables are limited in size and definition for effective control. However, they should neither be so small that the cost of control is excessive, nor should

they be so large that the item is unmanageable or the associated risks cannot be identified.

- **Provides sufficient detail for communicating all work.** A WBS facilitates conceptualization and definition of the product, service, or result (deliverable) details. But the degree of WBS detail necessary for conceptualization of project detail can vary. For example, existing modules can be satisfactorily described by a product number, while to-be-designed components might need to be described in greater detail. To ensure clarity of communication regarding the intent of any WBS element, an entry detailing specific information about the WBS element should be placed in the WBS Dictionary. This will minimize misunderstanding of the WBS and, in turn, the project scope.
- **Is appropriate for tracking, as required by the specific project or organization.** Some projects or organizations can require highly detailed performance reporting at the work package level, while others might require only summary level reporting at a WBS rollup level.
    - The WBS has logical summary points that assist in tracking the evaluation of performance accomplishments, resource allocations, costs, and schedule performance.
    - Suitable management control points are identified in the WBS that can be used to facilitate communication and to control scope, quality, and technical soundness.
    - In summary, the WBS provides a feasible mechanism to assess performance and progress.
- **Is appropriate for control activities.** A WBS balances the control needs of management with an effective level of project detail. It provides a good balance between complexity, risk, and the project manager's need for control.
    - Shorter, less complex projects may require only a few performance assessments at higher WBS levels, whereas larger, more complex projects may require many intermediate reviews at the work package level.
    - Elements are detailed enough to meet performance measurements and accountability objectives, thereby facilitating effective planning, monitoring, and control.
- **Can contain specific kinds of WBS elements, as needed for each project.** Some projects might need to include a majority of the following types of WBS elements, while other projects need only one or two:
    - Some project WBSs can include elements for integration, procurement, supply chain management, information/communication, administration, documentation, training, and software development.
    - WBS elements representing subcontracted or externally committed deliverables should directly correspond to matching elements in the subcontractor's WBS.
    - A WBS might include level-of-effort WBS elements.
    - Deliverables from the development life cycle stages, such as planning, analysis, design, assembly, testing, and implementation, can be reflected in the WBS, where appropriate.
    - WBS elements can reflect the deliverables within the product development life cycle, where appropriate, such as in the IT industry.
- **Enables assignment of accountability at the appropriate level.** Some projects or organizations can require assignment of accountability at a very detailed, work package level, while others might be satisfied with accountability assigned at a summary rollup level.
    - Each WBS element can be assigned to an accountable individual, subcontractor, or organizational unit.

- ○ The WBS can serve as the mechanism for documenting the accountability and responsibility for the various deliverables by having a direct relationship among the WBS elements related to the Organizational Breakdown Structure (OBS) identified through the Responsibility Assignment Matrix (RAM).
    - ○ WBS elements clearly identify accountability to the level of detail required for managing and controlling the project.
- **Has a succinct, clear, and logically organized structure to meet project management and oversight requirements.** The logic of the hierarchical decomposition of a project can vary in response to a variety of project and organizational factors.
    - ○ The WBS decomposition level balances the project definition with data collecting and reporting requirements.
    - ○ WBS elements are compatible with relevant organizational and accounting structures.

4.3 WBS Quality Principle 2

WBS quality characteristics apply at all levels of scope definition.

There is no conceptual difference between a project WBS, a program WBS, and a portfolio WBS. A high-quality WBS developed at any of these broader levels possess precisely the same characteristics and attributes as a high-quality WBS developed at the individual project level. These differ only in the breadth of the content and scope.

4.4 Annotated Example of a High-Quality WBS

This WBS example is based on a hypothetical organization that builds bicycles to an individual customer's specifications. The annotations refer to specific characteristics of a high-quality WBS. Figure 4-1 illustrates a simplified WBS as it pertains to a sample project. The project is the design and building of a bicycle and is an example of a WBS to encompass the work for this sample project.

4.4.1 Level 1

This level comprises the full scope of work necessary to produce the bicycle. It includes all direct and indirect work. Level 1 is the overall product, always a single WBS element. In this example, the top level is represented by both a name and a WBS identifier to differentiate it from other WBSs in a program or portfolio of which it is a member. This may not always be the case. If the project stands alone, the top level or Level 1 identifier may not be required. When the top level identifier is not included, numbering for the remaining WBS levels will also change accordingly.

4.4.2 Level 2

This is the first level of decomposition. This level is the high-level breakdown of the major areas in the scope of work. It holds the basic components of the product, along with integration and project management. The *frame set* is basically the parts you sit on, steer with, and to which you attach wheels and other parts. The *crank set* includes the pedals, bearings, crank arms, and sprocket. The *braking system* includes the brake pads and related mechanisms for the wheels, cables, and levers. The *shifting system*
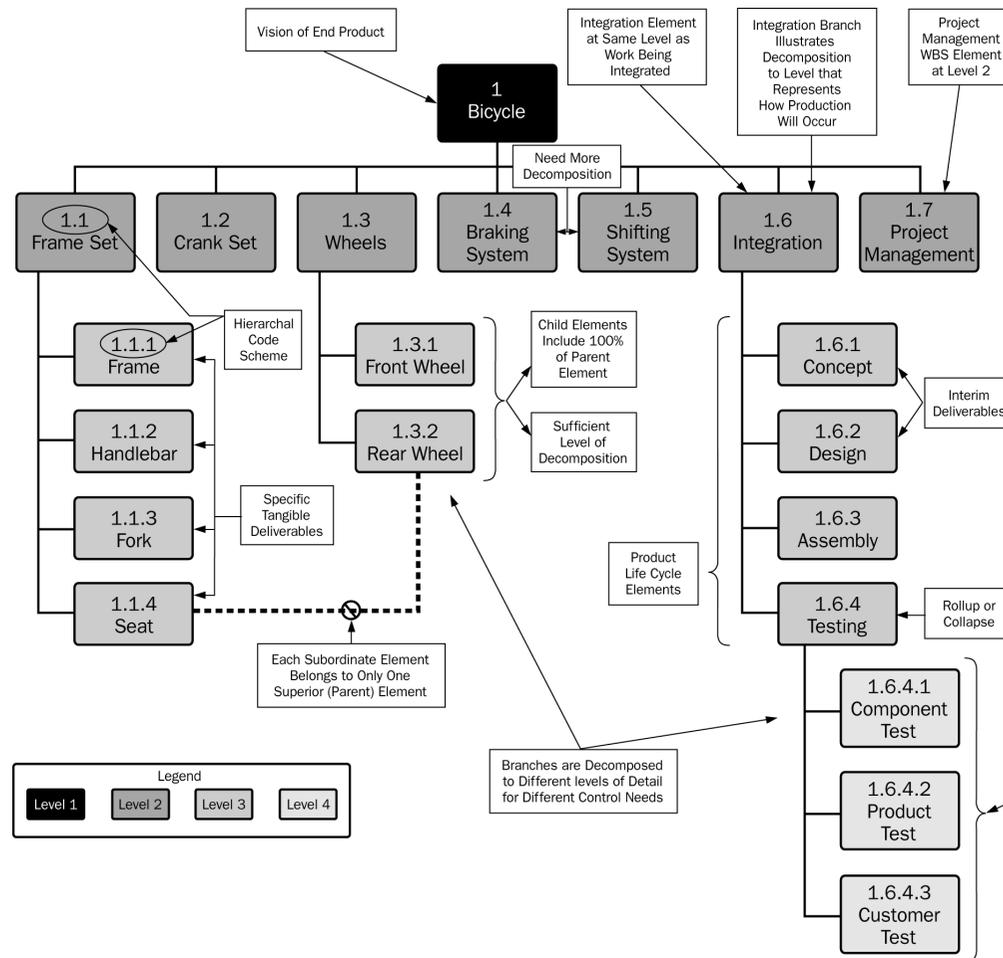
Figure 4-1. Annotated Example of a High-Quality WBS

includes the front and rear shift mechanism, cables, and levers. This level is numbered as #.#—for example, frame set is 1.1.

4.4.3 Level 3

This level decomposes each major area from Level 2 into its constituent parts. It is important to note that the 100% Rule is always adhered to in the development of a WBS. This level would tend to start targeting specific, tangible deliverables of the project effort. Here, *integration* is decomposed into interim deliverables based on the project life cycle chosen for this project. This level is numbered as #.#.#—for example, rear wheel is 1.3.2.

4.4.4 Level 4

In the same manner, each exclusive area in Level 3 would be decomposed further, if applicable. Again, the complexity of the work will drive the depth and number of levels of the WBS decomposition. Note that testing is further decomposed into three elements: *component test* is pre-assembly testing; *product test* is quality control and

pre-customer test; and *customer test* is customer delivery, final adjustments, and customer acceptance. This level is numbered as #.#.#.#—for example, Product Test is 1.6.4.2.

4.5 Problem Diagnostic Checklist

The following are representative examples of major project problems resulting from key WBS defects.

- There are frequently missed deadlines and an extended schedule
  - Have all major and minor deliverables been included? Failure to include all deliverables within the initial WBS can increase project schedules when missed deliverables are identified.
  - Have deliverables been defined specifically enough to allow for appropriate work packages to be developed?
  - Does the WBS facilitate the use of earned value management techniques?
- Project is over budget
  - Does the WBS provide logical summary points for assessing accomplishments, as well as for measuring costs and schedule performance?
  - Does the WBS facilitate the use of Earned Value Management techniques?
- Individuals are unable to use the new product or feature
  - Are deliverables decomposed into smaller, more specific deliverables? For example, a deliverable of training might not be decomposed thoroughly enough to cover all of the people who need training to use the new product, process, or service.
  - Are the WBS elements deliverable-focused?
  - Were appropriate assembly or integration deliverables and testing activities present?
  - Were training and implementation deliverables defined?
- The project scope has changed and is unmanageable
  - Has a WBS been created for the project?
  - Does the WBS decompose the overall project scope into deliverables?
  - Does the WBS provide a level of flexibility for change?
  - Has the WBS been updated when necessary changes are approved by the change control process?
  - Has the WBS been placed under change control?
- The project has become an ongoing project with no end in sight
  - Has a maintenance plan been developed for post implementation if needed?
  - Does the project have a specific end point?
  - Does the WBS include a closeout phase or plan?
  - Is the endeavor actually a project or is it an ongoing operation?
- Project team members are confused about their individual responsibilities
  - Do the WBS elements define overlapping responsibilities for the creation of a deliverable?
  - Is the information within the WBS at the appropriate level of detail, and in formats and structures meaningful to those performing the work? If so, were clear communication processes and decision authorities agreed upon beforehand?
  - Do the WBS elements reflect work with specific, tangible deliverables?
  - Have all key stakeholders, including subject matter experts, contributed to the creation and validation of the WBS?

- Some planned work does not get done
  - Has all required work been included in the WBS?
  - Are the WBS elements deliverable-focused?
  - Has the WBS organized around deliverables rather than process steps?
  - Was decomposition completed before dependencies and durations were defined?

4.6 Summary

There are several characteristics that need to be present to produce a quality WBS deliverable. For a WBS to be considered as high quality, it should conform to its original requirements and be fit for use by the project. More simply stated, it should satisfy the purpose for which it was originally intended.

In summary, a high-quality WBS:

- Is constructed in a consistent fashion, varying only in its level of focus based upon its intended use
- Satisfies the needs of the project
- Contains all of the key elements necessary to represent the full scope of work
- Is usable by project managers with a broad base of experience to manage the varying degrees of scope, budget, schedule, and risk
- Avoids the common pitfalls associated with WBS construction.

Chapter 5

Considerations While Creating a WBS

5.1 Overview

There are many ways to create a Work Breakdown Structure (WBS). It can be developed entirely as a new document, can reuse components from existing WBSs, can be based on a template, or can follow pre-defined WBS standards. When reusing existing components, WBS elements can be drawn from similar projects or from standard project templates that the organization has determined support accepted good practices.

This chapter discusses the methods used to create a WBS, as well as some considerations that should be taken into account during WBS development. The sections of this chapter are presented as guides for use during the WBS development process, while some sections can be used as checklists for the development and refinement of the WBS. The remaining sections of this chapter are as follows:

5.2 Preparing a WBS
5.3 General Factors to be Considered
5.4 Essential Judgments
5.5 Evaluating WBS Quality
5.6 WBS Usage Continuum
5.7 WBS for Program and Portfolio Management
5.8 Summary

All project, program, or portfolio requirements need to be considered during development of the WBS. A critical factor for success at any level is the creation of a high-quality Work Breakdown Structure.

5.2 Preparing a WBS

The WBS evolves through an iterative consideration of the project's purpose and objectives (both business and technical), functional and performance design criteria, project scope, technical performance requirements, and other technical attributes. A high-level WBS can often be developed early in the conceptual stage of the project. Once the project is defined and specifications are prepared, a more detailed WBS can then be developed. It should be customized to the specific needs and requirements

of the project. All non-required work and deliverables should be listed and removed so the WBS represents only the project's scope. The end result is a WBS that represents the complete list of deliverables for the project. A number of authors have provided useful guidance on preparing a WBS (Haugan, 2002; Pritchard, 1998; Uyttewaal, 2005).

The WBS can assist the project manager and stakeholders in communicating a clear vision of the end product(s) of the project, and of the overall process by which those products will be created. It helps communicate the work to be accomplished as well as the interim and end-point deliverables to be completed. With this in mind, the following list of questions should stimulate thought when developing a WBS to manage a project:

- Is the project charter defined and issued?
- Is the project scope statement defined and issued?
- Have the project manager and the team formulated a vision of the final product(s), services, or results?
- Have personnel who will do the work been assigned to develop the WBS?
- What are the project's component parts?
- How do the pieces work together?
- What needs to be done?
- Have the project's intended business objectives been defined? What is required to achieve the business value?
- Has the entire project been thought through? Have the high-level deliverables been progressively decomposed?
- Have all deliverables, both interim and final, been identified? What is to be provided? What is required?
- Has the relationship of each component to the end product been defined? How will this component contribute to the finished deliverables?
- Has the process for production of the deliverables been defined? What methods will be employed? What special processes will be needed? What are the quality requirements? What kinds of inspections need to be done?
- Have the activities that are needed to support the deliverables been identified, including those that directly or indirectly facilitate their creation?
- Has technical input from knowledgeable Subject Matter Experts (SMEs) been obtained, and is that technical input communicated to and validated by other key SMEs assigned to the project?
- Does the project require any external sources to contribute to the project and have they been identified?
- Has all work associated with risk management been identified? Have risks associated with project assumptions been identified?

These thoughts and questions are intended to help the project manager develop a clear statement of what the product(s) of the project are. They should be iteratively reviewed until all questions have been completely addressed and all information is known—to the extent possible. Once completed, all of the work packages (i.e., the lowest-level WBS elements) should together comprise the complete list of deliverables for the project. They depict the project's scope.

5.2.1 Preparation Methods

A number of methods and tools can be employed to create a WBS including outlines, organization charts, fishbone diagrams, brainstorming techniques, and top-down and

bottom-up development strategies. WBS templates, as well as corporate guidelines or standards can be referenced or copied for quick-starting WBS development.

There are many benefits to using tools to develop a WBS. For example, tools often promote consistency and repeatability in the development of a WBS, especially if it is an enterprise productivity tool. WBS tools can also promote and enforce the principles of the organization's WBS guidelines or standards, and can significantly reduce the development effort, simplify the WBS process, and even promote reuse of WBS elements.

Some of the more popular methods employed to create a WBS include a top-down approach, a bottom-up approach, the use of organization-specific WBS guidelines or standards, and the use of WBS templates. The choice of appropriate method should be based on the specific project objectives, requirements, assumptions, and constraints. Table 5-1 highlights some advantages and challenges of the aforementioned methods.

WBS Creation Method	Advantages	Challenges
Top-Down	• Structures project conveniently for status reporting • Helps ensure projects are logically structured • Is valuable when brainstorming/discovering project deliverables • Can accommodate additional deliverables as they are uncovered	• Requires constant attention that no work packages are overlooked • WBS needs to be elaborated to sufficiently detailed level to permit management oversight and control
Bottom-Up	• Starts with all deliverables and works backwards into a project • Confirms that all work packages are included	• Identifying all deliverables before producing the WBS • Making sure work packages are logically grouped • Can lose focus on big picture
WBS Standards	• Formats are predefined • Enhances cross-project WBS consistency	• Making a project fit the standard • Can lead to inclusion of unnecessary deliverables or failure to include project-specific deliverables • Not all projects fit into a highly structured set of WBS standards
WBS Templates	• Provides a starting point for WBS creation • May help determine appropriate level of detail required • Enhances cross-project WBS consistency	• Requires a project fit the standard • Can lead to inclusion of unnecessary deliverables or failure to include project-specific deliverables • Not all projects fit into a highly structured set of WBS templates

Table 5-1. WBS Creation Methods

.1 Top-Down
The following steps describe the general top-down process for developing a WBS:
- **Step 1.** Identify the final products of the project—what must be delivered to achieve project success. A thorough review of high-level project scope documents (such as Statement of Work and Technical Requirements) is recommended to ensure consistency between the WBS and the project requirements.
- **Step 2.** Define the project's major deliverables, which are often interim deliverables necessary for the project, but which in themselves do not satisfy a business need (such as a design specification).

- **Step 3.** Decompose major deliverables to a level of detail appropriate for management and integrated control. These WBS elements are normally tied to clear and discrete identification of stand-alone deliverable products. The sum of the elements at each level should represent 100% of the work in the element above it, as noted in the 100% Rule. Each work package of the WBS should contain only one deliverable.
- **Step 4.** Review and refine the WBS until project stakeholders agree that project planning can be successfully completed, and that execution and control will successfully produce the desired deliverables and results.

.2 Bottom-Up

The following steps describe the general bottom-up process for developing a WBS:

- **Step 1.** Identify all of the deliverables (or work packages) involved in the project. If participants propose activities, then the associated deliverables, but not the activities, should be included (i.e., translate suggested activities into associated deliverables). This will encompass the entire output of the effort. Each work package should contain only one deliverable.
- **Step 2.** Logically group related work packages (or deliverables) together.
- **Step 3.** Aggregate deliverables to the next level, for instance, the parent level. The sum of the elements at each level should represent 100% of the work below it, as noted in the 100% Rule.
- **Step 4.** Once a given group of related tasks has been aggregated to a parent, analyze the subset again to ensure that all of the work has been encompassed.
- **Step 5.** Repeat until all subelements have been aggregated to a single parent representing the project. Ensure that the completed structure includes all of the project scope.
- **Step 6.** Review and refine the WBS until project stakeholders agree that project planning can be successfully completed, and that execution and control will successfully produce the desired deliverables and results.

.3 WBS (Organizational) Standards

An organizational WBS standard is a set of principles for constructing a WBS and might include a format, numbering scheme, naming convention, or required elements. WBS standards are common in many organizations with a high level of project management maturity. These standards help ensure consistency and completeness in WBSs throughout the organization. Examples of WBS standards include the following:

- Project management must be a Level 2 WBS element
- Graphical and textual WBS views must be developed and maintained.

.4 WBS Templates

A WBS template is a sample WBS, with hierarchical elements filled in to some level of detail, or a generic WBS ''container'' that is customized (i.e., filled) with project-specific information. An organization can have templates for different types of projects and different life cycles.

The use of WBS standards and WBS templates helps promote consistency through reuse of WBSs or WBS components. When reusing existing components, be sure to customize the WBS to the specific needs and requirements of the project. Any non-required work or deliverables should be removed so that the WBS is aligned with the project scope. In addition, the questions defined in

Section 5.2 should again be iteratively reviewed for these two methods. The use of standards and templates in the creation of WBSs helps promote quality assurance through the application of successfully applied WBS good practices.

The use of WBS standards and WBS templates differs from top-down and bottom-up methodology in that top-down and bottom-up are methods of creating new WBSs, while standards and templates involve the reuse of existing WBS materials.

5.2.2 Guidance in Choosing a Method for Preparing a WBS

In developing a WBS, the project management team needs to decide first which development method to use. The choice between a top-down or a bottom-up approach is somewhat personal, and can depend on the habits and thinking styles of the project team, as well as on organizational practices. Aside from those considerations, some guidelines and explanations for which approach might be more appropriate are as follows:

.1 Top-Down

Use the top-down approach in these situations:
- The project manager and project management team have little to no experience in developing Work Breakdown Structures. Top-down development allows for progressive understanding and elaboration of the WBS.
- The nature of the project's products or services is not well understood. The development of a WBS jointly with all stakeholders using the top-down approach is useful in gaining understanding and consensus when the scope and nature of the project is unclear.
- The nature of the project life cycle is not familiar or well known. Top-down development of the WBS more easily uncovers life cycle issues and characteristics.
- No appropriate WBS templates are available. When developing a WBS from scratch, it is far easier to start with the overall project deliverable, such as building a bicycle, and then iteratively determine subelements.

.2 Bottom-Up

Use the bottom-up approach in these situations:
- The nature of the project's products or services is well understood. For example, if the organization has developed very similar products or services on previous projects, the project team might already have a very good understanding of all interim deliverables required for the new project.
- The nature of the project life cycle is well known. If the organization always uses the same project life cycle, the interim deliverables for that life cycle are well known and can be used to begin bottom-up WBS development.
- Appropriate WBS templates are available. If the organization has WBSs from projects with similar products or services, and these can be reused, a bottom-up approach enhances the team's ability to customize the WBS template.

.3 WBS Standards and Templates

In general, if WBS standards or WBS templates are available, they should be used, with the caveats expressed in Figure 5-1. There are plenty of sample WBSs available in the literature, but the choice to use sample WBSs as templates must be made carefully. The organization can have WBS templates for very similar

projects, and the use of these templates is highly encouraged. However, if the project significantly differs from other projects in the organization, and no template seems to apply, develop the WBS from scratch with a top-down approach.

.4 Iterations
Construction of the WBS is an iterative process and may rely on more than one method to produce the final high quality WBS. For example, a WBS template and the top-down approach may be used initially to determine the overall structure of the WBS, while it might be more appropriate to use the bottom-up method to verify that all the elements are present to achieve a particular deliverable.

Regardless of what method is chosen to prepare the WBS, the resulting WBS must have all the core characteristics of a high-quality WBS. The WBS must describe 100% of the work on the project, must be oriented toward deliverables rather than activities, and must be hierarchically arranged. For additional details on WBS quality principles, please see Chapter 4, and specifically Section 4.2 for a discussion of WBS core quality characteristics.

5.3 General Factors to Be Considered

In developing a WBS, the following basic tenets should be considered:
- Each WBS element represents a single tangible or intangible deliverable.
- Deliverables include both final and interim deliverables that are required to create the final results.
- Deliverables include intangible items, such as information/communication, integration, administration, training, process management, and procurement.
- All deliverables are explicitly included in the WBS.
- Deliverables are unique and distinct.
- All significant reporting mechanisms, such as review meetings, monthly reports and test reports are included and identified in the WBS.
- Clearly defining the project deliverables, so that each is unique, ensures there will be no duplication in the outcomes of the project or of the work performed to produce the end-products.
- Accountability for each work package can be assigned to a single project team member or subcontractor. If this is not possible, then reconsider whether or not the work package can be further decomposed.
- Each element in the WBS representing subcontracted or externally committed deliverables directly corresponds to matching elements in the subcontractor's WBS.
- The deliverables are logically decomposed to the level that represents how they will be produced and managed (e.g., designed, purchased, subcontracted, or fabricated).
- All WBS elements are compatible with organizational and accounting structures.

The following basic guidelines should be considered when organizing WBS elements into the WBS hierarchy:
- Each WBS element belongs to only one parent WBS element.
- The set of child elements into which a parent element is decomposed includes all of the work contained in the parent, such that the 100% Rule applies.

- A coding scheme is used for WBS elements that clearly represents the hierarchical structure when viewed in text format.
- All ''legs'' of the WBS need not be to the same depth. Some areas of the WBS will need to show more detail than others.
- There is no need to have all work packages at the same level.
  The WBS development process should:
- Be iterative
- Be reviewed and revised as the rest of the project planning process progresses
- Provide a vehicle for flexibility, particularly when the scope of the project effort might change.

A well-managed project, however, will incorporate a rigorous change control process to document and manage scope changes. When work scope changes do take place, the WBS must be updated. Any change in the WBS requires an associated change in related project management tools, such as the WBS Dictionary, network diagram, and schedule.

5.3.1 Project Management Knowledge Area Considerations

In the iterative WBS development process, the following guidelines and questions should be considered as they relate to each Project Management Knowledge Area in the *PMBOK® Guide*—Third Edition:

.1 **Project Integration Management**
  - Include work in the WBS for the integration of components. Place the WBS element for component integration at the same level as the components being integrated.
  - Include work in the WBS for the necessary communications and meetings required for effective integration management.
  - Is the work defined by the WBS grouped in a logical manner? Have all reporting and control mechanisms been addressed?

.2 **Project Scope Management**
  - WBS development is critical to scope management. Revisit the WBS often and expect to iterate WBS development.
  - Are requirements defined and approved?
  - Is there a statement of work, a set of contract requirements, or other documented requirements? Be sure that each WBS element can be traced to these requirements. Include only those activities that are considered in scope and can be traced to contractual or other requirements.
  - As the WBS is defined, keep a list of activities and efforts that are considered to be out of scope. Confirm scope with stakeholders often by reviewing the WBS and the out of scope list.
  - Are all deliverables explicitly identified in the WBS?
  - Will horizon or rolling wave planning be applied to develop or further decompose the scope progressively over time?
  - Have historical data, risk registries, checklists, and lessons learned been consulted to ensure identification of all work?

.3 Project Time Management
- Deliverables should be decomposed to the level of detail needed to estimate the effort required to obtain or create them.
- How will the status of work in progress be determined?

.4 Project Cost Management
- Deliverables should be limited in size and definition for effective control— not so small as to make cost of control excessive, and not so large as to make the item unmanageable or the risk unacceptable.
- How will budgets be established?
- Will it be possible to relate the budget to the proposed work assignments?
- Is the level of detail in the WBS appropriate for effective planning and control?

.5 Project Quality Management
- Will the quality of the work be evaluated through efforts such as testing and inspection?
- Are there quality requirements for the project? If so, be sure to include WBS elements to document the periodic review of quality requirements, quality management activities, quality audits, and quality reviews.
- Are there requirements to show compliance with ANSI, ISO or other standards? If so, include WBS elements for outside auditing of the project for compliance.
- Are there quality requirements defined for the deliverables outlined in the WBS?
- Have metrics been defined for how the deliverables will be measured?

.6 Project Human Resource Management
- Ensure that each WBS element has a single point of accountability. If a WBS element might involve more than one accountable person, consider decomposing the WBS element.
- Is all the work planned to a degree of detail necessary to make and keep commitments?
- Ensure that the reporting structure indicated by this WBS supports establishing and managing individual work assignments.
- Can work assignments be established from a progressive expansion of the WBS?
- How will work generally be assigned and controlled?
- Will it be possible to reconcile individual work assignments to the formal scheduling system?
- Is more than one organization involved, requiring validation of the WBS with others before doing detailed resource planning?

.7 Project Communications Management
- Have all communication needs been accounted for?
- Are there long distance, Regional, National and International communications required?
- Are there any special deliverables required for international communications, such as translations and other country-specific requirements?
- Are there special communication needs for any deliverables outlined in the WBS?

.8 Project Risk Management
- For areas of the WBS that are considered high-risk, consider decomposing the WBS to a more detailed level. This will allow better definition of assumptions and expectations, and will allow for more accurate planning, thus reducing risk.
- Are the deliverables completely and clearly defined?
- What is the likelihood of change?
- Is the technology changing faster than the project can be accomplished?
- Have manpower, facilities capability, availability of internal resources, and potential suppliers been checked?
- Has a formal change process been defined and implemented?
- Have metrics been defined for how the deliverables will be measured?
- Have resource requirements been identified for development of the project deliverables?
- Have other risks been identified, including stakeholder buy-in, public relations, management approval, team understanding, and project opposition?
- Has both an internal and external communication plan been defined and implemented?
- Are third-party dependencies understood and monitored for change?
- Have alternate suppliers of required products, supplies, or expertise been identified?
- Have historical data, risk registries, checklists, and lessons learned been consulted to ensure identification of all risks?
- Has risk management and contingency work been included?

.9 Project Procurement Management
- Is extensive subcontracting expected?
- Is there a WBS element for each procured deliverable?
- Are intangible deliverables required for managing the procurement process?
- Will procurement be managed by the project team or by an existing procurement organization?

5.4 Essential Judgments

Effective application of use-related characteristics relies on experience and judgment. This section examines that concept in a bit more detail. Factors that can vary from one project or application to another, depending upon the purpose for which the WBS is intended, include, but are not limited to, the level of detail needed in the decomposition of the deliverables, the selection of the type of WBS element to be included, and structuring the logic of the decomposition.

5.4.1 Determining Appropriate WBS Level of Detail

The WBS development process has been described as proceeding to successive levels of increasing detail, culminating in a level of detail that captures all elements of the scope of the project. This process also provides needed insight for clear communications and effective project management. The level of detail in a WBS is a function of the size of the project, and reflects a balance between complexity, risk, and the project manager's need for control. The level of detail can also vary during the evolution of a project. A top-down and bottom-up analysis of the WBS can clarify whether the WBS is both complete and defined at the proper level of detail.

Short-duration projects can lend themselves to decomposition to a high degree (extensive level) of detail at the outset, while projects of longer duration and higher complexity can preclude decomposition of all deliverables until more is known about the project. Again, this means that on any given project, some portions of the WBS can have different levels of decomposition. This is especially true when doing rolling wave planning, where the plan is detailed only for the immediately upcoming work, and work far in the future is defined at a high level until later in the project life cycle.

When proceeding to successive levels of increasing detail, the 100% rule must still apply. This rule states that the children nodes of a parental node must make up 100% of the work of that parental node. Additionally, not all legs of the WBS must be symmetrical in terms of the number of levels developed. There is no need to decompose all legs of the WBS if the need is only present in one area.

Should the WBS be decomposed further? The following questions provide guidance for determining the need for further decomposition of the WBS. If the answer to any of these questions is yes, then further decomposition should be considered. The greater the number of positive answers, the stronger the justification for further division of some or all of the WBS.

.1 **Scope and Work Package Detail**
- Are clear, objective criteria missing for measuring the progress for the WBS element?
- Does the WBS element contain more than one deliverable?
- Do prerequisites differ among internal deliverables within the WBS element?
- Can a portion of the work to be performed within the WBS element be scheduled as a unit?
- Are there acceptance criteria applicable before completion of the entire WBS element?
- Is the WBS element clearly and completely understood to the satisfaction of the project manager, project team members, and other stakeholders—including the customer?
- Are there relationships between internal WBS element deliverables and other external WBS elements?
- Is there a stakeholder interested in analyzing status and performance of only a portion of the work covered by the WBS element?
- Can progress of the work be assessed as needed?

.2 **Resources and Risks**
- Can the work element be assigned to a single accountable individual? While there might be a variety of resources assigned to a given WBS element, there should ultimately be only one individual accountable for delivery of the work package.
- Are there specific risks that require focused attention to a portion of the WBS element?
- Can actionable risks be identified for each WBS element?

.3 **Costs and Timing**
- Are there significant time gaps in the execution of the work processes internal to the WBS element?
- Is there a need to improve the accuracy of the cost and duration estimates of the WBS element?
- Is there a need to separately define the cost of work processes or deliverables internal to the WBS element?
- Is there a need to precisely know and report the timing of deliverables internal to the WBS element?

5.4.2 Selection of the Type of WBS Element to be Included

A WBS organizes and defines the total work scope of the project. Not every WBS, however, needs to include all types of work. Rather, the kinds of work included in a WBS should be dictated by the scope and nature of the project for which the WBS is being developed. Some examples of this are presented here.

- Some projects require certain types of WBS elements that are not necessary for other projects. For example, in a project that involves production of several different components that need to be assembled into a finished product, it would be necessary to include an integration or assembly WBS element so that the assembly work can be identified, resourced, tracked, and reported. In contrast, a project to develop a business process might not require such an assembly element.
- All projects require a project management WBS element at Level 2, in order to ensure that the work of planning, tracking, and reporting is adequately captured and managed. A particular organization, however, might require use of a standardized WBS template that does not include certain kinds of project management WBS elements (for example, administration, documentation, or reporting elements) because the need for these is adequately addressed by other business processes established by that organization. In such cases, these elements would not be required.
- Quality assurance is applicable to all projects. Some organizations could have requirements for compliance with specific quality standards. In such cases, the WBS must include elements, such as documentation and audits, to account for compliance with the specified procedures.

5.4.3 Structuring the Logic of the Decomposition

An essential feature of a WBS is that it clearly and comprehensively defines the scope of the project work through decomposition of deliverables into a hierarchy of simpler components, thereby providing one of the primary methods for managing complex projects. The way that the project manager decomposes the project (i.e., the logic used for decomposing the work) can vary depending on the needs and requirements of the performing organization and the use to which the WBS will be put. This is illustrated by the following examples:

- One organization might be structured along very strict functional lines, with few business processes that facilitate communication among the separate subunits. In such a case, it can make sense to structure the decomposition in terms of the work and sub-deliverables that each function independently contributes. In contrast, in a projectized organization without functional divisions, the same deliverable might more effectively be decomposed into a hierarchy of subassemblies.
- Where new product development proceeds in sequential stage-like phases with later work contingent on the outcome of earlier work, it would make sense to organize the WBS in terms of the product development life cycle, rather than in terms of physical components of the product.
- A food-service enterprise with regional offices might find it particularly valuable to structure the WBS for a program to create a new chain of restaurants as a series of geographic subprojects, while a centralized enterprise that sub-contracts, for instance, building development, food sourcing, or marketing, would find it more useful to decompose the new restaurant program in terms of sub-systems.

In all cases, it is important that the WBS remain deliverable-oriented, rather than process-oriented, and explicitly contain all intermediate deliverables.

5.5 Evaluating WBS Quality

There are several points that are considered essential when creating a WBS. As detailed in Chapter 4, there is a set of core characteristics that every WBS must have, which enable it to satisfy project needs. Failure to address these considerations can lead to failure of the project, because there would be a high risk of not identifying all of the required work.

5.5.1 Core Characteristics

- The WBS structure is not based on timing or sequence dependencies among components. Timing, sequencing, and dependencies are project schedule concerns.
- The WBS is not structured strictly by process or organization.
- The WBS defines the logical relationships among all the components of the project.
- All WBS elements are deliverable-oriented.
- Project activities are not listed, as these are components of the project schedule, not the WBS.
- All element names are nouns. Verbs are not used to identify WBS elements.
- The WBS includes only sufficient and necessary deliverables. All deliverables are necessary components of the project's product, service, or end result, and are defined in the project's scope.
- All project deliverables including regulatory permits, packaging, distribution, or marketing, as well as preliminary, interim, internal, external, or final deliverables, are identified and detailed.
- There are no WBS elements with overlapping responsibilities. Each WBS element must have one person who is clearly accountable for its completion.

Also, as discussed in Chapter 4, there is an additional set of use-related characteristics that might vary from one WBS to another. These characteristics enable the use of the WBS for purposes that can be unique to a specific project, industry, or environment, or are applied in a particular way on individual projects. With respect to use-related characteristics, the quality of the WBS depends on how well the specific content and type of WBS elements meet the use for which the WBS was intended.

5.5.2 Use-Related Characteristics

- Identify key project management (non product) work such as:
  - Initiating, planning, executing, monitoring and controlling, and closing
  - Process management
  - Services and provisioning
  - Information/communication
  - Administrative documentation, training, and software.

  These should be defined as level-of-effort WBS elements in those cases where they can be interim deliverables, do not themselves generate discrete deliverables, and might not be included in the delivery of the final product.
- Include cross-project WBS elements, such as those representing opening and closing stages, for example, planning, assembly, integration, and testing.
- Balance the project definition aspects of the WBS with the data collecting and reporting requirements. The primary purpose of the WBS is to define the project's scope through the decomposition of deliverables.
- Decompose the WBS to the appropriate level of detail by achieving a balance between project complexity, risk, and the project manager's need for monitoring and control.
- Do not decompose the WBS too far. Each WBS is a tool designed to assist the project manager with decomposition of the project only to the levels necessary to meet

the needs of the project, the nature of the work, and the confidence of the team. Excessive WBS levels can require unrealistic levels of maintenance and reporting.

● Do not omit WBS development, such as Gantt chart, CPM schedule or precedence diagram before proceeding to the network diagram. Omitting the development and refinement of the WBS can lead to unforeseen and unexpected difficulty, including project delays, cost over-runs, or outright project failure.

5.6 WBS Usage Continuum

The ability of a WBS to meet the needs of a project is directly related to the level of project management competency available within the project management team.

An experienced project management team will be able to identify a greater range of stated and implied project needs that the WBS can address. A more experienced project management team will ensure the WBS is employed in a greater variety of project roles, and will use the WBS in more efficient and sophisticated ways than will a novice or inexperienced project management team. A WBS can be of high quality even if it is not being used to its full capacity by the project management team.

The project management team's development and use of the WBS as an effective planning and control tool represents its position on the WBS usage continuum. In other words, once the project management team begins using a WBS within the project context, their ability to make the WBS play an important defining and controlling role for scope, budget, and risk follows a growth continuum similar to that of any other project management methodology or tool. The following is an experience continuum for WBS development and use:

Limited	Intermediate	Extensive
• Develop a WBS that contains all Core Characteristics	• Develop a WBS that contains all Core Characteristics	• Develop a WBS that contains all Core Characteristics
• Apply at least a minimal level of experience in project estimating	• Identify & include some use-related attributes	• Identify & include all required use-related characteristics
• Apply subject matter expertise if appropriate	• Apply the WBS effectively to project schedule development and resource assignment	• Apply the WBS effectively to project schedule development and resource assignment
	• Apply project estimating techniques in developing the WBS	• Apply project estimating techniques to develop & manage the project using the WBS
		• Apply the WBS effectively to Change Control Planning and Execution, Quality Planning and Control, Risk Planning and Management, Cost and Budget Planning and Control, etc.

Figure 5-1. WBS Usage Continuum

5.7 WBS for Program and Portfolio Management

According to the *PMBOK® Guide*—Third Edition, projects, programs and portfolios are defined as follows:

Project. A temporary endeavor undertaken to create a unique product, service, or result.

Program. A group of related projects managed in a coordinated way to obtain benefits and control not available from managing them individually. Programs may include elements of related work outside of the scope of the discrete projects in the program.

Portfolio. A collection of projects or programs and other work that are grouped together to facilitate effective management of that work to meet strategic business objectives. The projects or programs of the portfolio may not necessarily be interdependent or directly related.

Work Breakdown Structures are useful not only for projects, but for programs and portfolios as well. Use of the WBS at these levels is a growing practice. There is no conceptual difference among a project WBS, a program WBS, or a portfolio WBS. A high-quality WBS developed at any of these broader levels possesses precisely the same characteristics and attributes as a high-quality WBS developed at the individual project level. These differ only in the breadth of the content (scope).

All of the principals defined in Section 4 that apply to a project WBS also apply to a program or portfolio WBS. Great care should be taken, however, when working with WBSs beyond the program level. The difficulty in verifying that all work and deliverables are defined increases significantly as the scope increases.

5.8 Summary

This chapter has shown that there are many ways in which a WBS can be created. It can be developed as an entirely new document, can reuse components from existing WBSs, can be based on a template, or can follow predefined WBS standards. Regardless of the method used to construct it, the WBS evolves through an iterative consideration of the project's scope, including the project's purpose and objectives (both business and technical), functional and performance design criteria, technical performance requirements, and other technical attributes.

This chapter has presented several guidelines and checklists to assist in the preparation of a WBS. All other Project Management Knowledge Areas (such as Project Time Management, Project Cost Management, and Project Quality Management) are highly dependent upon the resulting WBS. In the end, a high-quality WBS provides a strong foundation upon which to build a successful project.

Appendix A

Guidelines for a Project Management Institute Practice Standard

- Each practice standard provides guidelines on the mechanics (e.g., nuts and bolts, basics, fundamentals, step-by-step usage guide, how it operates, how to do it) of some significant process (input, tool, technique, or output) that is relevant to a project manager.
- A practice standard does not necessarily mirror the life-cycle phases of many projects. But, an individual practice standard may be applicable to the completion of one or more phases within a project.
- A practice standard does not necessarily mirror the knowledge areas within *A Guide to the Project Management Body of Knowledge*/Third Edition *(PMBOK® Guide)*, although an individual practice standard will provide sufficient detail and background for one or more of the inputs, tools and techniques, and/or outputs. Therefore, practice standards are not required to use the name of any knowledge area.
- Each practice standard should include information on *what* the significant process is and does, *why* it is significant, *how* to perform it, *when* it should be performed and, if necessary for further clarification, *who* should perform it.
- Each practice standard should include information that is accepted and applicable for most projects most of the time within the project management community. Processes that are generally restricted or applicable to one industry, country, or companion profession (i.e., an application area) may be included as an appendix for informational purpose, rather than part of the practice standard. With strong support and evidence, an application area-specific process may be considered as an *extension* practice standard, in the same manner as extensions to the *PMBOK® Guide*—Third Edition are considered.
- Each practice standard will benefit from the inclusion of examples and templates. It is best when an example or template includes a discussion of its strengths and weaknesses. A background description may be necessary to put this discussion in the appropriate context. The examples should be aligned with the relevant information in the standard or its appendix and placed in proximity to that information.
- All practice standards will be written in the same general style and format.

- Each practice standard project will assess the need to align with or reference other practice standards.
- Each practice standard will be consistent with the *PMBOK® Guide*—Third Edition.
- Each practice standard is intended to be more prescriptive than the *PMBOK® Guide*—Third Edition.

Appendix B

Evolution of the Project Management Institute Practice Standard for Work Breakdown Structures

B.1 Initial Development: 1999–2001

During the development and subsequent publication by the Project Management Institute (PMI®) of *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)*, it was recognized that project management practitioners and other stakeholders would be aided by more in-depth treatment of the listed inputs, tools and techniques, and outputs. Consequently, in early 1998, PMI asked for volunteers to develop the first such practice standard, specifically on the Work Breakdown Structure (WBS). A volunteer team was assembled and during the year worked through a number of drafts and revision cycles.

In early 1999, PMI Project Management Standards Program Team reviewed the draft and recommended the completion of the *Practice Standard*. In late spring 1999, Kim Colenso was approved as the new project manager for the *Practice Standard*. He was tasked to form a new team to make minor modifications to the current draft, and add example WBSs. The plan was to publish the *Practice Standard for Work Breakdown Structures* in an Exposure Draft to the PMI membership and other affected parties by the summer of 2000, and a final document would be published as a PMI Standard in 2001.

A team was assembled during the summer and fall of 1999 through solicitation of participation from the PMI Specific Interest Groups and other volunteer sources. During this period, a controversy developed within the project team as to whether or not an *activity* was or should be part of the WBS. Through further discussion among the project team and among the PMI Project Management Standards Program Member Advisory Group, the issue was resolved, and an article describing the outcome was published in the *PM Network* in April 2000 (see References).

The project team implemented a formal change-control procedure to guide and control the evolution of the practice standard. This procedure required all proposed

changes to be documented and approved by the project team. As a result of this process, the following events occurred:

- The team judged the structure of the specific working draft supplied by the PMI Project Management Standards Program Team to be unsatisfactory. With the approval of the PMI Project Management Standards Program Team, that draft was replaced with the earlier November 1998 draft, to which all further changes were applied.
- Over forty formal change requests were submitted and approved by the team between October 1999 and April 2000. Another six were disapproved, as the arguments were deemed unpersuasive.
- Twelve WBS examples were approved and incorporated as Appendices D through N of this practice standard.

The revised draft was submitted to the PMI Project Management Standards Program Team in May 2000 for consideration as the exposure draft to be circulated among PMI membership and other affected parties. Following approval by the PMI Project Management Standards Program Team, the proposed exposure draft was submitted for formal review to six other knowledge experts. The team evaluated the comments from these six reviewers and the PMI Project Management Standards Program Team. A final draft was then submitted to the PMI Project Management Standards Program Team and approved for the exposure draft.

The exposure draft was submitted for public review on 29 September 2000, with an exposure closure on 30 November 2000. During this period, 488 comments were received. All comments that the project team accepted for the current version have been incorporated.

When we look at the *PMBOK® Guide*—Third Edition, it is a remarkable achievement. It has gone through an evolutionary process for fourteen years. Each edition has improved upon the previous version. After several editions, the result is an extremely refined and powerful document. The same will be true for the *Practice Standard for Work Breakdown Structures*. It has gone through its initial development. Now it is ready to begin its journey through the refinement process.

B.2 Second Edition: 2003–2006

In April of 2003, the Practice Standard for Work Breakdown Structures update team received its charter from the PMI Standards MAG (Membership Advisory Group) and began the update to the first practice standard published by PMI. Following guidance received from the Standards Manager and MAG regarding approach, strategy, objectives, content, size, and structure, the team examined the existing practice standard as well as comments and recommendations received during the previous review and publication cycles. The update team also conducted surveys of project managers from a cross section of industries.

This analysis, which spanned a number of months, revealed the need for significant change to the practice standard to clarify the guidance it provides and improve its relevance. To summarize, the update team found there was a need to:

- Ensure the practice standard provides a consistent approach to WBS development throughout the body of the document
- Update the content to bring guidance in line with current practice and WBS application
- Use examples and figures throughout to clarify guidance provided

- Provide new material within the practice standard to clearly explain differences between poorly and well-constructed work breakdown structures
- Ensure the appendices reflect the guidance provided in the practice standard and provide a greater number of varied examples
- Provide a breakdown (WBS example) of the project management work defined by the *PMBOK® Guide*—Third Edition
- Add templates (WBS examples) that can be extracted and modified by practitioners who purchase the practice standard
- Provide a detailed perspective of the historic evolution of the concepts relating to work breakdown structures
- Synchronize the WBS practice standard with the latest release of the *PMBOK® Guide*—Third Edition
- Limit the content to WBS-related topics only, removing content related to scheduling, Earned Value Management and other non-WBS items.

With these items as an outline for the ''desired outcome'' and the analysis described above as the starting point, the update team began framing the second edition of the practice standard. By using an iterative development process, internal team comment review cycles, as well as SME (Subject Matter Expert) reviews and interviews, the team developed the latest updates to the practice standard content. The team additionally worked closely with PMI's standards organization to design the appropriate context for publication of the new standard—reflecting latest technology and the needs of the project management community at large.

As a result, the updated standard, *Practice Standard for Work Breakdown Structures*—Second Edition, now contains the following changes and improvements:
- Material in each of the original chapters has been rewritten for clarity
- A new chapter on WBS Quality was added
- The original appendices were revised to reflect current practice and quality attributes
- Appendices have been added to illuminate various methods for representing the WBS
- A CD-ROM is included with the practice standard and will contain the body of the practice standard, the appendices, and the white paper
- All of the examples found in the appendices will be extractable from the CD-Rom as templates for use in WBS development

Most importantly, the update team worked to ensure synchronization among the latest release of the Practice Standard for Work Breakdown Structures, the *PMBOK® Guide*—Third Edition, the current Earned Value Management Practice Standard, and the latest release of PMI's Lexicon for Project Management, while at the same time partnering with the Practice Standard for Scheduling Team and anticipating the release of a new Practice Standard for Scheduling.

To support the needs of project managers in today's environment, this updated practice standard provides the reader with new guidance regarding WBS construction and quality attributes. Beyond this, the update to the practice standard will be published as a hardcopy document—and will include a CD-ROM to provide the reader with the ability to scan and search the entire document for specific words or content. The CD-ROM will also carry copies of each of the appendices found in the practice standard. The electronic versions of the appendices will be presented as templates that can be, extracted, copied and modified by project managers for use in their own projects and programs.

We believe the latest release of the *Practice Standard for Work Breakdown Structures* reflects the outstanding achievement of the team that created the first edition and continues the tradition of extending and enhancing the document while setting the stage for the continued evolution of the practice standard.

Appendix C

Contributors and Reviewers of the *Practice Standard for Work Breakdown Structures*—Second Edition

This appendix lists, alphabetically within groupings, those individuals who have contributed to the development and production of the *Practice Standard for Work Breakdown Structures*—Second Edition. No simple list or even multiple lists can adequately portray all the contributions of those who have volunteered to develop the *Practice Standard for Work Breakdown Structures*—Second Edition. Appendix B describes specific contributions of many of the individuals listed below and should be consulted for further information about individual contributions to the project.

The Project Management Institute is grateful to all of these individuals for their support and acknowledges their contributions to the project management profession.

C.1 *Practice Standard for Work Breakdown Structures*—Second Edition Project Core Team

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C.2 Significant Contributors

Significant contributors supported key activities for the update to the Practice Standard including editing and sub-team participation in project efforts such as Content, Author-

ing, Quality, Communications and Research sub-teams. The update project's significant contributors offered depth of knowledge and insight as Subject Matter Experts (SME) in their fields of practice. In addition to the members of the Project Core Team, the following individuals provided significant support, input or concepts:

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Appendix D

Bicycle Work Breakdown Structure (WBS) Example

D.1 Overview

In Chapter 3, Work Breakdown Structure (WBS) ''use-related characteristics'' were described. These are WBS characteristics that vary from one project to another so that the WBS better satisfies the requirements of a specific project, industry or environment.

Consistent with this principle, a WBS can be represented in a variety of ways in order to achieve a specific purpose in a specific situation. A single WBS may also be represented in more than one way in various situations on a given project. This appendix illustrates a number of formats that are found in common practice today. All of these representations, as well as others not included here, may be used to detail the scope of a specific project. To allow the reader to focus on the differences among the various representations, a single WBS will be used to illustrate each format.

To help simplify the comparison of these WBS formats, we have chosen the bicycle project example described in the text of the practice standard.

D.2 Outline View

A very common representation of the WBS is the *Outline View* in which each level of the WBS is shown by the level of indentation and is accompanied by an alphanumeric outline code, or numbering scheme. Outline views are readily developed using a number of common tools, including word processors and spreadsheets

1 Bicycle
   1.1 Frame Set
      1.1.1 Frame
      1.1.2 Handlebar
      1.1.3 Fork
      1.1.4 Seat
   1.2 Crank Set
   1.3 Wheels
      1.3.1 Front Wheel
      1.3.2 Rear Wheel
   1.4 Braking System

1.5   Shifting System
            1.6   Integration
                  1.6.1   Concept
                  1.6.2   Design
                  1.6.3   Assembly
                  1.6.4   Testing
                          1.6.4.1   Component Test
                          1.6.4.2   Product Test
                          1.6.4.3   Customer Test
            1.7   Project Management

For some purposes, the outline view might not use indentation, but simply show the hierarchical structure through the numbering scheme:

Level	WBS Code	Element Name
1	1	Bicycle WBS
2	1.1	Frame Set
3	1.1.1	Frame
3	1.1.2	Handlebar
3	1.1.3	Fork
3	1.1.4	Seat
2	1.2	Crank Set
2	1.3	Wheels
3	1.3.1	Front Wheel
3	1.3.2	Rear Wheel
2	1.4	Braking System
2	1.5	Shifting System
2	1.6	Integration
3	1.6.1	Concept
3	1.6.2	Design
3	1.6.3	Assembly
3	1.6.4	Testing
4	1.6.4.1	Component Test
4	1.6.4.2	Product Test
4	1.6.4.3	Customer Test
2	1.7	Project Management

Table D-1. Hierarchical Structure

Eliminating indentation may make the WBS less intuitive for the reader, but may save space in certain documents.

D.3   Tabular View

Another common representation of a WBS is the *Tabular View* in which the hierarchical structure is represented through columns in a table. Tabular views are common in

situations where it may be difficult to use a more graphical format, such as text document with limited formatting capability.

Level 1	Level 2	Level 3	Level 4
1 Bicycle WBS			
	1.1 Frame Set	1.1.1 Frame 1.1.2 Handlebar 1.1.3 Fork 1.1.4 Seat	
	1.2 Crank Set		
	1.3 Wheels	1.3.1 Front Wheel 1.3.2 Rear Wheel	
	1.4 Braking System 1.5 Shifting System 1.6 Integration	1.6.1 Concept 1.6.2 Design 1.6.3 Assembly 1.6.4 Testing	1.6.4.1 Component Test 1.6.4.1 Product Test 1.6.4.1 Customer Test
	1.7 Project Management		

Table D-2. Tabular View 1

A different type of tabular structure is sometimes encountered in government publications. Such displays often include additional information such as cost accounting codes, organizational elements responsible for the WBS element, etc. It may be difficult to display more than a few levels of a WBS using this format.

Bicycle WBS 1	
1.1 Frame Set	
1.1.1 Frame 1.1.2 Handlebar	1.1.3 Fork 1.1.4 Seat
1.2 Crank Set	
1.3 Wheels	
1.3.1 Front Wheel 1.3.2 Rear Wheel	
1.4 Braking System	
1.5 Shifting System	
1.6 Integration	
1.6.1 Concept 1.6.2 Design	1.6.3 Assembly 1.6.4 Testing *1.6.4.1 Component Test* *1.6.4.2 Product Test* *1.6.4.3 Customer Test*
1.7 Project Management	

Table D-3. Tabular View 2

D.4 Tree Structure View

One of the most common ways to represent a WBS is the graphic *Tree Structure,* or ''Organizational Chart'' structure in which each ''child'' element is shown as a box with a line connecting it to the ''parent'' element of which it is a component. This representation makes very explicit the way in which the project and the subordinate components are hierarchically decomposed into smaller and smaller elements. The most common version of the tree structure places the project at the top level with successive levels of decomposition below.
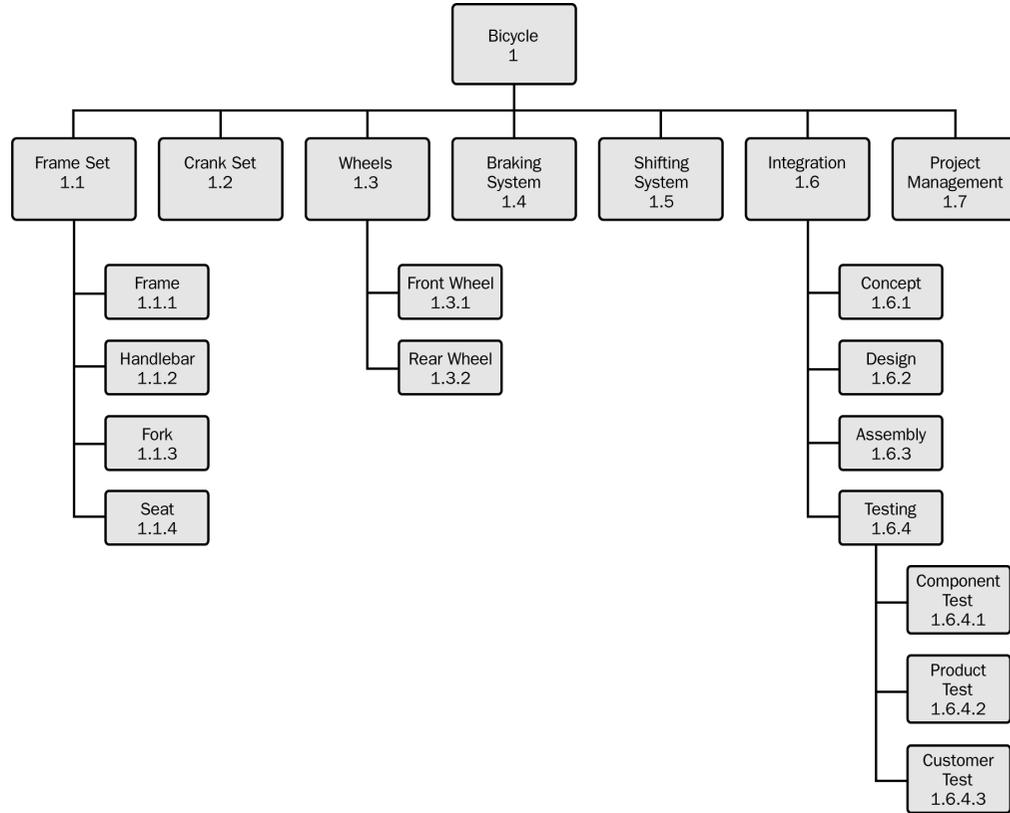
Figure D-1. WBS Tree Structure View 1

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Alternatively, the orientation of the WBS Tree Structure view may be modified. In these cases, the project may be placed on the left with lower levels of decomposition moving to the right. For some purposes a landscape orientation may be useful. Below are two similar examples of this.

Figure D-2. WBS Tree Structure View 2

Figure D-3. WBS Tree Structure View 3

Or in other cases, a horizontal portrait orientation may be more useful.

Figure D-4. WBS Horizontal Tree Structure View

An increasingly popular format is the *Centralized Tree Structure*. This type of format is produced by software that is used for facilitating development of the WBS through real time group interactions. Below are two examples of the centralized tree structure WBS.

Figure D-5. WBS Centralized Tree Structure View 1

Figure D-6. WBS Centralized Tree Structure View 2

D.5 Enhanced Uses of the WBS

By including information in the WBS in addition to the core WBS Element Name and WBS Code, the WBS can become the explicit means for integrating other project management processes with scope.

One example of such enhanced use is the WBS Dictionary which adds a detailed definition of each WBS Element. The WBS Dictionary may also include key cost control and resource assignment information, as in the following example. Note that the cost control number column is left blank, which can be a placeholder for the information once it is made available when the order is taken.

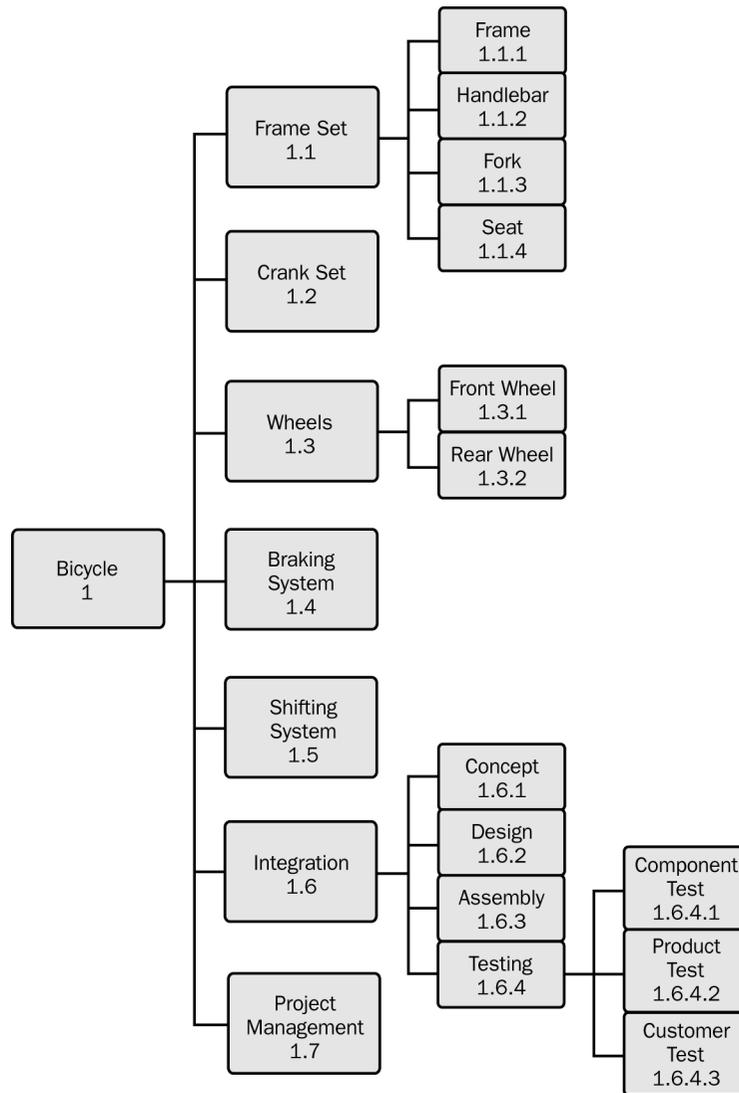| Level	WBS Code	Element Name	Definition	Cost Control Number	Responsible Organization
1	1	Bicycle WBS	All components and subassemblies required to specify design, assembly and testing of a custom bicycle.		Customer Sales and Support
2	1.1	Frame Set	The individual components that together constitute the frame once assembled		Customer Sales and Support
3	1.1.1	Frame	The unit tubular steel structure to which other components are attached. Provides basic design and strength.		Customer Sales and Support
3	1.1.2	Handlebar	Used by rider to steer bicycle. Also serves as point of attachment for hand brakes, lights, and other accessories. Style to be selected by customer.		Customer Sales and Support
3	1.1.3	Fork	Attaches wheel(s) to frame. Must be selected to match frame.		Customer Sales and Support
3	1.1.4	Seat	Padded saddle attached to frame for rider to sit on. Style to be selected by customer.		Customer Sales and Support
2	1.2	Crank Set	Mechanical linkage for converting rider's pedaling action into rotation of rear wheel to provide propulsion. Part selection is determined by customer's performance specifications and compatibility with other mechanical components.		Customer Sales and Support
2	1.3	Wheels	Interface with ground. Customer may select among several options with respect to materials, weight, and aerodynamic styling.		Customer Sales and Support
3	1.3.1	Front Wheel	Front wheel is specialized for steering through attachment of handlebars.		Customer Sales and Support
3	1.3.2	Rear Wheel	Rear wheel is specialized for propulsion.		Customer Sales and Support
2	1.4	Braking System	Mechanical system for converting hand pressure into friction on the wheel rim to control speed.		Customer Sales and Support

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Level	WBS Code	Element Name	Definition	Cost Control Number	Responsible Organization
2	1.5	Shifting System	Mechanical linkage system for changing position of chain on rear wheel sprocket to adjust leverage and gear ratio to match riding conditions.		Customer Sales and Support
2	1.6	Integration	The complete design, assembly and testing of the bicycle.		Customer Sales and Support
3	1.6.1	Concept	High level vision of finished bicycle desired by customer. Usually communicated to sales to serve as the basis for the bicycle design.		Customer
3	1.6.2	Design	The complete set of specifications that defines the finished bicycle. Developed by engineering department to satisfy customer's concept of the bicycle.		Engineering Dept.
3	1.6.3	Assembly	The series of sub-assemblies that together result in creation of the finished bicycle.		Manufacturing Shop
3	1.6.4	Testing	The series of inspection and measurements performed to determine whether the individual components and finished bicycle meet the design specifications and customer's vision of the finished bicycle appearance and performance.		Quality Control Organization
4	1.6.4.1	Component Test	The series of inspection and measurements performed to determine whether the individual components meet the design specifications.		Quality Control Organization
4	1.6.4.2	Product Test	The series of inspection and measurements performed to determine whether the sub-assemblies and finished bicycle meet the design specifications.		Quality Control Organization
4	1.6.4.3	Customer Test	The series of inspection and measurements performed by the customer to determine if the finished bicycle matches the expectations of the finished bicycle appearance and performance.		Customer
2	1.7	Project Management	The skills and processes used to ensure that the bicycle is designed, built, and delivered in accordance with quality, cost, and schedule that were agreed upon by the customer.		Project Management Organization

Table D-4. WBS Dictionary

There may also be occasions when a WBS may contain less information than is standard usage. For example, for communication of the WBS to a non-technical audience such as the customer or senior management, it may enhance the communication if the code numbers that normally accompany the WBS elements are suppressed. This is acceptable because it addresses the needs of a specific situation.
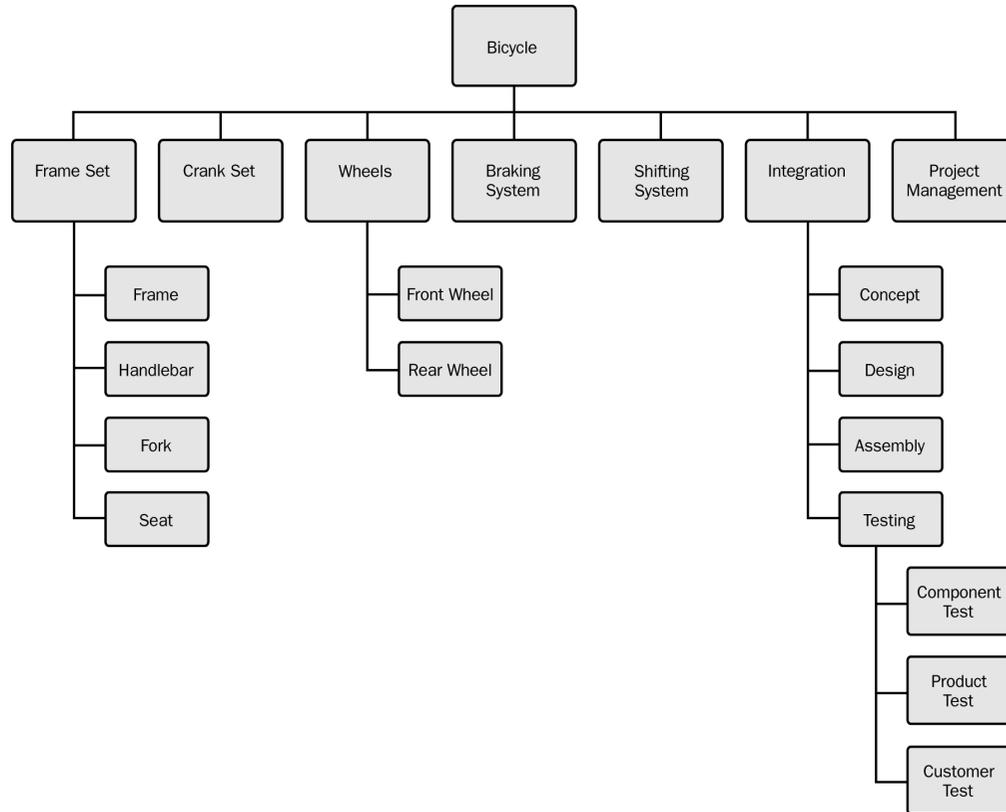
Figure D-7. WBS Dictionary

D.6 WBS Code Numbers

In the examples above, the WBS code uses a numbering scheme consisting of Arabic numbers separated by periods. This allows for easy and systematic expansion of the WBS as additional elements are added. In other cases, the WBS code might use a different alphanumeric system, for example, a combination of Roman numerals, letters and Arabic numbers. This particular system does not lend itself to systematic expansion as a purely numeric code. In some cases, the numbering scheme may be defined by the organization in such away as to permit coordination across projects and enable program level cost control. The WBS Code serves as a unique identification number.

I   Bicycle
    I.A   Frame Set
        I.A.1   Frame
        I.A.2   Handlebar
        I.A.3   Fork
        I.A.4   Seat
    I.B   Crank Set
    I.C   Wheel
        I.C.1   Front Wheel
        I.C.2   Rear Wheel
    I.D   Braking System
    I.E   Shifting System
    I.F   Integration

I.F.1 Concept

I.F.2 Design

I.F.3 Assembly

I.F.4 Testing

> *I.F.4.1 Component Test*
>
> *I.F.4.2 Product Test*
>
> *I.F.4.3 Customer Test*

I.G Project Management

The WBS examples in this appendix are illustrative only and are intended to provide guidance to the reader. No claim of completeness is made. All examples reflect the quality principles expressed in this Practice Standard. As expressed in the *PMBOK® Guide*—Third Edition ''the project management team is responsible for determining what is appropriate for any given project'' (Project Management Institute 2004).

Appendix E

Oil, Gas, and Petrochemical (OGP) Work Breakdown Structure (WBS) Example

This is an example of a Work Breakdown Structure (WBS), from the owner's point of view, for the detailed design, fabrication, and installation of an offshore production platform. As the detailed engineering, fabrication, and installation are distinct phases of the work, these are placed at Level 2 of the WBS. This fits with the progression of the work, but also with the contracting strategy; that is, different contractors for engineering, for fabrication, and so on may be employed or used. The logic of decomposition at the next level varies with the deliverable. Not all branches of the WBS are decomposed to the same level of detail. The WBS is generic and as such serves as a WBS template which would be customized for specific projects. Perhaps certain WBS elements will be decomposed to a greater level of detail as those details for a specific project become known (for example, 1.3.4.3 All Other Contractor Supplied Equipment). It is also possible that certain WBS elements will be decomposed by a sub-contractor.

1 WBS for Production Platform Project
   1.1 Project Management
   1.2 Engineering
      1.2.1 General
         1.2.1.1 Preliminary Engineering Acceptance
         1.2.1.2 Preliminary Engineering Acceptance
         1.2.1.3 Design Basis and Specifications
         1.2.1.4 Calculations and Engineering Data Books
         1.2.1.5 Summary Reports
         1.2.1.6 Platform Equipment Manuals
      1.2.2 Jacket
         1.2.2.1 Structural Engineering and Drafting
            1.2.2.1.1 Jacket In-Service Analyses
            1.2.2.1.2 Jacket Pre-Service Analyses
            1.2.2.1.3 Jacket Design Details
            1.2.2.1.4 Jacket Cathodic Protection

        1.2.2.1.5 Jacket Weights and Material Takeoffs

        1.2.2.1.6 Jacket Approved for Construction (AFC) Drawings

        1.2.2.1.7 Jacket Detailed Engineering and Design Report

     1.2.2.2 Mechanical Engineering & Drafting

        1.2.2.2.1 Flood and Vent System

        1.2.2.2.2 Grouting System

  1.2.3 Piling—Structural Engineering and Drafting

     1.2.3.1 Piling In-Service Analyses

     1.2.3.2 Piling Pre-Service Analyses

     1.2.3.3 Piling Design Details

     1.2.3.4 Piling Weights and Material Takeoffs

     1.2.3.5 Piling AFC Drawings

     1.2.3.6 Piling Detailed Engineering and Design Report

  1.2.4 Topsides

     1.2.4.1 Structural Engineering and Drafting

        1.2.4.1.1 Deck In-Service Analyses

        1.2.4.1.2 Deck Pre-Service Analyses

        1.2.4.1.3 Deck Design Details

        1.2.4.1.4 Deck Weights and Material Takeoffs

        1.2.4.1.5 Deck AFC Drawings

        1.2.4.1.6 Deck Detailed Engineering and Design Report

     1.2.4.2 Mechanical/Process Engineering and Drafting

        1.2.4.2.1 Process Simulation/Calculations

        1.2.4.2.2 Equipment Design/Sizing

        1.2.4.2.3 Pipe Stress Analysis

        1.2.4.2.4 Hazard Analysis

        1.2.4.2.5 Specifications, Data Sheets, and Request for Quotations

        1.2.4.2.6 Vendor Data Reviews

        1.2.4.2.7 Weight, Material Takeoffs, Bill of Materials

        1.2.4.2.8 AFC Drawings for:

            1.2.4.2.8.1 Process Flow Diagrams/Utility Flow Diagrams

            1.2.4.2.8.2 Mechanical Flow Diagrams/Piping and Instrument Drawings

            1.2.4.2.8.3 Equipment Layouts/Arrangements/ Skid Layouts

            1.2.4.2.8.4 Piping Supports

            1.2.4.2.8.5 Piping General Arrangements, Elevations, and Isometrics

            1.2.4.2.8.6 Other AFC Drawings

        1.2.4.2.9 Data Books, Equipment Manuals, Engineering and Design Report

     1.2.4.3 Electrical Engineering & Drafting

        1.2.4.3.1 Electrical Engineering and Design

        1.2.4.3.2 Electrical Specifications, Data Sheets, and Request for Quotations

        1.2.4.3.3 Electrical Load Study/List

        1.2.4.3.4 Vendor Data Reviews

        1.2.4.3.5 Weight, Material Takeoffs, Bill of Materials

        1.2.4.3.6 AFC Drawings for:

1.2.4.3.6.1   Area Classifications
1.2.4.3.6.2   Electrical Symbol Legend
1.2.4.3.6.3   Electrical One-Line Drawings
1.2.4.3.6.4   Schematics/Schedule/Plans
1.2.4.3.6.5   Buildings and Equipment Layouts
1.2.4.3.6.6   Electrical Arrangement and Cable Tray Routing
1.2.4.3.6.7   Electrical Installation Details
1.2.4.3.6.8   Other AFC Drawings
1.2.4.3.7   Data Books, Equipment Manuals, Engineering and Design Report
1.2.4.4   Instrument Engineering & Drafting
1.2.4.4.1   Instrument Engineering & Design
1.2.4.4.2   Fire & Safety Engineering & Design
1.2.4.4.3   Relief Systems Sizing Calculations
1.2.4.4.4   Instrument Specification, Data Sheets, and Request for Quotations
1.2.4.4.5   Instrument Index
1.2.4.4.6   Vendor Data Reviews
1.2.4.5   Weight, Material Takeoffs, Bill of Materials
1.2.4.6   AFC Drawings for:
1.2.4.6.1   SAFE Charts/PSFDs
1.2.4.6.2   Control Panels
1.2.4.6.3   PLC System
1.2.4.6.4   Tubing Tray Routing
1.2.4.6.5   Loop Diagrams
1.2.4.6.6   Instrument Installation Details
1.2.4.6.7   Fire and Safety
1.2.4.6.8   Pressure Relief Systems
1.2.4.6.9   Other AFC Drawings
1.2.4.7   Data Books, Equipment Manuals, Engineering and Design Reports
1.3   Procurement
1.3.1   General
1.3.1.1   Procurement Procedures
1.3.1.2   Expediting and Inspection Procedures
1.3.2   Jacket
1.3.2.1   Owner Furnished Equipment (OFE)
1.3.2.2   Contractor Furnished Reimbursable Equipment (CFRE)
1.3.2.3   All Other Contractor Supplied Equipment
1.3.2.4   Bulk Materials—Contractor Supplied
1.3.2.4.1   Structural
1.3.2.4.2   Anodes
1.3.3   Piling
1.3.3.1   Bulk Materials—Contractor Supplied
1.3.3.1.1   Structural
1.3.4   Topsides
1.3.4.1   Owner Furnished Equipment (OFE)
1.3.4.1.1   Rotating Equipment
1.3.4.1.2   Pressure Vessels
1.3.4.1.3   Electrical Generation

1.4.4 Topsides
    1.4.4.1 Main Deck
        1.4.4.1.1 Plate Girders
        1.4.4.1.2 Deck Panels
        1.4.4.1.3 Tertiary Steel
    1.4.4.2 Cellar Deck
        1.4.4.2.1 Plate Girders
        1.4.4.2.2 Deck Panels
        1.4.4.2.3 Tertiary Steel
    1.4.4.3 Sub-Cellar Deck
    1.4.4.4 Legs
    1.4.4.5 Bracing
    1.4.4.6 Equipment Installation
    1.4.4.7 Interconnect Piping
    1.4.4.8 Electrical
    1.4.4.9 Instrumentation
    1.4.4.10 Precommissioning
    1.4.4.11 Appurtenances
        1.4.4.11.1 Flare Boom
        1.4.4.11.2 Stairs, Walkways, & Landings
        1.4.4.11.3 Installation Aids
    1.4.4.12 Loadout and Seafasten
1.5 Transportation
  1.5.1 General
    1.5.1.1 Safety Manual and Plan
    1.5.1.2 Seafastening Drawings
    1.5.1.3 Marine Warranty Surveyor Review and Approval
  1.5.2 Jacket
  1.5.3 Piling
  1.5.4 Topsides
1.6 Installation, Hookup, and Commissioning
  1.6.1 General
    1.6.1.1 Safety Manual and Plan
    1.6.1.2 Installation Procedures and Drawings
    1.6.1.3 Qualification of Welding Procedures and Welders
        1.6.1.3.1 Structural
        1.6.1.3.2 Piping
    1.6.1.4 As-Installed Drawings
    1.6.1.5 Mobilization
    1.6.1.6 Demobilization
  1.6.2 Jacket
  1.6.3 Piling
  1.6.4 Topsides
    1.6.4.1 Hookup
    1.6.4.2 Commissioning
    1.6.4.3 Startup

This WBS example is illustrative only and is intended to provide guidance to the reader. No claim of completeness is made—for any specific project, the example may be complete or incomplete. All examples reflect the quality principles expressed in this Practice Standard. As expressed in the *PMBOK® Guide*—Third Edition ''the project management team is responsible for determining what is appropriate for any given project'' (Project Management Institute 2004).

Appendix F

Environmental Management Work Breakdown Structure (WBS) Example

This Work Breakdown Structure (WBS) is organized according to the project lifecycle at Level 2 while specific deliverables within each stage of the lifecycle are included at Level 3. This is a high level WBS template which can be customized at lower levels to apply to a variety of specific projects.

1 WBS for Environmental Management Project to Conduct a Bio-Venting Test for the Remediation of Hydrocarbon Impacted Soils

   1.1   System Design

      1.1.1   Initial Design

      1.1.2   Client Meeting

      1.1.3   Draft Design

      1.1.4   Client and Regulatory Agency Meeting

      1.1.5   Final Design

   1.2   System Installation

      1.2.1   Facility Planning Meeting

      1.2.2   Well Installation

      1.2.3   Electrical Power Drop Installation

      1.2.4   Blower and Piping Installation

   1.3   Soil Permeability Test

      1.3.1   System Operation Check

      1.3.2   Soil Permeability Test

      1.3.3   Test Report

   1.4   Initial In Situ Respiration Test

      1.4.1   In Situ Respiration Test

      1.4.2   Test Report

   1.5   Long-Term Bio-Venting Test

      1.5.1   Ambient Air Monitoring

      1.5.2   Operation, Maintenance, and Monitoring

      1.5.3   Three-Month In Situ Respiration Test

      1.5.4   Test Report

1.5.5   Six-month In Situ Respiration Test
        1.5.6   Test Report
    1.6   Confirmation Sampling
        1.6.1   Soil Boring and Sampling
        1.6.2   Data Validation
    1.7   Report Preparation
        1.7.1   Pre-Draft Report
        1.7.2   Client Meeting
        1.7.3   Draft Report
        1.7.4   Client and Regulatory Agency Meeting
        1.7.5   Final Report
    1.8   Project Management

A landscape tree structure view of this WBS is depicted in Figure F1.. This view of the WBS shows the top of the tree at the left, with lower levels of decomposition moving to the right. Like the outline view above, the project life cycle elements are at level 2 while specific deliverables within each stage of the lifecycle are included at level 3.
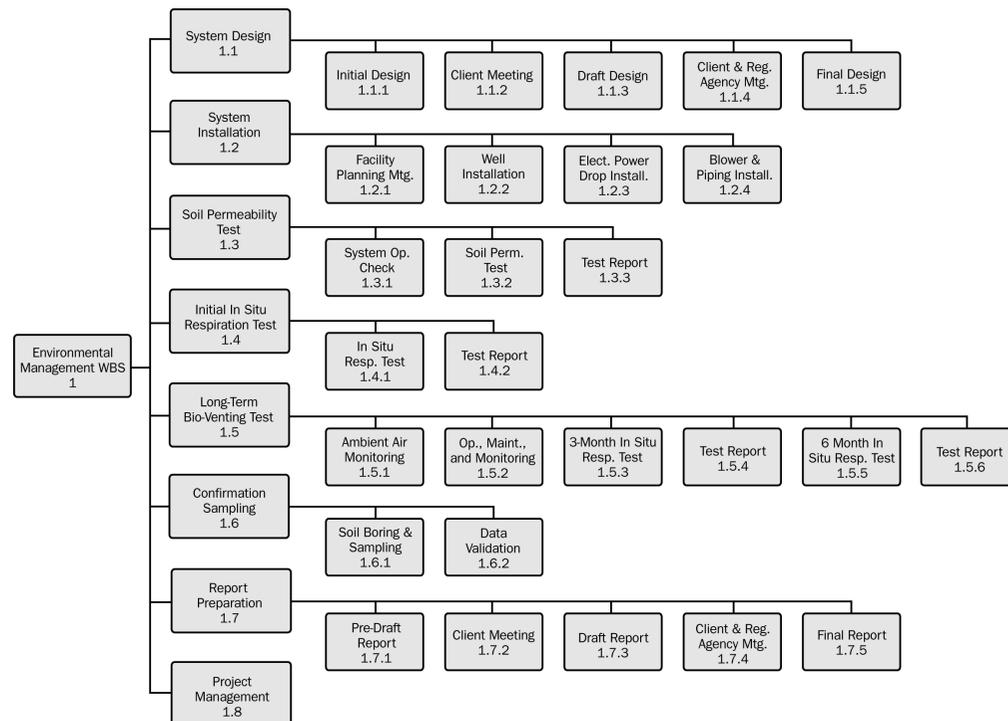
Figure F-1. Horizontal Tree Structure

Appendix G

Process Improvement Work Breakdown Structure (WBS) Example

This Work Breakdown Structure (WBS) example is used with permission of the California Department of Transportation. This is an example of a WBS for a process improvement project. It is divided into three phases:

1. Research to determine the best solution to the problem. This research includes the recommendation of a solution, or solutions, to the sponsor.
2. Implementation of the approved solution(s). If there were more than one approved solution, then the ''Phase 2'' WBS would be repeated for each solution.
3. Evaluation to determine if the solution works. This leads back to further research and continuous process improvement.

Note that not all branches of the WBS are decomposed to the same level of detail. Also some WBS elements, e.g., 1.1.2 and 1.2, are modular templates which are repeated as often as needed.

1 WBS for Process Improvement Project
   1.1 Phase 1: Research and recommendations
      1.1.1 Phase 1 Charter
      1.1.2 Project Management Plans for Phase 1
      1.1.3 Research
         1.1.3.1 Documentation of the ''State of the Art''
            1.1.3.1.1 Document Search
            1.1.3.1.2 Consultation with Experts
            1.1.3.1.3 Benchmarking
            1.1.3.1.4 Product and Software Review
         1.1.3.2 Documentation of the Current State in the Subject Organization
            1.1.3.2.1 Interviews
            1.1.3.2.2 Surveys

1.1.3.2.3 Statistical Analysis
          1.1.3.2.4 Flow Charts of Current Processes
  1.1.4 Identification of Improvement Needs
      1.1.4.1 Determination of Desired State (Vision Statement)
      1.1.4.2 Gap Analysis
      1.1.4.3 Most Likely Solutions
          1.1.4.3.1 Brainstorming
          1.1.4.3.2 Statistical Analysis
          1.1.4.3.3 Flow Charts of Desired Processes
  1.1.5 Recommendations
      1.1.5.1 Recommendation 1
          1.1.5.1.1 Draft Charter
          1.1.5.1.2 Estimated Cost
      1.1.5.2 Recommendation 2
          1.1.5.2.1 Draft Charter
          1.1.5.2.2 Estimated Cost
      1.1.5.3 Recommendation n
          1.1.5.3.1 Draft Charter
          1.1.5.3.2 Estimated Cost
1.2 Phase 2: Implementation of Approved Recommendation x
    (This portion of the WBS is repeated for each approved recommendation)
    1.2.1 Recommendation x Charter (approved and amended version of the draft from 1.1.5)
    1.2.2 Project Management Plans for Phase 2 (seven plans, as for Phase 1)
    1.2.3 Process Documentation
        1.2.3.1 Draft process (policy, handbook, manual chapter, etc.)
        1.2.3.2 Review
        1.2.3.3 Revision (1.2.3.2 and 1.2.3.3 are iterative—repeat until there is consensus)
        1.2.3.4 Publication
            1.2.3.4.1 Hardcopy
            1.2.3.4.2 Internet or Intranet
            1.2.3.4.3 Other
    1.2.4 Tools (software, etc.)
        1.2.4.1 Design
        1.2.4.2 Build
        1.2.4.3 Test
        1.2.4.4 Revision (1.2.4.3 and 1.2.4.4 are iterative—repeat until the product meets its goals)
        1.2.4.5 Implementation
    1.2.5 Training
        1.2.5.1 Instructors
            1.2.5.1.1 Hiring
            1.2.5.1.2 Training (''Train the Trainers'')
        1.2.5.2 Development
            1.2.5.2.1 Draft Training Materials
            1.2.5.2.2 Review and Pilot
            1.2.5.2.3 Revision (1.2.5.2.2 and 1.2.5.2.3 are iterative—repeat until the class meets its goals)
        1.2.5.3 Delivery

1.3 Phase 3: Evaluation
   1.3.1 Project Management Plans for Phase 3 (seven plans, as for Phase 1)
   1.3.2 Documentation of the New State in the Subject Organization
      1.3.2.1 Interviews
      1.3.2.2 Surveys
      1.3.2.3 Statistical Analysis
      1.3.2.4 Flow Charts of New Processes
   1.3.3 Identification of Deficiencies
      1.3.3.1 Flow Charts of Desired Processes (from 1.4.3.3)
      1.3.3.2 Gap Analysis
   1.3.4 Recommendations for New Projects
      1.3.4.1 Recommendation 1
         1.3.4.1.1 Draft Charter
         1.3.4.1.2 Estimated Cost
      1.3.4.2 Recommendation 2
         1.3.4.2.1 Draft Charter
         1.3.4.2.2 Estimated Cost
      1.3.4.3 Recommendation n
         1.3.4.3.1 Draft Charter
         1.3.4.3.2 Estimated Cost

The following table is another representation of Phase 1 of this same WBS . . . an outline view developed with a spreadsheet application. Though the entire WBS can be represented in this manner, only Phase 1 of this WBS example is shown as an illustration.

WBS Level	WBS Code	WBS Element
1	1	WBS for Process Improvement Project
2	1.1	Phase 1: Research and Recommendations
3	1.1.1	Phase 1 Charter
3	1.1.2	Project Management Plans for Phase 1
3	1.1.3	Research
4	1.1.3.1	Documentation of the ''State of the Art''
5	1.1.3.1.1	Document Search
5	1.1.3.1.2	Consultation with Experts
5	1.1.3.1.3	Benchmarking
5	1.1.3.1.4	Product and Software Review
4	1.1.3.2	Documentation of the Current State in the Subject Organization
5	1.1.3.2.1	Interviews
5	1.1.3.2.2	Surveys
5	1.1.3.2.3	Statistical Analysis
5	1.1.3.2.4	Flow Charts of Current Processes
3	1.1.4	Identification of Improvement Needs
4	1.1.4.1	Determination of Desired State (Vision Statement)
4	1.1.4.2	Gap Analysis
4	1.1.4.3	Most Likely Solutions
5	1.1.4.3.1	Brainstorming
5	1.1.4.3.2	Statistical Analysis
5	1.1.4.3.3	Flow Charts of Desired Processes
3	1.1.5	Recommendations
4	1.1.5.1	Recommendation 1
5	1.1.5.1.1	Draft Charter
5	1.1.5.1.2	Estimated Cost
4	1.1.5.2	Recommendation 2
5	1.1.5.2.1	Draft Charter
5	1.1.5.2.2	Estimated Cost
4	1.1.5.3	Recommendation 3
5	1.1.5.3.1	Draft Charter
5	1.1.5.3.2	Estimated Cost
2	1.2	Phase 2: Implementation of Approved Recommendation

Table G-1. Process Improvement WBS Example

This WBS example is illustrative only and is intended to provide guidance to the reader. No claim of completeness is made—for any specific project, the example may be complete or incomplete. All examples reflect the quality principles expressed in this Practice Standard. As expressed in the *PMBOK® Guide—Third Edition* ''the project management team is responsible for determining what is appropriate for any given project'' (Project Management Institute 2004).

Appendix H

Pharmaceutical Work Breakdown Structure (WBS) Example

Pharmaceutical Project WBS

The following represents an example of a WBS for a pharmaceutical development project. It is not intended to represent the only feasible WBS for this type of project. There are numerous variations and approaches that a project manager can take to develop the WBS for the project.

In this example, a WBS is presented for a new compound. A development program containing more than one compound would consist of a similar WBS structure for each compound. Some Level 2 WBS elements describe deliverables that fall within the area of expertise of specific technical specialties and occur at different points over the course of the product development lifecycle. These are structured to reflect the organizations making up the enterprise, such as Marketing, Regulatory Affairs, Pharmaceutical Development, etc. Other Level 2 elements are organized according to the product development lifecycle itself, thus: Phase 1 Clinical Program, Phase 2 Clinical Program, etc., because this organization reflects the way that the business manages the overall development program. The WBS is not intended to illustrate the sequence by which the deliverables will be created. When the Network Diagram and Schedule for this project are created they would reflect the sequence of the activities that produce the deliverables within both the functionally organized elements and those organized by product lifecycle.

Note that this WBS describes a generic product, not a project to develop a specific compound. As such, it is a ''WBS Standard'' that can be customized using specific terms to describe different development projects. Some elements are modular and may be repeated as often as necessary in a given project. For example, the elements listed as components of 1.7.3 would be repeated for each multiple dose safety clinical trial to be conducted. Depending on the particular project, the project manager would include some but not all of the possible elements included in the standard WBS. For example, if the objective of the project were to develop a line extension of an existing product, it is likely that the project manager would choose not to include any aspect of lead identification in the WBS. In other cases, the project manager might want to illustrate geographic components in the WBS that would necessitate a modification to that depicted here. This might be the case if some clinical trials were to be performed outside the US. Similarly, if some of deliverables are to be developed by a different

organization as part of a collaborative program, the project manager might organize the WBS to show the deliverables for each organization in separate branches.

The Level 2 WBS elements are not all decomposed to the same level of detail. In part this reflects the need to provide more detail for some but not others. In practice, the level of detail would also reflect the amount of information available for certain deliverables. Thus, the specific clinical trials to be conducted in Phase 3 are not usually known until after Phase 2 has been completed. Thus, early in development, these might be described with a single high-level WBS element called ''Phase 3 Clinical Trial Program,'' while the Phase 1 trials would be described in much more detail. It is recommended that the project manager develop the WBS to a level of detail that is appropriate to enable management of the specific project.

1   WBS for New Compound Development Project
    1.1   Project Initiation
        1.1.1   Decision to Develop Business Case
        1.1.2   Business Case
        1.1.3   Project Initiation Decision
    1.2   Marketing/Sales Support
        1.2.1   Market Research Program
        1.2.2   Branding Program
        1.2.3   Pricing Program
        1.2.4   Sales Development Program
        1.2.5   Other Marketing/Sales Support
    1.3   Regulatory Support
        1.3.1   IND Submission
            1.3.1.1   Pre-IND Meeting
            1.3.1.2   IND Preparation
                1.3.1.2.1   Preclinical Package
                1.3.1.2.2   Clinical Package
                1.3.1.2.3   Clinical Pharmacology Package
                1.3.1.2.4   CM&C Package
            1.3.1.3   IND Submission
        1.3.2   End of Phase 2 Meeting
            1.3.2.1   Pre-Meeting Package
            1.3.2.2   End of Phase 2 Meeting
        1.3.3   BLA/NDA Submission
            1.3.3.1   Pre-BLA/NDA Meeting
            1.3.3.2   BLA/NDA Preparation
                1.3.3.2.1   Preclinical Package
                1.3.3.2.2   Clinical Package
                1.3.3.2.3   Clinical Pharmacology Package
                1.3.3.2.4   CM&C Package
            1.3.3.3   BLA/NDA Submission
            1.3.3.4   Advisory Committee Meeting
            1.3.3.5   FDA review support
            1.3.3.6   Pre-Approval Inspection
            1.3.3.7   Approval
        1.3.4   Post-approval Regulatory Support Program
            1.3.4.1   Annual Reports
            1.3.4.2   Adverse Event Reporting
            1.3.4.3   Post-market Commitment Administration

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1.4 Lead Identification Program
    1.4.1 Hypothesis Generation
    1.4.2 Assay Screening
    1.4.3 Lead Optimization
    1.4.4 Other Discovery Support
1.5 Clinical Pharmacology Support
    1.5.1 Pharmacokinetic Study(ies)
    1.5.2 Drug Interaction Study(ies)
    1.5.3 Renal Effect Study(ies)
    1.5.4 Hepatic Effect Study(ies)
    1.5.5 Bioequivalency Study(ies)
    1.5.6 Other Clinical Pharmacology Study(ies)
1.6 Preclinical Program
    1.6.1 Tox/ADME Support
        1.6.1.1 Non-GLP Animal Studies
        1.6.1.2 Bioanalytical Assay Development
        1.6.1.3 ADME Evaluations
        1.6.1.4 Acute Toxicological Studies
        1.6.1.5 Sub-Chronic Toxicological Studies
        1.6.1.6 Chronic Toxicological Studies
        1.6.1.7 Other Tox/ADME Support
    1.6.2 Clinical Pharmacology Support
        1.6.2.1 Pharmacokinetic Study(ies)
        1.6.2.2 Drug Interaction Study(ies)
        1.6.2.3 Renal Effect Study(ies)
        1.6.2.4 Hepatic Effect Study(ies)
        1.6.2.5 Bioequivalency Study(ies)
        1.6.2.6 Other Clinical Pharmacology Study(ies)
1.7 Phase I Clinical Study Program
    1.7.1 Pharmacokinetic/Pharmacodynamic Study(ies)
    1.7.2 Dose Ranging Study(ies)
    1.7.3 Multiple Dose Safety Study(ies)
        1.7.3.1 Pre-Enrollment Activities
        1.7.3.2 Enrollment
        1.7.3.3 Treatment
        1.7.3.4 Follow-up
        1.7.3.5 Data Management
        1.7.3.6 Data analysis
        1.7.3.7 Study Report1.10
1.8 Phase II Clinical Study Program
    1.8.1 Multiple Dose Efficacy Study(ies)
    1.8.2 Other Clinical Study(ies)
1.9 Phase III Clinical Study Program
    1.9.1 Pivotal Registration Study(ies)
    1.9.2 Other Clinical Study(ies)
1.10 Submission/Launch Phase
    1.10.1 Pre-Launch preparation
    1.10.2 Launch
    1.10.3 Post-Launch Support
1.11 Phase IV/Commercialization Clinical Study Program
    1.11.1 Investigator-Sponsored Studies

This WBS example is illustrative only and is intended to provide guidance to the reader. No claim of completeness is made—for any specific project, the example may be complete or incomplete. All examples reflect the quality principles expressed in this Practice Standard. As expressed in the *PMBOK® Guide— Third Edition* "the project management team is responsible for determining what is appropriate for any given project" (Project Management Institute 2004).

Appendix I

Process Plant Construction Work Breakdown Structure (WBS) Example

Process Plant Construction Project WBS

This is an example of an engineering-oriented WBS, rather than a contractor-oriented WBS, as the orientation is on the design of systems rather than on the startup and commissioning of systems. Communication between the engineering team and the construction/commissioning team needs to be very good to minimize problems during construction. In practice there can be problems when engineers design based on ''Systems,'' while the Crafts/Trades (Contractors) do their work by location and sequence.

It should be noted, however, that whether the WBS has a systems focus, a structure focus, or deliverable focus, the sequence of work is not the purpose of the WBS. The objective of the WBS is to ensure that the work required to complete the desired outcome and meet the project objectives has been captured completely and in enough detail to identify resources, assign responsibility, and set sequence.

Note that all branches of the WBS are not decomposed to the same level of detail. This could be due to a variety of factors. For example, a subcontractor might have responsibility for detailing one WBS element, or another WBS element might be detailed at a later point in the planning process.

1   WBS for Process Plant Construction Project
   1.1   Plant System Design
      1.1.1   Business requirements
         1.1.1.1   System Engineering
         1.1.1.2   Site Development
         1.1.1.3   Civil Structures
         1.1.1.4   Thermal Systems
         1.1.1.5   Flow Systems
         1.1.1.6   Storage Systems
         1.1.1.7   Electrical Systems
         1.1.1.8   Mechanical Systems

1.1.1.9   Environmental Systems
                    1.1.1.10 Instrumentation and Control Systems
                    1.1.1.11 Auxiliary Systems
                    1.1.1.12 Security Systems
            1.1.2   Process Models
                    1.1.2.1   System Engineering
                    1.1.2.2   Site Development
                    1.1.2.3   Civil Structures
                    1.1.2.4   Thermal Systems
                    1.1.2.5   Flow Systems
                    1.1.2.6   Storage Systems
                    1.1.2.7   Electrical Systems
                    1.1.2.8   Mechanical Systems
                    1.1.2.9   Environmental Systems
                    1.1.2.10 Instrumentation and Control Systems
                    1.1.2.11 Auxiliary Systems
                    1.1.2.12 Safety systems
        1.2   Construction
            1.2.1   Site Development
            1.2.2   Civil Structures
            1.2.3   Thermal Systems
            1.2.4   Flow Systems
            1.2.5   Storage Systems
            1.2.6   Electrical Systems
            1.2.7   Mechanical Systems
            1.2.8   Instrument and Control Systems
            1.2.9   Environmental Systems
            1.2.10 Temporary Structure
            1.2.11 Auxiliary Systems
            1.2.12 Safety Systems
        1.3   Legal and Regulatory
            1.3.1   Licensing (Non-Government)/Permitting (government)
                    1.3.1.1   Licensing (Non-Government)
                            1.3.1.1.1   Roofing, Gutters, Insulation
                            1.3.1.1.2   Electric
                            1.3.1.1.3   Plumbing
                            1.3.1.1.4   Commercial Signs
                            1.3.1.1.5   Elevators
                            1.3.1.1.6   Steam/Hot Water Boilers
                            1.3.1.1.7   Air Conditioning
                            1.3.1.1.8   Commercial Fire Suppression Systems
                            1.3.1.1.9   Forced Air Furnaces/Ventilation
                            1.3.1.1.10 Water Heaters and Gas Lines
                    1.3.1.2   Permitting (Government)
                            1.3.1.2.1   Application
                            1.3.1.2.2   Acceptance Criteria
                            1.3.1.2.3   Issuance of License
            1.3.2   Environmental Impact
                    1.3.2.1   Preliminary Assessment
                    1.3.2.2   Impact Review
                    1.3.2.3   Magnitude Assessment

1.3.2.4   Mitigation Plan
            1.3.3   Labor Agreements
                    1.3.3.1   Agreement
                    1.3.3.2   Collective Bargaining
                    1.3.3.3   Agreement Finalization
            1.3.4   Land Acquisition
                    1.3.4.1   Available Property
                    1.3.4.2   Local Government Zoning Rights/Restrictions
                    1.3.4.3   Price Comparisons
                    1.3.4.4   Professional Survey
                    1.3.4.5   Financing
            1.3.5   Other Legal/Regulatory Requirements
    1.4   Testing
            1.4.1   System Test
                    1.4.1.1   System Test Plans and Procedures
                    1.4.1.2   System Testing
            1.4.2   Acceptance Test
                    1.4.2.1   Acceptance Test Plans
                    1.4.2.2   Acceptance Testing
                    1.4.2.3   Formal Acceptance
    1.5   Startup
    1.6   Project Management

Note: PMI Project Management Standards Open Working Session volunteers at
PMI's '99 Seminars & Symposium originally created this WBS example. It has been
subsequently updated as part of the development of this release of the Practice
Standard.

This WBS example is illustrative only and is intended to provide guidance to the reader. No claim of
completeness is made—for any specific project, the example may be complete or incomplete. All examples
reflect the quality principles expressed in this Practice Standard. As expressed in the *PMBOK® Guide—
Third Edition* ''the project management team is responsible for determining what is appropriate for any
given project'' (Project Management Institute 2004).

Appendix J

Service Industry Outsourcing Work Breakdown Structure (WBS) Example

Service Industry Outsourcing Project WBS

The unique aspect of this WBS is its inclusion of an RFP (Request for Proposal) process. This WBS is generic and could be made more specific for use in a particular project. It therefore serves as a WBS template. Not all branches of the WBS are decomposed to the same level of detail. For example Project Management (1.7) is not decomposed at all.

1   WBS for Outsourcing Project
   1.1. Needs Analysis
      1.1.1   Needs Analysis
         1.1.1.1   Feasibility Study
         1.1.1.2   Historical Information
      1.1.2   Definition and Baseline Requirements
         1.1.2.1   Project Approach Strategy
         1.1.2.2   High-Level Project Plan
         1.1.2.3   Cost Estimates
         1.1.2.4   Scope Statement
      1.1.3   Specifications
      1.1.4   High-Level Statement of Work
   1.2   Market Analysis
      1.2.1   Internal Capability Plus Cost
      1.2.2   Qualified Vendors
      1.2.3   RFI (Information)
      1.2.4   RFI Submissions
      1.2.5   Decision Analysis (Includes Make/Buy)
   1.3   Request for Proposal (RFP)
      1.3.1   RFP Development
         1.3.1.1   Solution Criteria
         1.3.1.2   Background and General Scope of Work
         1.3.1.3   Priorities/Requirements
         1.3.1.4   Type of Solution Sought
         1.3.1.5   Maintenance and Support; Warranty; Training

1.3.2   Acceptance Requirements
        1.3.3   Schedule
        1.3.4   Budget
        1.3.5   RFP Package
                1.3.5.1   Instructions for Preparation/Delivery of Submissions
                1.3.5.2   Evaluation Criteria
                1.3.5.3   Site Inspection Requirements
                1.3.5.4   Withdrawal or Modifications of Proposals
                1.3.5.5   Responsibility for Proposal Costs
    1.4   Solicitation
        1.4.1   RFP Issuance
        1.4.2   Bids
        1.4.3   Bidder Conference
        1.4.4   RFP submissions/Receipt
        1.4.5   Response Evaluation
        1.4.6   Vendor Criteria Matrix
        1.4.7   Scorecard
        1.4.8   Vendor Qualification
                1.4.8.1   Prior Experience
                1.4.8.2   Available Vendor Resources/Available Time
                1.4.8.3   Quality references
        1.4.9   Vendor Award
                1.4.9.1   Management Approvals
                1.4.9.2   Legal Review and Approvals
        1.4.10 Letter of Intent (LOI)
    1.5   Contract
        1.5.1   Master Agreement
                1.5.1.1   Contract Negotiation
                1.5.1.2   Finalized Terms and Conditions (Use Boiler Plate)
                1.5.1.3   Finalized Scope/Schedule/Cost
        1.5.2   Contract Orders/Task Orders/CSOWs
                1.5.2.1   Specific Deliverables
                1.5.2.2   Identified Resources
                1.5.2.3   Defined SLAs
                1.5.2.4   Defined Acceptance Criteria
                1.5.2.5   Defined Performance Measures
                1.5.2.6   Issued PO/Task Order
        1.5.3   Executed Agreement/Signed Contract
    1.6   Task Order/Contract Order SOW
    1.7   Project Management

Note: PMI Project Management Standards Open Working Session volunteers at
PMI's '99 Seminars & Symposium originally created this WBS example. It has been
subsequently been updated as part of the development of this release of the Prac-
tice Standard.

This WBS example is illustrative only and is intended to provide guidance to the reader. No claim of
completeness is made—for any specific project, the example may be complete or incomplete. All examples
reflect the quality principles expressed in this Practice Standard. As expressed in the *PMBOK® Guide*—
Third Edition ''the project management team is responsible for determining what is appropriate for any
given project'' (Project Management Institute 2004).

Appendix K

Web Design Work Breakdown Structure (WBS) Example

Web Design Project WBS

This example is of a WBS to design, build and deploy a commercial Internet Web site that sells the organization's own products within one country. The high-level phases of the development lifecycle are placed at Level 1 of the WBS. Major work within that phase is further elaborated within each area. As with all WBS examples, different branches of a WBS can be decomposed to different levels of detail. This WBS is generic and as such serves as a WBS template which would be customized for specific project instance. Additionally, both outline and tree-structure views of this WBS are provided for comparison.

1 WBS for Web Design Project
   1.1 Planning
      1.1.1 Product Definition
      1.1.2 Stakeholder Approval
   1.2 Definition
      1.2.1 Requirements Development
         1.2.1.1 Business Requirements Development
         1.2.1.2 System Requirements Development
      1.2.2 Conceptual Design Development
         1.2.2.1 Conceptual Data Design
         1.2.2.2 Conceptual Process Design
      1.2.3 Architectural Design Development
         1.2.3.1 Web Design Methods Evaluation
         1.2.3.2 Web Design Method Selection
      1.2.4 Bill of Materials (BoM) Creation
      1.2.5 Resource Procurement
         1.2.5.1 Human Resources Procurement
         1.2.5.2 Hardware Procurement
         1.2.5.3 Software Procurement
         1.2.5.4 Telecommunications Procurement
   1.3 Construction
      1.3.1 Detailed Design Development

<p style="margin-left: 4em;">1.3.1.1   Data Design</p>
<p style="margin-left: 4em;">1.3.1.2   Business Logic Design</p>
<p style="margin-left: 4em;">1.3.1.3   User Interface Design</p>
<p style="margin-left: 4em;">1.3.1.4   Internal Design Standards Consultation</p>
<p style="margin-left: 4em;">1.3.1.5   Industry Design Standards Consultation</p>
<p style="margin-left: 3em;">1.3.2   High-Level Test Plan Development</p>
<p style="margin-left: 3em;">1.3.3   System Components—Code, Unit Test</p>
<p style="margin-left: 4em;">1.3.3.1   Database Components</p>
<p style="margin-left: 4em;">1.3.3.2   Code/Logic Components</p>
<p style="margin-left: 4em;">1.3.3.3   Web GUI Interface Components</p>
<p style="margin-left: 3em;">1.3.4   System Installation (Configure)</p>
<p style="margin-left: 2em;">1.4   Testing</p>
<p style="margin-left: 3em;">1.4.1   Testing Execution</p>
<p style="margin-left: 4em;">1.4.1.1   System Test</p>
<p style="margin-left: 4em;">1.4.1.2   User Acceptance Test</p>
<p style="margin-left: 4em;">1.4.1.3   Performance Test</p>
<p style="margin-left: 3em;">1.4.2   Analyze Defects/Correct</p>
<p style="margin-left: 3em;">1.4.3   Production Readiness Verification</p>
<p style="margin-left: 2em;">1.5   Deployment</p>
<p style="margin-left: 3em;">1.5.1   Transition</p>
<p style="margin-left: 4em;">1.5.1.1   Support Personnel Training</p>
<p style="margin-left: 4em;">1.5.1.2   Support Procedures Documentation</p>
<p style="margin-left: 4em;">1.5.1.3   Software</p>
<p style="margin-left: 4em;">1.5.1.4   Hardware</p>
<p style="margin-left: 3em;">1.5.2   Legacy System Decommissioning</p>
<p style="margin-left: 2em;">1.6   Project Management</p>

Tree Structure View

One of the most common ways to represent a WBS is the graphic *Tree Structure*, or *Organizational Chart* structure in which each ''child'' element is shown as a box with a line connecting it to the ''parent'' element of which it is a component. This representation makes very explicit the way in which the project and the subordinate components are hierarchically decomposed into smaller and smaller elements. The example illustrates horizontal distribution for WBS levels. The phases are placed vertically in top down sequence. This approach works well for WBS with variable decomposition of each phase. Two techniques are illustrated in Figures K1 and K2 to show how paper position (landscape or vertical) can change the WBS. In the horizontal landscape the boxes for Level 3 had been omitted for additional clarity to the graph.
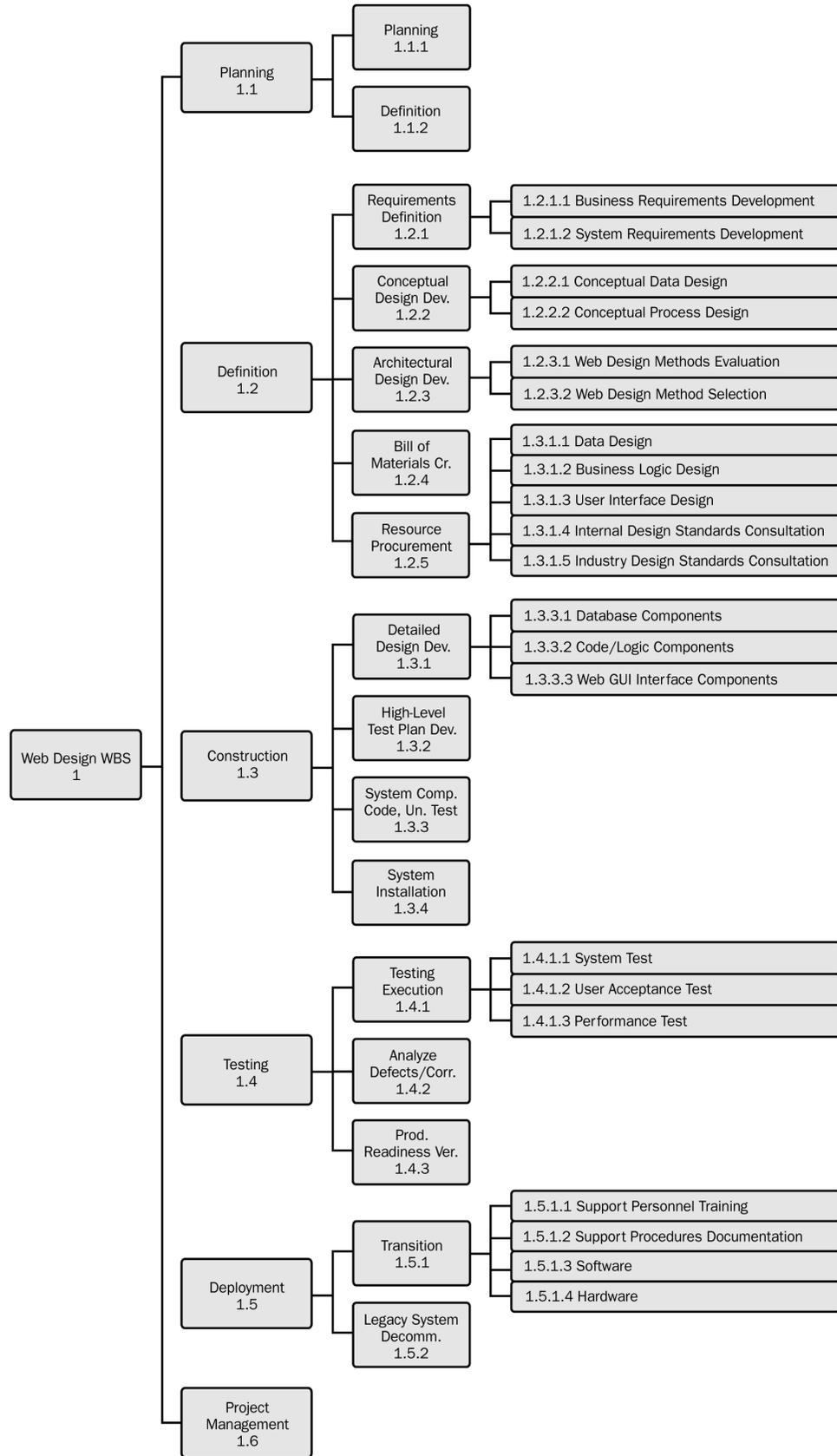
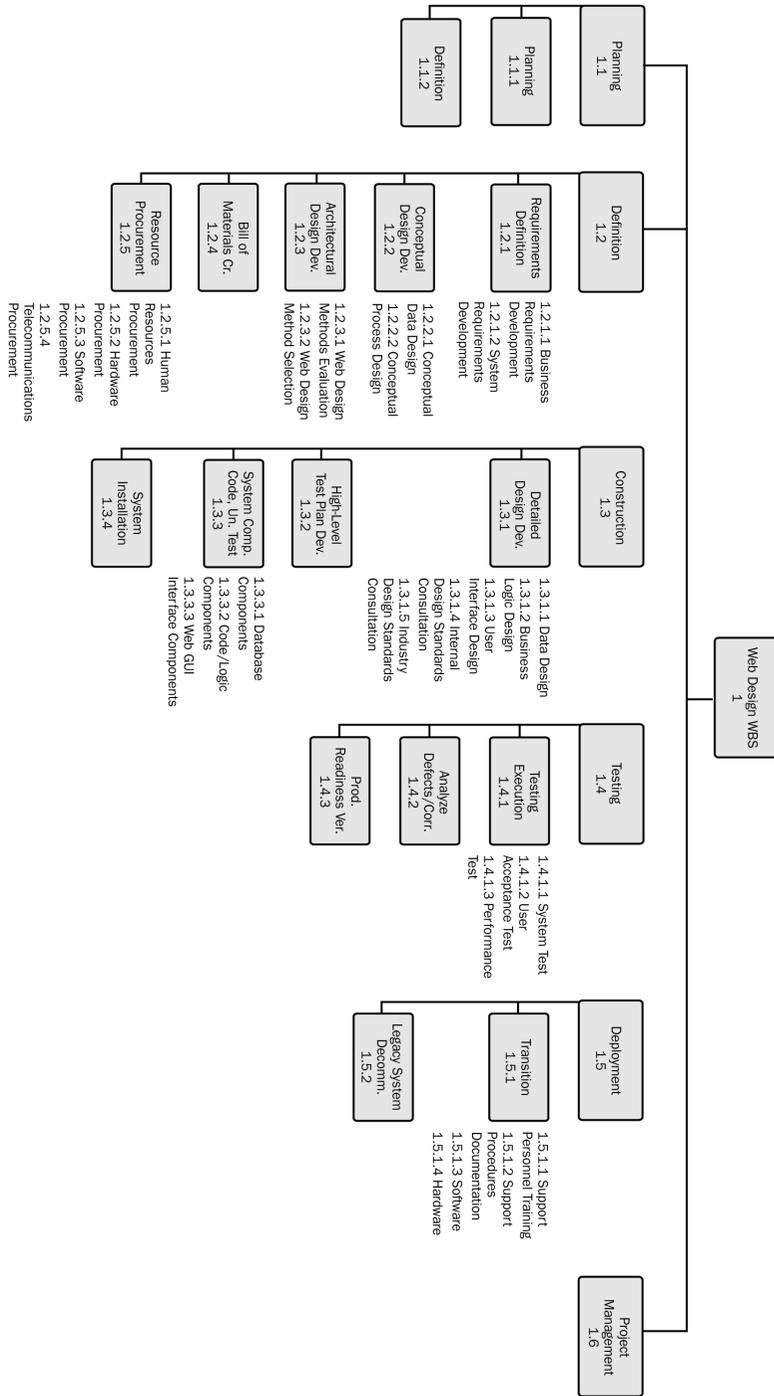**Figure K-1.** Horizontal Portrait View

Figure K-2. Horizontal Landscape View

Web Design WBS 1

Planning 1.1
- Planning 1.1.1
- Definition 1.1.2

Definition 1.2
- Requirements Definition 1.2.1
  - 1.2.1.1 Business Requirements Development
  - 1.2.1.2 System Requirements Development
- Conceptual Design Dev. 1.2.2
  - 1.2.2.1 Conceptual Data Design
  - 1.2.2.2 Conceptual Process Design
- Architectural Design Dev. 1.2.3
  - 1.2.3.1 Web Design Methods Evaluation
  - 1.2.3.2 Web Design Method Selection
- Bill of Materials Cr. 1.2.4
- Resource Procurement 1.2.5
  - 1.2.5.1 Human Resources Procurement
  - 1.2.5.2 Hardware Procurement
  - 1.2.5.3 Software Procurement
  - 1.2.5.4 Telecommunications Procurement

Construction 1.3
- Detailed Design Dev. 1.3.1
  - 1.3.1.1 Data Design
  - 1.3.1.2 Business Logic Design
  - 1.3.1.3 User Interface Design
  - 1.3.1.4 Internal Design Standards Consultation
  - 1.3.1.5 Industry Design Standards Consultation
- High-Level Test Plan Dev. 1.3.2
- System Comp. Code, Un. Test 1.3.3
  - 1.3.3.1 Database Components
  - 1.3.3.2 Code/Logic Components
  - 1.3.3.3 Web GUI Interface Components
- System Installation 1.3.4

Testing 1.4
- Testing Execution 1.4.1
  - 1.4.1.1 System Test
  - 1.4.1.2 User Acceptance Test
  - 1.4.1.3 Performance Test
- Analyze Defects/Corr. 1.4.2
- Prod. Readiness Ver. 1.4.3

Deployment 1.5
- Transition 1.5.1
  - 1.5.1.1 Support Personnel Training
  - 1.5.1.2 Support Procedures Documentation
  - 1.5.1.3 Software
  - 1.5.1.4 Hardware
- Legacy System Decomm. 1.5.2

Project Management 1.6

Note: PMI Project Management Standards Open Working Session volunteers at PMI's '99 Seminars & Symposium originally created this WBS example. It has been subsequently been updated as part of the development of this release of the Practice Standard.

This WBS example is illustrative only and is intended to provide guidance to the reader. No claim of completeness is made—for any specific project, the example may be complete or incomplete. All examples reflect the quality principles expressed in this Practice Standard. As expressed in the *PMBOK® Guide—Third Edition* ''the project management team is responsible for determining what is appropriate for any given project'' (Project Management Institute 2004).

Appendix L

Telecom WBS Example

The WBS example below is displayed in a standard outline format. At level 2, this WBS is organized according to the project lifecycle, from creation of the concept through product development, customer acceptance and ongoing support and maintenance. Within each level 2 WBS Element are included lower level deliverables that are specific to that stage and include, among others, reviews and decisions, analyses, tangible deliverables, and services. The Project Management WBS Element is not decomposed to the same level of detail as the others. Both an outline and vertical tree-structure view are provided for comparison.

1 WBS for Telecom Project
  1.1 Concept/Feasibility
      1.1.1 Concept
      1.1.2 Marketing Analysis
      1.1.3 Market Plan
      1.1.4 Technical Analysis
      1.1.5 Product Scope Definition
      1.1.6 Prototype
  1.2 Requirements
      1.2.1 End-User Requirements
      1.2.2 Application Requirements
      1.2.3 Infrastructure (Systems) Requirements
      1.2.4 Operations/Maintenance Requirements
      1.2.5 Service Requirements
  1.3 Go/No Go Decision
      1.3.1 Prototype Review
      1.3.2 Financial Review
      1.3.3 Schedule Review
      1.3.4 Technical Capabilities Review
      1.3.5 Financial Commitment Review
      1.3.6 Go/No-Go Decision
  1.4 Development
      1.4.1 End-User Systems
      1.4.2 Application

1.4.3   Infrastructure Systems
        1.4.4   Network
        1.4.5   Operations/Maintenance Systems
        1.4.6   Service Plan
    1.5   Testing
        1.5.1   Test Plans
        1.5.2   Tests
        1.5.3   Results
        1.5.4   Corrective Actions
        1.5.5   Retests
        1.5.6   Retest Results
    1.6   Deployment
        1.6.1   Trial in a Non-Penalty Environment
        1.6.2   First Action Site
        1.6.3   Deployment
    1.7   Life-cycle Support
        1.7.1   Customer Training & Education
        1.7.2   Turnover to Customer
        1.7.3   Customer Acceptance
        1.7.4   Support & Maintenance
    1.8   Project Management

The information shown in the above outline format can be displayed in many other views. For example, a top-down tree structure is frequently used. This view is depicted below.
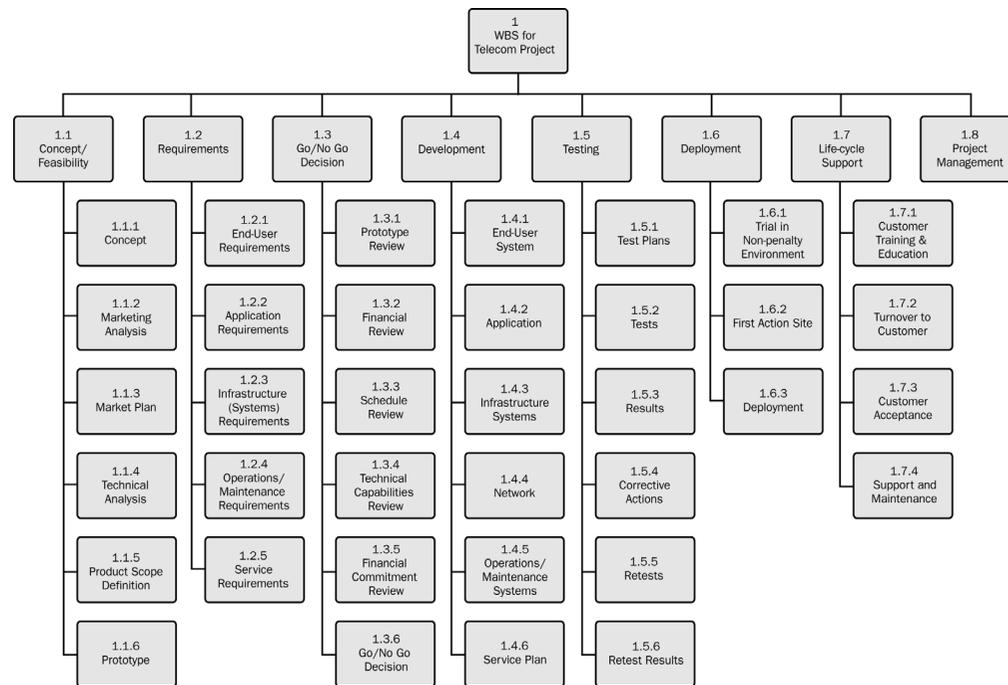
Figure L-1. Top-Down Tree Structure

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Note: PMI Project Management Standards Open Working Session volunteers at PMI's '99 Seminars & Symposium originally created this WBS example. It has been subsequently been updated as part of the development of this release of the Practice Standard.

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Appendix M

Refinery TurnAround WBS Example

Refinery TurnAround Project WBS

This is an example of a WBS for the TurnAround (T/A) of equipment for a refinery. Work orders are rolled up under the Equipment ID 1.2.1.3 (WBS Level 4). In this example, the Level 3 deliverable (Coolant) is decomposed to the work level in alignment with how the work will be performed. Not all branches of the WBS are decomposed to the same level of detail. This WBS is generic and as such serves as a WBS template which would be customized for specific projects. Certain WBS elements will be decomposed to a greater level of detail as those details for a specific project become known.

This example is shown in two formats, as an indented tabular outline and as a graphic tree structure. Any format is acceptable as long as it is consistent with the Quality principles described in this Standard.

1 WBS for Refinery Turn Around Project
   1.1 Pre-Turn Around
   1.2 Shutdown
      1.2.1 Coolant
         1.2.1.1 Main Coolant System(s) Shut Down
         1.2.1.2 Radiator CDWEST02
            1.2.1.2.1 Work Order #1
            1.2.1.2.2 Work Order #2
            1.2.1.2.3 Work Order #3
         1.2.1.3 Radiator CDWEST03
         1.2.1.4 Auxiliary Coolant System(s) Shut Down
      1.2.2 Hydraulic
      1.2.3 Electrical
         1.2.3.1 Transformer ELECTNWDC05
            1.2.3.1.1 Work Order #1
            1.2.3.1.2 Work Order #2
            1.2.3.1.3 Work Order #3
         1.2.3.2 Transformer ELECTNWDC07

This WBS example is illustrative only and is intended to provide guidance to the reader. No claim of completeness is made—for any specific project, the example may be complete or incomplete. All examples reflect the quality principles expressed in this Practice Standard. As expressed in the *PMBOK® Guide—Third Edition* ''the project management team is responsible for determining what is appropriate for any given project'' (Project Management Institute 2004).

Appendix N

Government Design-Bid-Build WBS Example

Government Design-Bid-Build Project WBS

This is an example of a WBS for a Government Design-Bid-Build Construction project, depicted from the government's point of view.

This is a very high level WBS and would be decomposed to a greater level of detail in specific cases. Because this is a Design-Bid-Build Project, each phase is treated almost as a separate project because each may be planned and executed by a different organization. For this reason it makes sense to include certain service deliverable WBS elements separately within each phase, e.g., Project Management. These are modular WBS Elements.

1   WBS for Government-sponsored Design-Bid-Build Project
   1.1   Phase 1: Prospectus
      1.1.1   Project Management Plans for Phase 1
         1.1.1.1   Scope Management Plan
         1.1.1.2   Cost and Schedule Management Plan
         1.1.1.3   Quality Management Plan
         1.1.1.4   Human Resources Management Plan
         1.1.1.5   Communication Management Plan
         1.1.1.6   Risk Management Plan
         1.1.1.7   Procurement Management Plan
      1.1.2   Description of Customer Needs
      1.1.3   Preliminary Plans of Alternatives
      1.1.4   Estimates for Alternatives
      1.1.5   Cost/Benefit Analysis
      1.1.6   Report
   1.2   Phase 2: Selected Alternative (may be combined with Phase 1, depending on the requirements set by the legislative branch)
      1.2.1   Project Management Plans for Phase 2 (seven plans, as for Phase 1)
      1.2.2   Environmental Studies
         1.2.2.1   Biological
         1.2.2.2   Archaeological
         1.2.2.3   Air Quality

                1.2.2.4   Water Quality

                1.2.2.5   Social and Economic

        1.2.3   More Detailed Plans of Alternatives

        1.2.4   Estimates for Alternatives

        1.2.5   Draft Report

        1.2.6   Final Report

    1.3   Phase 3: Real Property

        1.3.1   Project Management Plans for Phase 3 (seven plans, as for Phase 1)

        1.3.2   Appraisal

        1.3.3   Acquisition

        1.3.4   Relocation of Occupants

        1.3.5   Demolition

        1.3.6   Relocation of Utilities

        1.3.7   Hazardous Waste Removal

        1.3.8   Environmental Mitigation

    1.4   Phase 4: Contract Award Documents

        1.4.1   Project Management Plans for Phase 4 (seven plans, as for Phase 1)

        1.4.2   Detailed Plans of Selected Alternative

                1.4.2.1   Civil Plans

                1.4.2.2   Water Supply and Removal Plans

                1.4.2.3   Structural Plans

                1.4.2.4   Furnishing Plans

        1.4.3   Specifications

                1.4.3.1   General Provisions

                1.4.3.2   Special Provisions

        1.4.4   Estimate

        1.4.5   Bid Documents

        1.4.6   Signed Contract

    1.5   Phase 5: Physical Improvement (construction)

        1.5.1   Project Management Plans for Phase 5 (seven plans, as for Phase 1)

        1.5.2   Civil Work

                1.5.2.1   Earthwork

                1.5.2.2   Pavement

        1.5.3   Water Supply, Drainage, and Sanitation

                1.5.3.1   Drainage

                1.5.3.2   Water Supply

                1.5.3.3   Sanitary Sewers and Purification

        1.5.4   Structural Work

                1.5.4.1   Structures

                1.5.4.2   Electrical

                1.5.4.3   Mechanical

        1.5.5   Furnishings

This WBS example is illustrative only and is intended to provide guidance to the reader. No claim of completeness is made—for any specific project, the example may be complete or incomplete. All examples reflect the quality principles expressed in this Practice Standard. As expressed in the *PMBOK® Guide—Third Edition* ''the project management team is responsible for determining what is appropriate for any given project'' (Project Management Institute 2004).

Appendix O

Software Implementation WBS Example

This example illustrates a generic WBS that could be applied to range of different software development projects by suitable customization, especially at the lower levels. As such it is a WBS Template. The deliverables include overhead work, such as "Administration", intermediate deliverables, such as "requirements approvals", tangible end products, such as "configured software" and services such as "training". Not all WBS Elements are decomposed to the same level of detail, for example, "Go Live". These could be decomposed further in the context of a specific project. This WBS example is shown below in two formats. The first is the standard outline format, the second top-down tree structure view is provided for comparison.

1   WBS for Software Implementation Project
   1.1   Project Management
   1.2   Product Requirements
      1.2.1   Software Requirements
         1.2.1.1   Draft Software Requirements
         1.2.1.2   Final Software Requirements
         1.2.1.3   Software Requirements Approval
      1.2.2   User Documentation
         1.2.2.1   Draft User Documentation
         1.2.2.2   Final User Documentation
         1.2.2.3   User Documentation Approval
      1.2.3   Training Program Materials
         1.2.3.1   Initial Training Requirements
         1.2.3.2   Initial Training Materials
         1.2.3.3   Trial Course Delivery
      1.2.4   Hardware
         1.2.4.1   Draft Hardware Requirements
         1.2.4.2   Final Hardware Requirements
         1.2.4.3   Hardware Requirements Approval
      1.2.5   Implementation & Future Support
   1.3   Detail Software Design
      1.3.1   Initial Software Design
      1.3.2   Final Software Design
      1.3.3   Software Design Approval
   1.4   System Construction
      1.4.1   Configured Software
      1.4.2   Customized User Documentation
      1.4.3   Customized Training Program Materials
      1.4.4   Installed Hardware
      1.4.5   Implementation & Future Support

1.5 Test
    1.5.1 System Test Plan
    1.5.2 System Test Cases
    1.5.3 System Test Results
    1.5.4 Acceptance Test Plan
    1.5.5 Acceptance Test Cases
    1.5.6 Acceptance Test Results
    1.5.7 Approved User Documentation
1.6 Go Live
1.7 Support
    1.7.1 Training
    1.7.2 End User Support
    1.7.3 Product Support
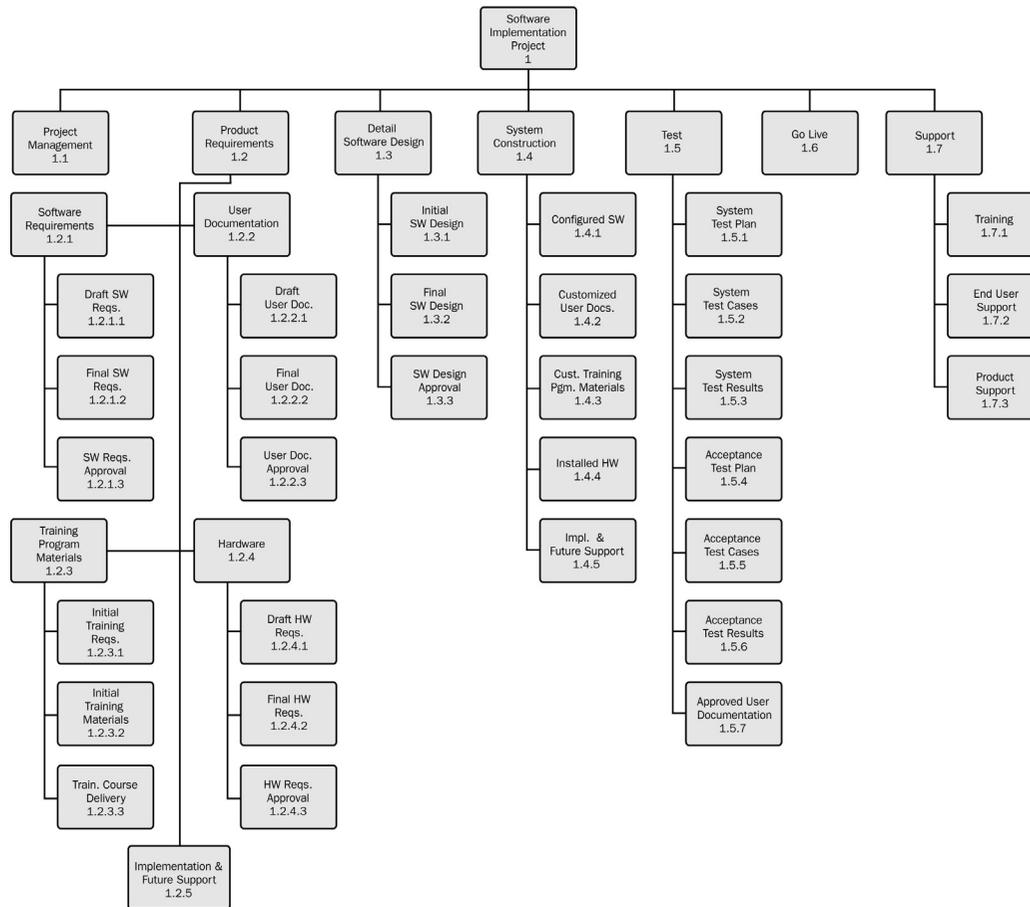

Figure O-1. Software Implementation WBS Example

Note: PMI Project Management Standards Open Working Session volunteers at PMI's '99 Seminars & Symposium originally created this WBS example. It has been subsequently been updated as part of the development of this release of the Practice Standard.

This WBS example is illustrative only and is intended to provide guidance to the reader. No claim of completeness is made—for any specific project, the example may be complete or incomplete. All examples reflect the quality principles expressed in this Practice Standard. As expressed in the *PMBOK® Guide—Third Edition* ''the project management team is responsible for determining what is appropriate for any given project'' (Project Management Institute 2004).

Appendix P

Horizontal Tree Structure Format WBS Example

This horizontal tree display of a high level Work Breakdown Structure (WBS) contains all basic work associated with the concrete canoe design, construction, and documentation. It clearly defines the work to be performed, identifies the needed expertise, assists in selection of the project team and establishes a base for project scheduling and control. Each of the items listed can continue to be broken down (as indicated by the arrows) until there is a specific task that can be assigned to members of the concrete canoe team. For example, under ''Canoe Display Stands'', the specific tasks would include procuring materials, constructing the stands, painting the stands, and applying any decals. These are work tasks that can be given specifically to a group or individual. An issue with this WBS is the fact that some WBS elements are stated as activities using verb phrases. Ideally, all WBS elements should be stated as nouns that describe decomposed elements of the work.
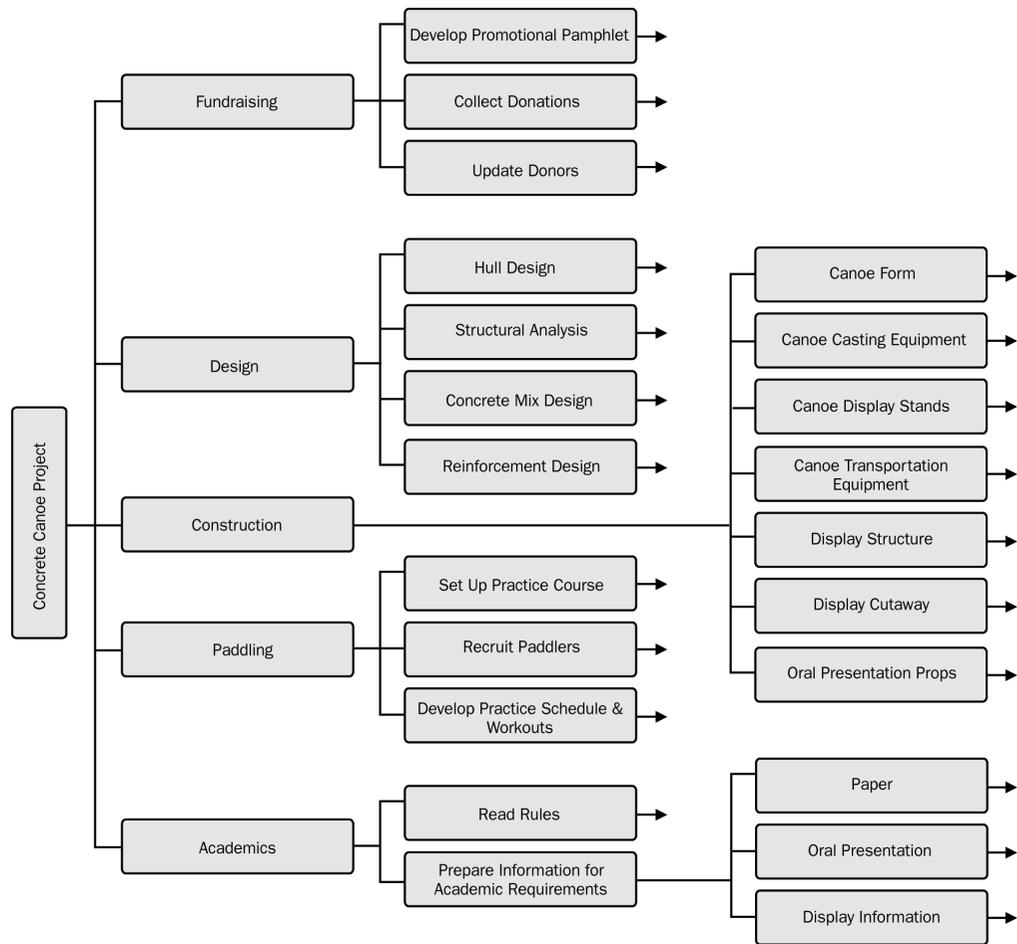
Figure P-1. Horizontal Tree Structure Format WBS Example

Source: Modified from: Concrete Canoe Design Guide—Scott Rutledge & Ryan McKaskle, http://members.cox.net/concretecanoe/wbs.htm

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References

Haugan, Gregory T. (2002). *Effective Work Breakdown Structures.* Vienna, VA ManagementConcepts.

Pritchard, Carl L. (1998). *How to Build a Work Breakdown Structure: The Cornerstone of Project Management.* Arlington VA. ESI International.

Project Management Institute. (2003). *Organizational Project Management Maturity Model* (*OPM3*®): Knowledge Foundation. Newtown Square, PA: Project Management Institute.

Project Management Institute. (2004). *Practice Standard for Earned Value Management* (*EVM*). Newtown Square, PA: Project Management Institute.

Project Management Institute. (2001) *Practice Standard for Work Breakdown Structures.* Newtown Square, PA: Project Management Institute.

Project Management Institute. (2004). *A Guide to the Project Management Body of Knowledge (PMBOK*® *Guide)*—Third Edition. *Newtown Square, PA: Project Management Institute.*

Project Management Institute. (in development). *The Practice Standard for Scheduling.* Newtown Square, PA: Project Management Institute.

Project Management Institute. (Available May 2006). *The Standard for Portfolio Management.* Newtown Square, PA: Project Management Institute.

Project Management Institute. (Available May 2006). *The Standard for Program Management.* Newtown Square, PA: Project Management Institute.

Uyttewaal, Eric (2005). *Dynamic Scheduling with Microsoft Office Project 2003: The Book by and for Professionals.* Boca Raton, FL: J. Ross Publishing, Inc.

McDonald Bradley, Inc. 2002. *Independent Verification and Validation (IV and V) White Paper.* December 2002, available from http://www.mcdonaldbradley.com/comps/ white%20papers/IVV%20white%20paper.pdf; accessed 20 February 2005.

Berg, Cindy and Colenso, Kim. 2000. ''Work Breakdown Structure Practice Standard Project—WBS vs. Activities,'' *PM Network*, April 14(4): 69–71. Project Management Institute, 2000. *(Journal article) CID 1253*

Chapman, James R. 2004. *Work Breakdown Structures, Version 2.01*, November, 2004. available from http://www.hyperthot.com/pm_wbs.htm; accessed 22 February 2005.

Cleland, David I. 1964A. *Air University Review.* November–December. p. 13.

Cleland, David I. 1964B. *Why Project Management?* Business Horizons. Winter. p. 81.

Department of Defence. 1995. *Work Breakdown Structures for Defence Materiel Projects.* Commonwealth of Australia, Australian Defence Standard Draft Def(Aust)5664 Issue A.

Department of Defense. 1975. *Military Standard Work Breakdown Structures for Defense Materiel Item., (MIL-STD-881A).* Washington DC. 1 November 1975.

Department of Defense, 1998. *Department of Defense Handbook. Work Breakdown Structure MIL-HDBK-881.* Washington DC. 2 January 1998.

Department of Energy. 2001. *Performance Based Contracting: Development of a Work Statement.* August.. available from http://www1.pr.doe.gov/acqguide/AGChapter37.htm; accessed 18 January 2005.

Dinsmore, Paul C. 2000. ''Enterprise Project Management: A Road Map for Getting off to the Right Start,—*PM Network.* June. p. 27.

Githens, Gregory D. 2001. ''Manage Innovation Programs with a Rolling Wave.— *PM Network.* May. p. 35.

Globerson, S. 1994. ''Impact of Various Work-Breakdown Structures on Project Conceptualization.'' *International Journal of Project Management.* 12 (3) p. 165.

Grove, Cornelius, Hallowell, Willa and Smith, Cynthia J. ''A Parallel WBS for International Projects.'' *PM Network.* March. p. 37.

Halli, Wayne. 1993. *PM Network.* May. p. 12.

Haugan, Gregory T. 2002. *Effective Work Breakdown Structures.* Vienna, VA Management Concepts.

Homer, John L and Gunn, Paul D. 1995. *Work Structuring for Effective Project Management.* Project Management Institute 26th Annual Seminar/Symposium. New Orleans LA, October, 1995. p. 84.

Kast, Fremont and Rosenzweig, James. 1961. ''Weapon System Management and Organizational Concepts.'' *Journal of American Military.* December.

Kerzner H. 1997. *Project Management: A Systems Approach to Planning, Scheduling, and Controlling (6th ed.).* New York: John Wiley & Sons.

Kerzner H. 1996. *The Growth and Maturity of Modern Project Management.* 27th Annual Seminar/Symposium October 1996. Boston MA: Project Management Institute.

Kloppenborg, Timothy J and Opfer, Warren A. 2002. ''The Current State of Project Management Research: Trends, Interpretations, and Predictions.'' *Project Management Journal.* 33 (2).

Luby, Robert E., Peel, Douglas, and Swahl, William. 1995. ''Component-Based Work Breakdown Structure (CBWDS).'' *Project Management Journal.* December. p. 38.

Mansuy, John. 1991. ''Work Breakdown Structure: A Simple Tool for Complex Jobs.'' *Cost Engineering.* 33(12). December.

McDonald Bradley, Inc.. 2002. Independent Verification and Validation White Paper. December 2002., retrieved 2/20/2005, Website: http://www.mcdonaldbradley.com/comps/white%20papers/IVV%20white%20paper.pdf

National Aeronautics and Space Administration. 1962. *DOD and NASA Guide. PERT Cost Systems Design.* June 1962. Washington DC: Office of the Secretary of Defense.

National Aeronautics and Space Administration. *NASA PERT and Companion Cost System Handbook.* Washington, DC. October 30, 1962.

National Aeronautics and Space Administration. (1994) Work Breakdown Structure. May, 1994.

Pritchard, Carl L. 1998. *How to Build a Work Breakdown Structure: The Cornerstone of Project Management.* Arlington VA. ESI International.

Project Management Institute. 1969. *Articles of Incorporation.*

Project Management Institute. *PMI Today.* April 2003.

Project Management Institute. 2003. *Organizational Project Management Maturity Model* (*OPM3®*): Knowledge Foundation. Newtown Square, PA: Project Management Institute.

Project Management Institute. 2004. *Practice Standard for Earned Value Management* (*EVM*). Newtown Square, PA: Project Management Institute.

Project Management Institute. 2001. *Practice Standard for Work Breakdown Structures.* Newtown Square, PA: Project Management Institute.

Project Management Institute. 2004. *A Guide to the Project Management Body of Knowledge (PMBOK® Guide*—Third Edition). Newtown Square, PA: *Project Management Institute.*

Project Management Institute. (currently in development). *The Practice Standard for Scheduling.* Newtown Square, PA: Project Management Institute.

Project Management Institute. (Available May 2006). *The Standard for Portfolio Management.* Newtown Square, PA: Project Management Institute.

Project Management Institute. (Available May 2006). *The Standard for Program Management.* Newtown Square, PA: Project Management Institute.

Project Management Institute. 2000. *Practice Standard for Work Breakdown Structures* . Newtown Square, PA: Project Management Institute.

Project Management Institute Standards Committee. 1987. *A Guide to the Project Management Body of Knowledge (PMBOK Guide®).* Newtown Square, PA: Project Management Institute.

Project Management Institute Standards Committee. 1996. *A Guide to the Project Management Body of Knowledge.* Darby PA: Project Management Institute.

Rad, Parviz F. 1999 ''Advocating a Deliverable-Oriented Work Breakdown Structure.'' *Cost Engineering.* 41(12). December, p 35.

Raz, T. and Globerson, S. 1998. ''Effective Sizing and Content Definition of Work Packages.'' Project Management Journal. December.

Shtub, Avraham. 1997. ''Project Segmentation—A Tool for Project Management.'' *International Journal of Project Management.* 15(1). p. 15.

Stewart, John M. 1965. ''Making Project Management Work.'' *Business Horizons.* Fall. 1965.

Uyttewaal, Eric. 2005. *Dynamic Scheduling with Microsoft Office Project 2003: The Book by and for Professionals.* Boca Raton, FL. J. Ross Publishing, Inc.

Ward, Gregory F. 2001. ''The WBS Dictionary—Extending the Work Breakdown Structure,'' *Proceedings of the Project Management Institute Annual Seminars & Symposium.* November. Nashville TN: Project Management Institute.

Webster, Francis M. Jr. 1999. ''They Wrote the Book. The Early Literature of Modern Project Management.'' *PM Network.* August.

Youker, Robert. 1999. ''A New Look at the WBS: Project Breakdown Structure. *PM Network.* November. p. 33.

Glossary

Many of the words defined here have broader, and in some cases, different dictionary definitions.

The definitions use the following conventions:

- Terms used as part of the definitions and that are defined in the glossary are shown in *italics.*
  - When the same glossary term appears more than once in a given definition, only the first occurrence is italicized.
  - In some cases, a single glossary term consists of multiple words (e.g., risk response planning).
- When synonyms are included, no definition is given and the reader is directed to the preferred term (i.e., see preferred term).
- Related terms that are not synonyms are cross-referenced at the end of the definition (i.e., see also related term).

Activity. A component of work performed during the course of a project.

Apportioned Effort (AE). Effort applied to project work that is not readily divisible into discrete efforts for that work, but which is related in direct proportion to measurable discrete work efforts. Contrast with discrete effort.

Control Account (CA). A management control point where scope, budget (resource plans), actual cost, and schedule are integrated and compared to earned value for performance measurement. Control accounts are placed at selected management points (specific components at selected levels) of the *work breakdown structure.* Each control account may include one or more work packages, but each work package may be associated with only one control account. Each control account is associated with a specific single organizational component in the organizational breakdown structure (OBS). Previously called a cost account. See also work package.

Customer. The person or organization that will use the project's product or service or result. (See also *user)*.

Decomposition. A planning technique that subdivides the *project scope* and project *deliverables* into smaller, more manageable components, until the project work associated with accomplishing the project scope and providing the deliverables is defined in sufficient detail to support executing, monitoring, and controlling the work.

Deliverable. Any unique and verifiable product, result, or capability to perform a service that must be produced to complete a process, phase, or *project.* Often used more narrowly in reference to an external deliverable, which is a deliverable that is subject to approval by the project sponsor or *customer.*

Level of Effort (LOE). Support-type activity (e.g., seller or *customer* liaison, project *cost accounting,* project management, etc.) which does not produce definitive

end products. It is generally characterized by a uniform rate of work performance over a period of time determined by the activities supported.

Organizational Breakdown Structure (OBS). A hierarchically organized depiction of the *project* organization arranged so as to relate the work packages to the performing organizational units.

Phase. See *project phase*.

Portfolio. A collection of *projects* or *programs* and other work that are grouped together to facilitate effective management of that work to meet strategic business objectives. The projects or programs of the portfolio may not necessarily be interdependent or directly related.

Portfolio Management. The centralized management of one or more portfolios, which includes identifying, prioritizing, authorizing, managing, and controlling *projects*, *programs*, and other related work, to achieve specific strategic business objectives.

Product Scope. The features and functions that characterize a product, service, or result.

Program. A group of related *projects* managed in a coordinated way to obtain benefits and control not available from managing them individually. Programs may include elements of related work outside of the scope of the discrete projects in the program.

Program Management. The centralized coordinated management of a *program* to achieve the program's strategic objectives and benefits.

Progressive Elaboration. Continuously improving and detailing a plan as more detailed and specific information and more accurate estimates become available as the *project* progresses, and thereby producing more accurate and complete plans that result from the successive iterations of the planning process.

Project. A temporary endeavor undertaken to create a unique product, service, or result.

Project Phase. A collection of logically related *project* activities, usually culminating in the completion of a major deliverable. Project phases (also called phases) are mainly completed sequentially, but can overlap in some project situations. Phases can be subdivided into subphases and then components; this hierarchy, if the project or portions of the project are divided into phases, is contained in the *work breakdown structure*. A project phase is a component of a project life cycle. A project phase is not a project management process group.

Project Scope. The work that must be performed to deliver a product, service, or result with the specified features and functions.

Resource Breakdown Structure (RBS). A hierarchical structure of resources by resource category and resource type used in resource leveling schedules and to develop resource-limited schedules, and which may be used to identify and analyze *project* human resource assignments.

Responsibility Assignment Matrix (RAM). A structure that relates the project *organizational breakdown structure* to the *work breakdown structure* to help ensure that each component of the *project's scope* of work is assigned to a responsible person/team.

Risk. An uncertain event or condition that, if it occurs, has a positive or negative effect on a *project's* objectives.

Scope. The sum of the products, services, and results to be provided as a project. (See also *project scope* and *product scope*.)

Scope Change. Any change to the *project* scope. A scope change almost always requires an adjustment to the project cost or schedule.

Stakeholder. Person or organization (e.g., customer, sponsor, performing organization, or the public) that is actively involved in the *project*, or whose interests may be positively or negatively affected by execution or completion of the project. A stakeholder may also exert influence over the project and its *deliverables*.

Standard. A document established by consensus and approved by a recognized body that provides, for common and repeated use, rules, guidelines, or characteristics for activities or their results, aimed at the achievements of the optimum degree of order in a given context.

Statement of Work (SOW). A narrative description of products, services, or results to be supplied.

Task. A term for work whose meaning and placement within a structured plan for *project* work varies by the application area, industry, and brand of project management software.

User. The person or organization that will use the *project's* product or service. (See also *customer*.)

Work Breakdown Structure (WBS). A deliverable-oriented hierarchical decomposition of the work to be executed by the project team to accomplish the project objectives and create the required *deliverables*. It organizes and defines the total scope of the project. Each descending level represents an increasingly detailed definition of the project work. The WBS is decomposed into *work packages*. The deliverable orientation of the hierarchy includes both internal and external deliverables. (See also *work package* and *control account*.)

Work Breakdown Structure Component. An entry in the *work breakdown structure* that can be at any level.

Work Breakdown Structure Dictionary. A document that describes each component in the *work breakdown structure* (WBS). For each WBS component, the WBS dictionary includes a brief definition of the *scope* or *statement of work*, defined *deliverable(s)*, a list of associated activities, and a list of milestones. Other information may include: responsible organization, start and end dates, resources required, an estimate of cost, charge number, contract information, quality requirements, and technical references to facilitate performance of the work.

Work Breakdown Structure Element. Any single *work breakdown structure* (WBS) element or component and its associated WBS attributes contained within an individual work breakdown structure.

Work Package. A *deliverable* or *project* work component at the lowest level of each branch of the *work breakdown structure*. The work package includes the schedule activities and schedule milestones required to complete the work package deliverable or project work component. (See also *control account*.)

Index by Keyword