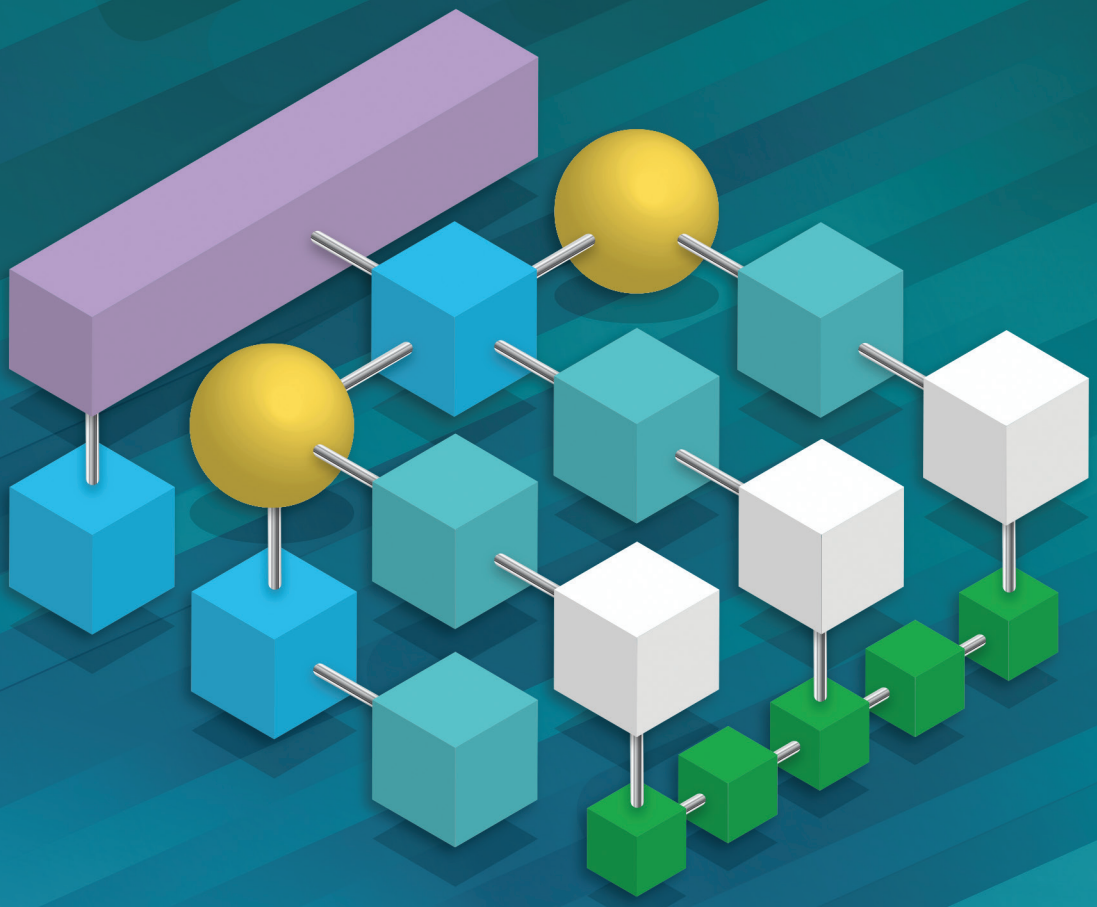
Practice Standard for WORK BREAKDOWN STRUCTURES

Third Edition



Project Management Institute

GLOBAL**STANDARD**

PRACTICE STANDARD FOR WORK BREAKDOWN STRUCTURES – THIRD EDITION

Library of Congress Cataloging-in-Publication Data has been applied for.

ISBN: 978-1-62825-619-2

Published by:
Project Management Institute, Inc.
14 Campus Boulevard
Newtown Square, Pennsylvania 19073-3299 USA
Phone: +610-356-4600
Fax: +610-356-4647
Email: customercare@pmi.org
Internet: PMI.org

To place a Trade Order or for pricing information, please contact Independent Publishers Group:
Independent Publishers Group
Order Department
814 North Franklin Street
Chicago, IL 60610 USA
Phone: +1 800-888-4741
Fax: +1 312-337-5985
Email: orders@ipgbook.com (For orders only)

For all other inquiries, please contact the PMI Book Service Center.
PMI Book Service Center
P.O. Box 932683, Atlanta, GA 31193-2683 USA
Phone: 1-866-276-4764 (within the U.S. or Canada) or +1-770-280-4129 (globally)
Fax: +1-770-280-4113
Email: info@bookorders.pmi.org

The paper used in this book complies with the Permanent Paper Standard issued by the National Information Standards Organization (Z39.48—1984).

10 9 8 7 6 5 4 3 2 1

NOTICE

The Project Management Institute, Inc. (PMI) standards and guideline publications, of which the document contained herein is one, are developed through a voluntary consensus standards development process. This process brings together volunteers and/or seeks out the views of persons who have an interest in the topic covered by this publication. While PMI administers the process and establishes rules to promote fairness in the development of consensus, it does not write the document and it does not independently test, evaluate, or verify the accuracy or completeness of any information or the soundness of any judgments contained in its standards and guideline publications.

PMI disclaims liability for any personal injury, property or other damages of any nature whatsoever, whether special, indirect, consequential or compensatory, directly or indirectly resulting from the publication, use of application, or reliance on this document. PMI disclaims and makes no guaranty or warranty, expressed or implied, as to the accuracy or completeness of any information published herein, and disclaims and makes no warranty that the information in this document will fulfill any of your particular purposes or needs. PMI does not undertake to guarantee the performance of any individual manufacturer or seller's products or services by virtue of this standard or guide.

In publishing and making this document available, PMI is not undertaking to render professional or other services for or on behalf of any person or entity, nor is PMI undertaking to perform any duty owed by any person or entity to someone else. Anyone using this document should rely on his or her own independent judgment or, as appropriate, seek the advice of a competent professional in determining the exercise of reasonable care in any given circumstances. Information and other standards on the topic covered by this publication may be available from other sources, which the user may wish to consult for additional views or information not covered by this publication.

PMI has no power, nor does it undertake to police or enforce compliance with the contents of this document. PMI does not certify, test, or inspect products, designs, or installations for safety or health purposes. Any certification or other statement of compliance with any health or safety-related information in this document shall not be attributable to PMI and is solely the responsibility of the certifier or maker of the statement.

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

1

INTRODUCTION TO THE *PRACTICE STANDARD FOR WORK BREAKDOWN STRUCTURES*

1.1 PURPOSE OF THIS PRACTICE STANDARD

A **standard** is a document established by consensus and approved by a recognized body that provides rules, guidelines, or characteristics for activities or their results. Standards aim to achieve the optimum degree of order in a given context through common and repeated use. Developing a standard follows a process based on the concepts of consensus, openness, due process, and applicability. PMI standards provide guidelines for achieving specific portfolio, program, and project management results, which apply to most projects, in most organizations, most of the time.

The purpose of a standard is to convey the *what*, not the *how*.

A **practice standard** differs from a standard by providing more explanations, specifications, and in-depth experience-based knowledge about a topic and its implementation. More importantly a practice standard is descriptive, not prescriptive. A practice standard conveys both the *what* and recommended *how*. It is important to note that the *how* aims to be a guideline for most projects, in most organizations, most of the time.

Objectives of the *Practice Standard for Work Breakdown Structures* – Third Edition are to:

- Provide a common ground for understanding the concepts and principles of the work breakdown structure (WBS);
- Present guidelines and recommended practices for the creation and use of the WBS; and
- Render standard application of the WBS as an essential mechanism to ensure integrated program and/or project schedule, cost, risk, resource, technical, and contractual control.

This practice standard promotes consistent application of the WBS, thus maximizing the effectiveness and efficiency of program or project planning and control efforts.

This practice standard also sets out to demonstrate what a quality WBS looks like, providing numerous examples throughout. In addition to the WBS examples, quality work breakdown structures are annotated in later sections, outlining the application of key principles. Appendix X3 of this practice standard comprises various industry-specific WBS examples. The examples demonstrate how to create and use work breakdown structures in different types of programs and projects. Some of these examples also illustrate the application of quality concepts on industry-related work breakdown structures.

The *Practice Standard for Work Breakdown Structures* – Third Edition elaborates on WBS-related guidance presented in *A Guide to the Project Management Body of Knowledge (PMBOK® Guide*) [1],[1] *The Standard for Program Management* [2], and the *Agile Practice Guide* [3], based on literature, research, and practical application of work breakdown structures in industry today. Other PMI standards and practice standards also reference content found in this practice standard.

When referring to the processes of WBS creation and update, unless otherwise noted, the WBS applies to program and project interchangeably. Other sections of this practice standard discuss specific aspects pertaining to the content and application of the program WBS.

The *Practice Standard for Work Breakdown Structures* – Third Edition provides the framework to build, decompose, organize, utilize, and regularly update the WBS. This practice standard contains five main sections:

- **Section 1 Introduction**—This section provides the background and overview of a WBS, its objectives, uses, and business value.
- **Section 2 Concepts and Principles**—This section presents the core concepts and principles of using the WBS; discusses its implementation in different project life cycles; and describes methods and instructions on how the WBS applies, all of which are accompanied by numerous examples.
- **Section 3 Relationships, Integration, and Context**—This section provides the project-wide context of the WBS by describing its integration with other standards and other project management processes. Cross-process examples for the four main project life cycles demonstrate the project-wide context.
- **Section 4 WBS Quality**—This section presents specific quality guidelines and checklists that serve as a framework for ensuring the completeness and correctness of the WBS. It also explains the usage of a quality WBS in programs and projects.
- **Section 5 WBS Application and Usage**—This section provides the necessary guidelines required for the actual application of the WBS, from WBS creation throughout the entire project life cycle. This section also covers the application of work breakdown structures for programs.

[1] The numbers in brackets refer to the references at the end of this practice standard.

- **The Appendixes of the *Practice Standard for Work Breakdown Structures* – Third Edition** comprise numerous examples of work breakdown structures for a multitude of project types, industries, market segments, and project life cycles, to provide the reader with as comprehensive an understanding as possible of the applicability of the WBS.

1.2 OVERVIEW

A project is a temporary endeavor undertaken to create a unique product, service, or result. This very often involves a significant amount of uncertainty. A project, in its entirety, is an endeavor that has not been carried out before, hence it carries with it a certain degree of risk.

Successful project management, regardless of the project's life cycle approach, depends on a thorough and complete planning process, which in its essence is multidisciplined and involves technical and subject-matter aspects. The differing viewpoints on scope, schedule, cost, and risk are crucial during the planning stage. Planning begins by defining the project goals and objectives with sufficiently detailed information and specifying the precise deliverables the project typically creates. The project's scope of work derives from these definitions and specifications, whereas the WBS establishes the framework for planning, controlling, executing, and managing the project's work to its completion and successfully handing over its deliverables.

1.2.1 WHAT IS A WBS?

A WBS is a hierarchical decomposition of the total scope of work to be carried out by the project team to accomplish the project objectives and create the required deliverables. Whereas the project scope statement describes the project scope and its major deliverables, assumptions, and constraints, the WBS elaborates on this description by defining, and hierarchically organizing, the total scope of the project. The WBS represents the entirety of the work specified in the current approved project scope.

1.2.2 WHY IS A WBS REQUIRED?

The WBS is a practical tool assisting the project planning team in overcoming large uncertainties. The WBS aids in converting an uncertain challenge into a series of challenges with lesser uncertainties. In simpler terms, the WBS helps in converting the entire project scope, not carried out before as a whole, into a series of smaller components called work packages. These work packages may have been dealt with in the past, which makes them more easily assessed, measured, managed, and communicated.

WBS components carry a fundamental role in many aspects of project management, planning, and control. They assist in defining and understanding the relationships between scope, time, and cost and thus play an essential role in successful project planning. Launching a project based on a complete, logical, and accurate hierarchical scope description facilitates all aspects of project management throughout the project's life cycle.

1.2.3 WHEN IS A WBS CREATED? WHEN IS A WBS UPDATED?

The *PMBOK® Guide*'s Create WBS process identifies the WBS as an important and influential output. From the project life cycle's perspective, the Create WBS process occurs in the very early stages of the project. Following Scope Management planning, collection and documentation of requirements and preparation of the scope statement take place. Subsequently, the creation of the WBS, based on available scope information, commences.

Updates to the WBS arise through the formal Perform Integrated Change Control process as additional scope information surfaces, coupled with information revealed from project planning (or, in adaptive life cycles, iteration or release planning), project execution, and monitoring and control. This recurring process is known as *progressive elaboration*.

The WBS provides the framework and serves as the basis for various other planning processes, such as the Define Activities process in the Project Schedule Management Knowledge Area, the Estimate Costs process in the Project Cost Management Knowledge Area, the Estimate Activity Resources process in the Project Resource Management Knowledge Area, and the Identify Risks process in the Project Risk Management Knowledge Area.

Monitoring and control of the WBS happen throughout the project life cycle, as part of the Control Scope process in the Project Scope Management Knowledge Area. Modifications and updates to the WBS occur throughout the project life cycle, as derived from the project's change control process. Outputs from the change control process often yield approved change requests to the project's scope.

1.2.4 WHAT TYPES OF PROJECTS HAVE A WBS?

Creating a WBS is an essential part of the planning process of every type of project, whether externally facing or internally focused. A WBS is crucial, regardless of the industry or the discipline in which the project takes place. Applying a WBS is critical, irrespective of the type of project deliverables or the type of project life cycle.

This practice standard elaborates on the implementation of work breakdown structures in predictive, iterative, incremental, and agile project life cycles. It also provides a hands-on approach to the use of work breakdown structures in these varying life cycles.

1.3 PURPOSE OF A WBS

1.3.1 WHAT IS A WBS GOOD PRACTICE?

The WBS provides the foundation for a visual representation of the scope of work. The WBS relates to the project objectives and deliverables. The WBS assists in verifying consistency and completeness of scope and avoiding duplication. Additionally, the WBS provides the foundation for clear responsibility and cost assignment in later stages of the planning process.

The WBS is an important communication mechanism that assists in understanding and communicating the scope of work and addresses what is in and out of scope. The WBS creates a common language among all project stakeholders, including project management and subject-matter aspects.

The WBS provides the project management team and project stakeholders with a visual framework for project planning and control. The WBS is the basis for the project's scope, schedule, budget, risk, and performance tracking. It serves as a cross-discipline mechanism for reporting project status and progress in a unified and standard manner. It also serves as a mechanism that balances management's need for control of the work through representation of various levels of detail. It allows specification of planning and control data in the most detailed manner in the lower levels of the WBS, or aggregation to several higher WBS levels, so that it suits the information needs for varying management levels.

1.3.2 WHY IS A WBS ESSENTIAL?

Project planning processes that are not based on a well-designed hierarchical structure of the project's scope—fully accepted and commonly used by all project functions and stakeholders—are likely to be inaccurate, inconsistent, and result in poor planning deliverables. These deliverables, in turn, will not allow for effective and efficient control processes, possibly resulting in poor decision making, inability to achieve project objectives, and scope creep.

Research demonstrates that communication is one of the project management disciplines with the highest impact on project success. The WBS serves as a critical project communication mechanism that helps convey the scope of the project through its graphical depiction.

1.3.3 BUSINESS VALUE OF THE WBS

A WBS provides business value through the clear communication of scope and expectations. The understanding of scope and expectations across the team results in lower risk through the proper management of cost, budget,

schedule, resources, quality, contracts, and technical aspects of the work. This understanding leads to reduced uncertainty and better control, likely providing improved business stability.

At the program level, elements of the WBS contribute quantifiable value to the business case. The value associated with a WBS work package or element is important when considering project value optimization or recovery actions.

1.4 APPLICABILITY

This practice standard applies to programs or projects, irrespective of industry, life cycle, deliverable, complexity, size, budget, or duration. This practice standard applies to roles involved in delivering programs or projects, including public and private organizations of various sizes and sectors.

1.4.1 RELATIONSHIPS AMONG THIS PRACTICE STANDARD AND OTHER PROJECT MANAGEMENT STANDARDS

Figure 1-1 presents the relationships among the *Practice Standard for Work Breakdown Structures* – Third Edition and the other documents comprising the PMI Standards Library.

The first branch of Figure 1-1 represents the global foundational standards providing a foundation for project management knowledge and represents the four areas of the profession: portfolio, program, project, and the organizational approach. Some of these standards are ANSI-certified documents upon which other practice standards and industry-specific extensions are built.

The second branch of Figure 1-1 shows the global practice standards that have the over-arching purpose of describing the use of a tool, technique, or process as identified in the foundational standards. All practice standards directly interact with the WBS practice standard.

The third branch of Figure 1-1 depicts the global standard application area extensions that relate directly to the WBS processes.

The fourth branch represents the practice guides that provide supporting information and instructions to help industry experts apply global foundational and global practice standards. The three practice guides listed in the

dark gray areas directly relate to the WBS processes. The other three in the light gray areas do not. More detailed information on the relationships exists in the respective section of this practice standard.

The fifth and final branch of Figure 1-1 consists of the *PMI Lexicon of Project Management Terms* and the *Project Manager Competency Development Framework* [4]. These tie together all the underpinning language and competencies necessary to apply to any of the other PMI publications.

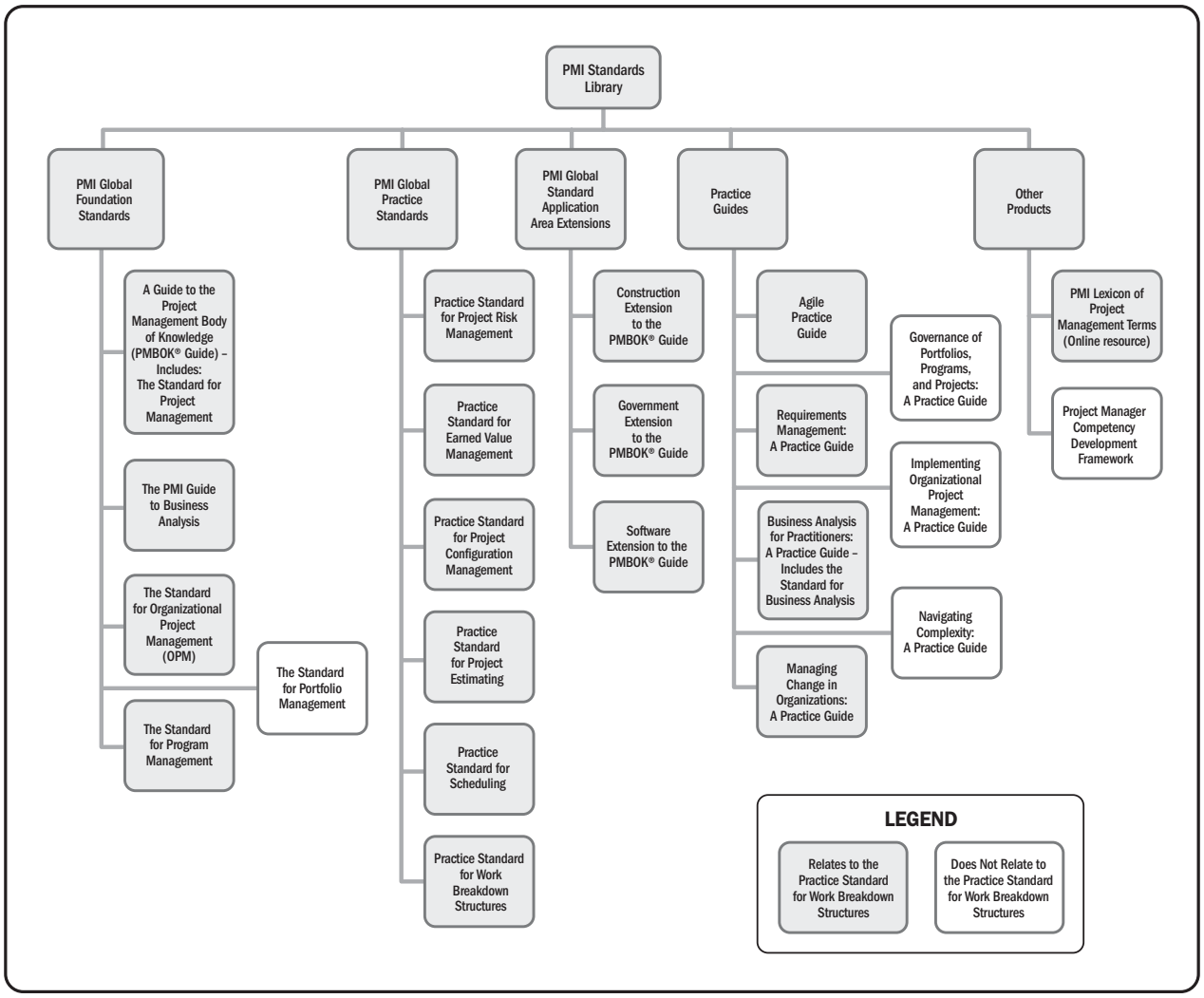


Figure 1-1. WBS Relationship Diagram

1.4.2 RELATIONSHIPS OF WBS PROCESSES AMONG OTHER *PMBOK® GUIDE* PROCESSES

The WBS is integral to the project planning and implementation processes. The WBS receives inputs and products from several preceding processes and feeds into several succeeding processes.

Detailed descriptions of these integrated processes are the core of the *PMBOK® Guide*. In general terms, however, the Create WBS process uses products of preceding processes as inputs, specifically the scope management plan, project scope statement, and requirements documentation.

The developed WBS articulates the project scope and is a critical input to several project management processes, such as the Define Activities process, the Sequence Activities process, the Estimate Costs process, the Plan Quality Management process, and the Identify Risks process.

Various processes receive inputs from, and submit outputs to, the WBS—from the initial planning stage through the entire project life cycle—and are detailed in the *PMBOK® Guide*.

1.4.3 PLACEMENT OF THE WBS IN THE PROJECT LIFE CYCLE

The WBS journey begins with an effort to understand the work as much as possible, given the available scope information. Representing the work as a WBS becomes a part of the scope baseline. This representation continues to guide all stakeholders involved through scheduling, budgeting, and resourcing. This representation of work persists throughout the project life cycle, leveraging the WBS for requirements, earned value management (EVM), and for many other purposes elaborated on later in this practice standard.

1.4.4 PROGRAM WBS VS. PROJECT WBS

A program is a group of "related projects, subsidiary programs, and program activities, managed in a coordinated manner to obtain benefits not available from managing them individually" (*The Standard for Program Management* – Fourth Edition, Section 1.2, p. 3).

Program management introduces several terms not included in the day-to-day project management vocabulary, such as:

- Component—A project, subsidiary program, or other program-related activities conducted to support a program.
- Benefit—The gains and assets realized by the organization and other stakeholders as the result of outcomes delivered by the program.

The program scope encompasses all benefits delivered by the program, reflected in the form of a program WBS. A program WBS is a hierarchical decomposition encompassing the total scope of the program, and it includes the deliverables to be produced by the constituent components.

The program WBS encompasses the projects, subsidiary programs, and program activities included in the program. Decomposition of projects in the program WBS typically stops at the first or second level, as complexity warrants. Decomposition of the program and subsidiary programs stops at the level required to effectively manage and control the program.

1.5 SUMMARY

This practice standard provides insight into the WBS as well as guidance and directives toward its development and application. The expectation is that the use of the principles and implementation methods found in this practice standard enables the reader to prepare a valuable, quality WBS and put it to work while managing a program or a project.

2

CONCEPTS AND PRINCIPLES

2.1 OVERVIEW

Making a project more manageable requires breaking it down into individual components (subcomponents) that together are known as a WBS. The WBS is a hierarchical structure that defines unique work elements arranged and completed during the project sequentially, in parallel, or in the specific order necessary to accomplish project outcomes. The WBS facilitates other project management processes and activities, such as make-or-buy analysis, stakeholder identification, time and cost estimating, scheduling, resource allocation, risk analysis, measurement, and control of the project.

The work breakdown structure (WBS) defines:

- W = Work. Sustained physical or mental effort, actions performed by automated processes, 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 outputs, work products, or deliverables that are the results of effort, not the effort itself.
- B = Breakdown. Division into parts or categories; separation into simpler and identifiable substances; decomposition.
- S = Structure. Something arranged in a definitive pattern of organization.

Based on these definitions, a WBS:

- Supports the definition of all work required to achieve an output, objective, deliverable, or tangible result.
- Is constructed to illustrate and define the hierarchy of deliverables (the *what*). This hierarchy is organized into parent–child relationships.
- Has an objective or tangible result (the *what*) referred to as a deliverable or output or result.

The WBS represents a clear description of the project's deliverables and scope—the *what* of the project. The WBS does not describe *how* or *when* the deliverables will be produced, but rather is specifically limited to describing and detailing the project's outputs, project scope, product scope, or deliverables.

The WBS is a hierarchical decomposition of the total scope of work to be carried out by the project team to accomplish the project objectives and create the required deliverables. The WBS organizes the projects into different types of work, defines the total scope of the project, and represents the work specified in the current approved project scope. Work packages, the lowest level of WBS components, contain the planned work. The work packages need to be a size for which cost and duration can be estimated. A work package can be used to group the activities where work is scheduled, estimated, monitored, and controlled. In the context of the WBS, work refers to work products or deliverables that are the results of activity and not to the activity itself.

The following concepts apply when creating a WBS:

- **Hierarchical.** Classified according to various criteria into successive levels or layers.
- **Decomposition.** A technique used for dividing and subdividing the project scope and project deliverables into smaller, more manageable parts.
- **Scope.** The sum of the products, services, and results to be provided as a project.
- **Deliverable.** Any unique and verifiable product, result, or capability to perform a service that is produced to complete a process, phase, or project.

The WBS subdivides the project work into smaller, shorter-duration, more manageable pieces of work, with each descending level of the WBS representing an increasingly detailed definition of the project work of the previous level. The planned work contained in work packages (the lowest level of WBS components) can be time and cost estimated, scheduled, executed, monitored, and controlled.

This section provides more information regarding WBS terms, concepts, and rules, as well as three WBS examples in action (build a house, organize a party, and construct a custom bicycle). Section 2 includes the following subsections:

- 2.2 Implementation Using Life Cycles
- 2.3 Principles
- 2.4 Methods
- 2.5 Styles
- 2.6 Representations of Work
- 2.7 Summary

2.2 IMPLEMENTATION USING LIFE CYCLES

Different project life cycles can be used for project implementation. A project life cycle is the series of phases that a project passes through from start to completion, providing the basic framework for managing the project. This basic framework applies regardless of the specific project work involved. The phases may be sequential, iterative, or overlapping. All projects can be mapped to the generic life cycle shown in Figure 2-1.

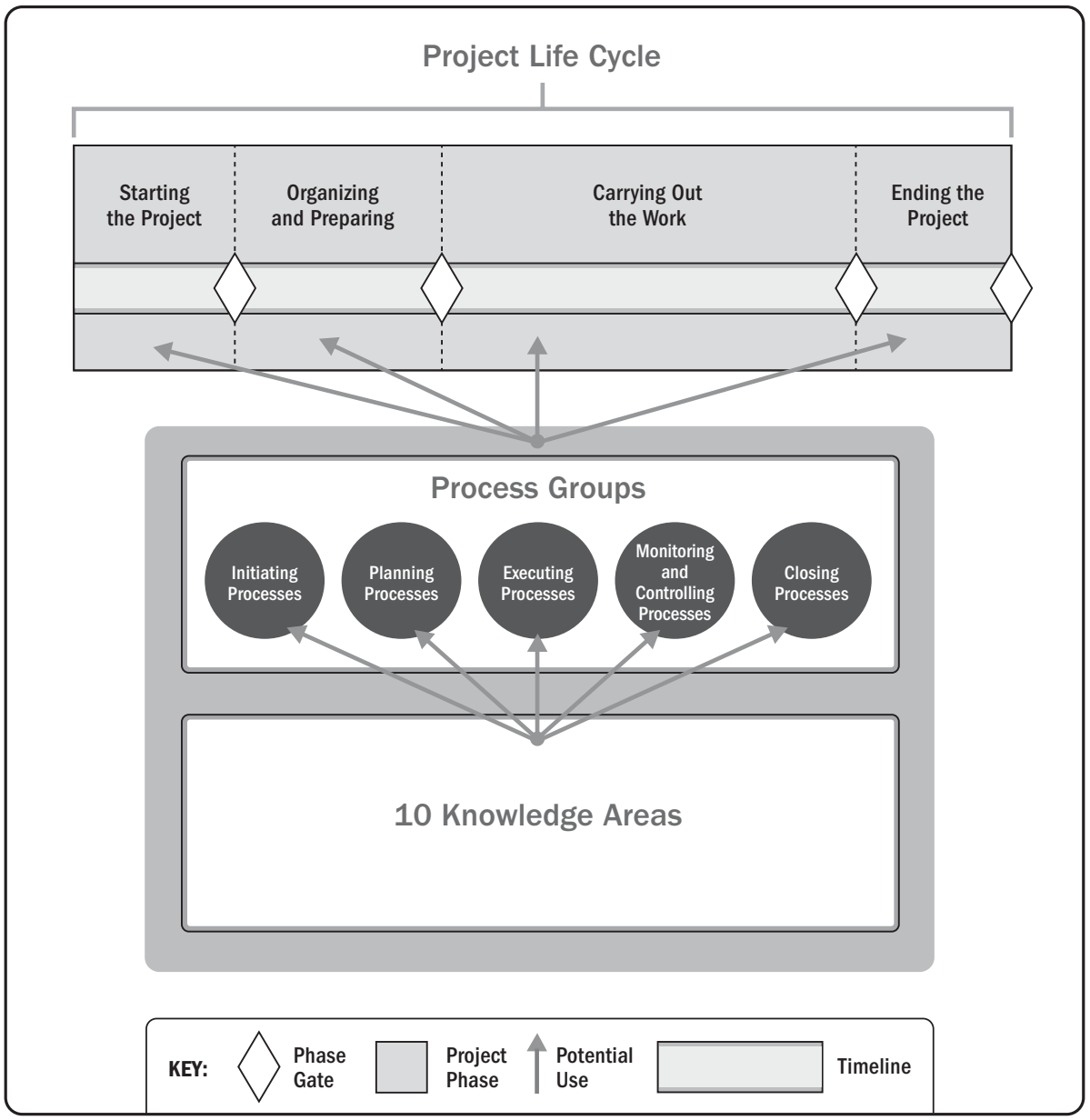


Figure 2-1. Interrelationship of *PMBOK® Guide* Key Components in Projects

The project management team determines the best life cycle for each project. The project life cycle needs to be flexible enough to deal with the variety of factors included in the project. Life cycle flexibility may be accomplished by:

- Identifying the processes needed to be performed in each phase;
- Performing the processes identified in the appropriate phase; and
- Adjusting the various attributes of a phase (e.g., name, duration, exit criteria, and entrance criteria).

The WBS assists project managers, project leaders, stakeholders, and participants in the development of a clear vision of the end products, deliverables, or outputs produced by the project (an output can be a product, service, or result). To be more precise, the WBS provides a clear vision of the work involved in the project to deliver a product, service, or result.

The creation of a WBS differs from project to project based on the selected project life cycle for each project, while projects and subsidiary programs comprise the program WBS.

Project life cycles can be predictive, iterative, incremental, or agile:

- In a predictive life cycle, the project scope, time, and cost are determined in the early phases of the life cycle. Any changes to the scope are carefully managed. A predictive life cycle may also be referred to as a waterfall life cycle.
- In an iterative life cycle, the project scope is generally determined early in the project life cycle, but time and cost estimates are routinely modified as the project team's understanding of the product increases (rolling wave planning). Iterations develop the product through a series of repeated cycles.
- In an incremental life cycle, the deliverable is produced through a series of iterations that successively add functionality within a predetermined time frame. The deliverable contains the necessary and sufficient capability to be considered complete only after the final iteration.
- In an agile life cycle, a series of iterations deliver the required functionality. These iterations have short durations, typically lasting one to four weeks. Iterations develop the product through a series of repeated cycles.

A hybrid life cycle is a combination of a predictive and an agile life cycle. Those elements of the project that are well known or have fixed requirements follow a predictive development life cycle, and those elements that are still evolving follow an agile development life cycle, more readily accommodating scope creep and changes.

In all project life cycles, 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 project team uses the WBS to communicate with stakeholders.

The different project life cycles have the following characteristics, as listed in Table 3-1 in the *Agile Practice Guide*:

Characteristics				
Approach	**Requirements**	**Activities**	**Delivery**	**Goal**
Predictive	Fixed	Performed once for the entire project	Single delivery	Manage cost
Iterative	Dynamic	Repeated until correct	Single delivery	Correctness of solution
Incremental	Dynamic	Performed once for a given increment	Frequent smaller deliveries	Speed
Agile	Dynamic	Repeated until correct	Frequent small deliveries	Customer value via frequent deliveries and feedback

The depth of a WBS depends upon the size and complexity of the project and the level of detail needed to plan and manage it. Work breakdown structures consist of a multilevel hierarchy describing the entire scope to be accomplished by the performing organization. However, the specific number of levels should be appropriate for effectively managing, executing, and monitoring and controlling the project.

2.2.1 USING WBS IN PREDICTIVE (WATERFALL) LIFE CYCLES

Predictive life cycles capitalize on the higher certainty of firm and stable requirements and low risk. As a result, project activities often execute in a sequential manner. To achieve this approach, the team requires detailed plans to know what to deliver and how. The team creates detailed requirements, a scope statement, a WBS, a WBS dictionary, and plans in the beginning of the project. The team does not typically deliver business value until the end of the project (Figure 2-2).

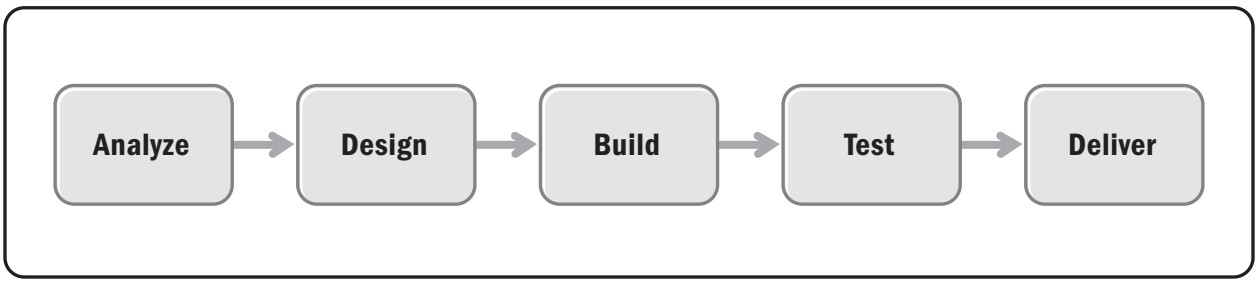


Figure 2-2. Predictive Life Cycle

In predictive life cycles, the project scope, time, and cost are determined in the early phases of the life cycle. Any changes to the scope are carefully managed through a formal change management process. Predictive life cycles may also be referred to as waterfall life cycles.

The typical predictive life cycle WBS adheres to the following conventions:

- The project name appears on the first level of the WBS.
- Project phases or major project deliverables are typically represented on the second level (see also Figure 4-1 for depiction of WBS levels).
- The third level and levels below (depending on the second level) can represent deliverables, control accounts, or work packages.
- The WBS decomposition can continue, depending on the size and complexity of the project.
- The lowest level of WBS components are called work packages.

Figure 2-3 represents these conventions in a phase-based WBS.

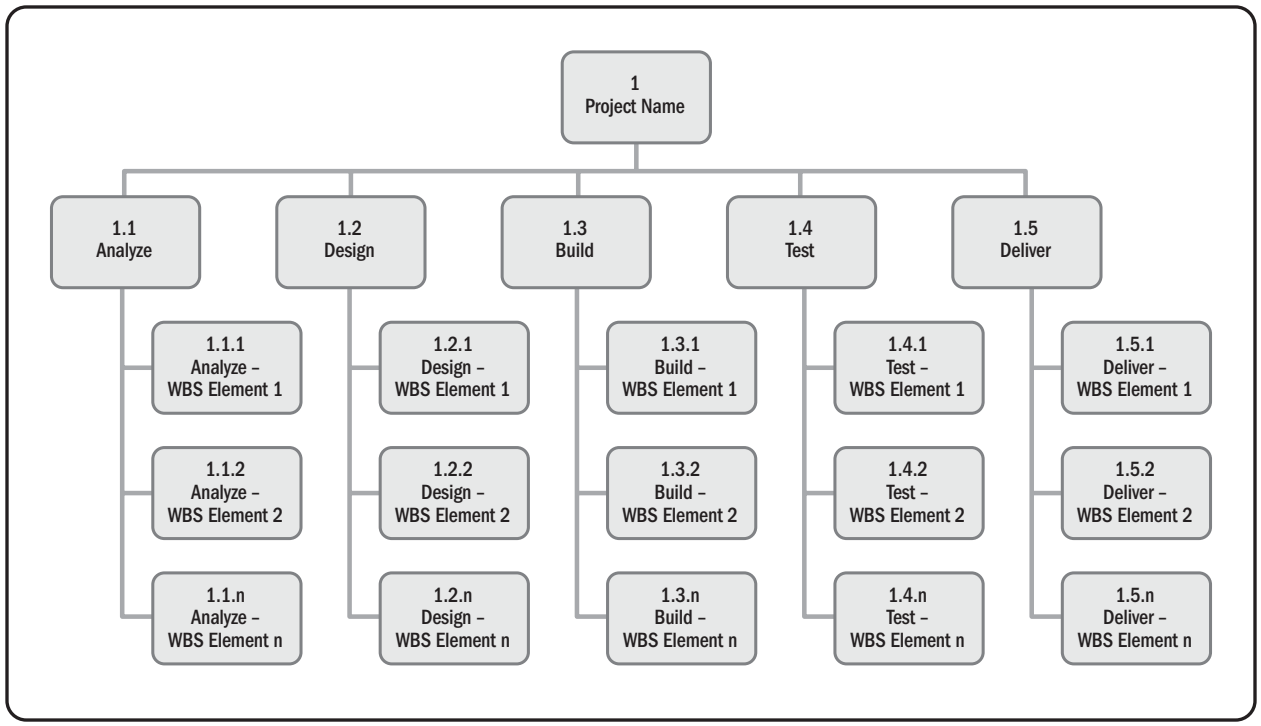


Figure 2-3. A Predictive Life Cycle WBS Example with Project Phases on the Second Level of the WBS

Figure 2-4 represents these conventions in a deliverable-based WBS.

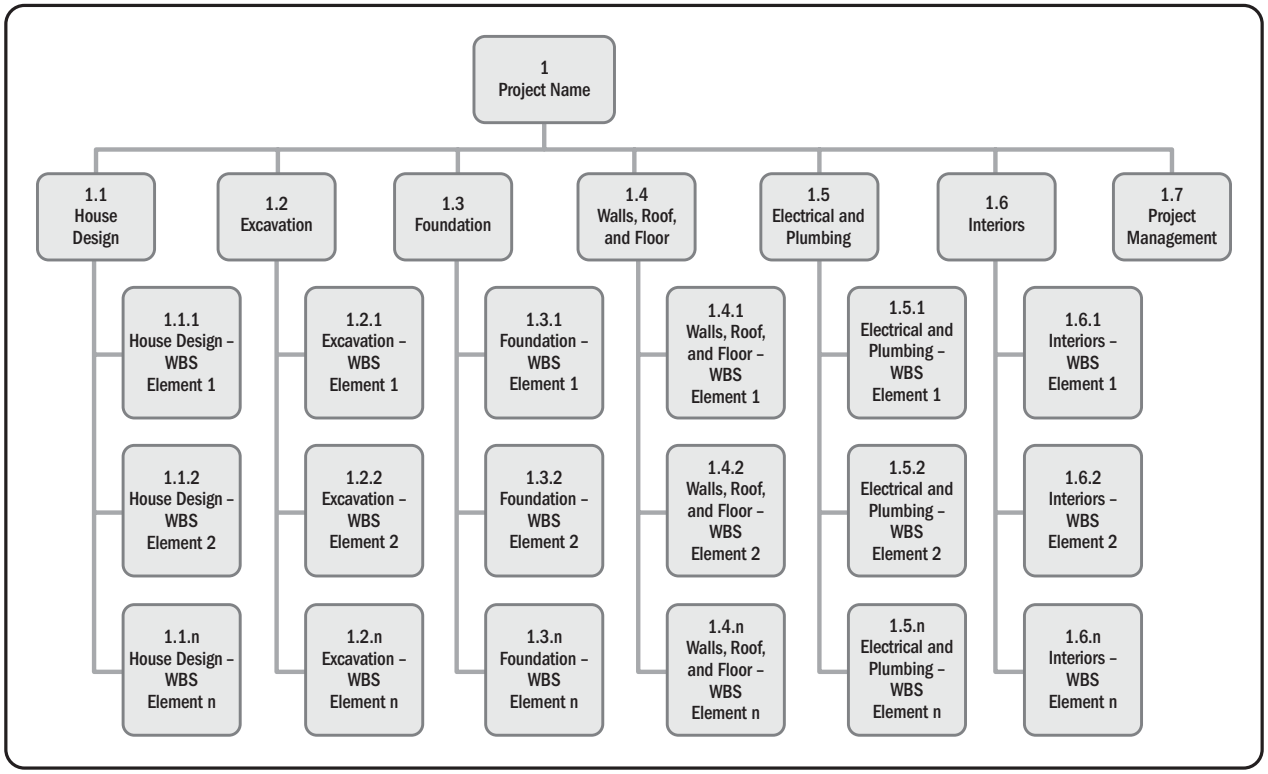


Figure 2-4. A Predictive Life Cycle WBS Example with Major Deliverables on the Second Level of the WBS

The WBS iteratively evolves along with the progressive elaboration of project scope, up to the point the scope has been baselined for the whole project.

In predictive life cycles, the scope baseline for the project is the approved version of the project scope statement, WBS, and its associated WBS dictionary. A baseline changes only through formal change control procedures and serves as a basis for comparison during project implementation, as shown in Figure 2-5.

WBS	Name	Duration	Year 1												Year 2	
			Dec	Q1 Jan	Feb	Mar	Q2 Apr	May	Jun	Q3 Jul	Aug	Sep	Q4 Oct	Nov	Dec	Q5 Jan Feb
1	**PREDICTIVE Life Cycle**	**280 Days**														
1.1	Requirements	1 Month														
1.2	Planning and Design	3 Months														
1.3	Construction	8 Months														
1.4	Deliver final product to customer	2 Months														

Figure 2-5. A Predictive Life Cycle Example in Gantt Chart Style

2.2.2 USING WBS IN ITERATIVE LIFE CYCLES

Iterative life cycles improve the product or result through successive prototypes or proofs of concept. Each new prototype yields new (or additional) stakeholder feedback and team insights. The team incorporates the new information by repeating one or more project activities into rebuilding, recreating, or performing the next cycle.

Projects benefit from iterative life cycles when complexity is high; when the project incurs frequent changes; or when the scope is subject to differing stakeholders' views, technological advancements, or limitations of the desired final product. Iterative life cycles may take longer because they are optimized for learning rather than speed of delivery. Iterative life cycles do not typically deliver substantive business value until the end of the project. In some cases, the iterative life cycle improves the likelihood of advancing to the next milestone or obtaining critical sign-offs for the next phase.

In an iterative life cycle, the project scope is generally determined early in the project life cycle, but time and cost estimates are routinely modified as the project team's understanding of the product increases. Iterations develop the product through a series of repeated cycles, while increments successively add to the functionality of the product, as shown in Figure 2-6.

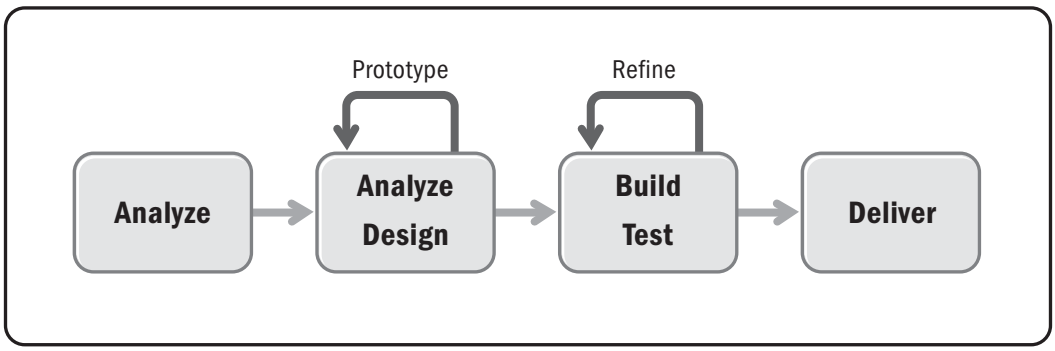


Figure 2-6. An Iterative Life Cycle Example

In an iterative life cycle, the representation of the WBS typically follows these conventions:

- The project name appears on the first level of the WBS.
- The second level represents project phases (called iterations). Multiple initial phases (iterations) of the project repeat until stakeholders agree on the decomposition. Also, later phases (iterations) of the project recur until the project delivers the final output.
- The third level and levels below represent deliverables or work packages.
- The WBS decomposition continues, depending on the size and complexity of the project.
- The lowest levels of WBS components are called work packages.

Figure 2-7 represents these conventions in a phase-based WBS.

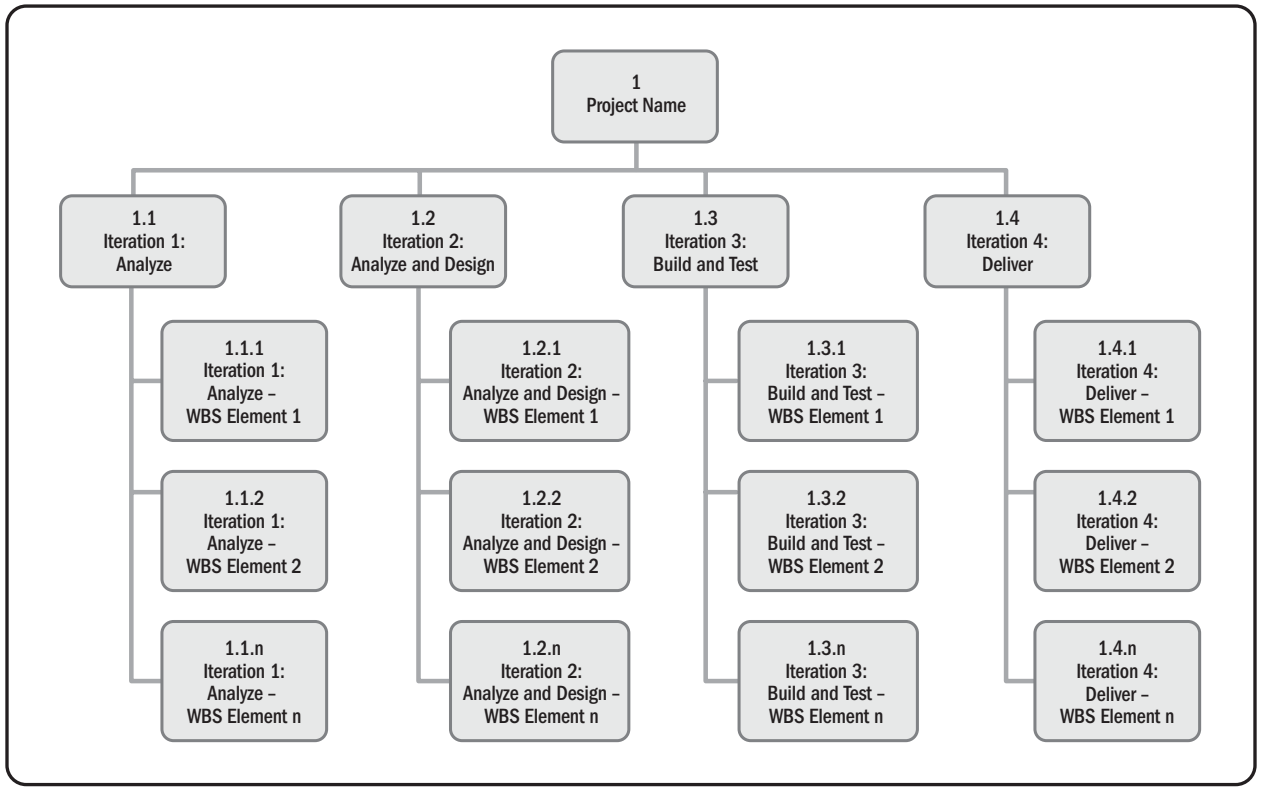


Figure 2-7. An Iterative Life Cycle WBS Example with Iterations on the Second Level of the WBS

A WBS iteratively evolves along with the progressive elaboration of project scope up to the point the scope has been baselined separately for every iteration.

In iterative life cycles, the scope baseline for the project is the approved version of the project scope statement, WBS, and its associated WBS dictionary elaborated throughout the project life cycle. A baseline changes only through formal change control procedures and serves as a basis for comparison during project implementation, as shown in Figure 2-8.

WBS	Name	Duration
1	**ITERATIVE Life Cycle**	**340 Days**
1.1	Iteration 1: Analyze	3 Months
1.2	Iteration 2: Analyze and Design	4 Months
1.3	Iteration 3: Build and Test	5 Months
1.4	Iteration 4: Deliver	5 Months

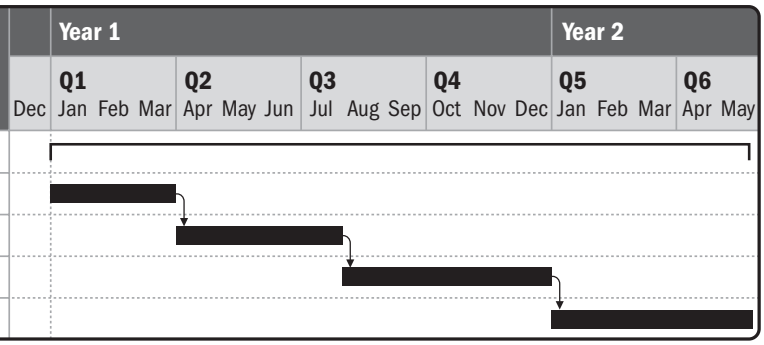


Figure 2-8. An Iterative Life Cycle Example in Gantt Chart Style

2.2.3 USING WBS IN INCREMENTAL LIFE CYCLES

Some projects optimize for speed of delivery. Many businesses and initiatives cannot afford to wait for everything to be completed; in these cases, customers are willing to receive a subset of the overall solution. This frequent delivery of smaller deliverables is called an incremental life cycle.

In an incremental life cycle, the deliverable is produced through a series of iterations that successively add functionality within a predetermined time frame. The deliverable contains the necessary and sufficient capability and value to be considered complete only after the final iteration, as shown in Figure 2-9.

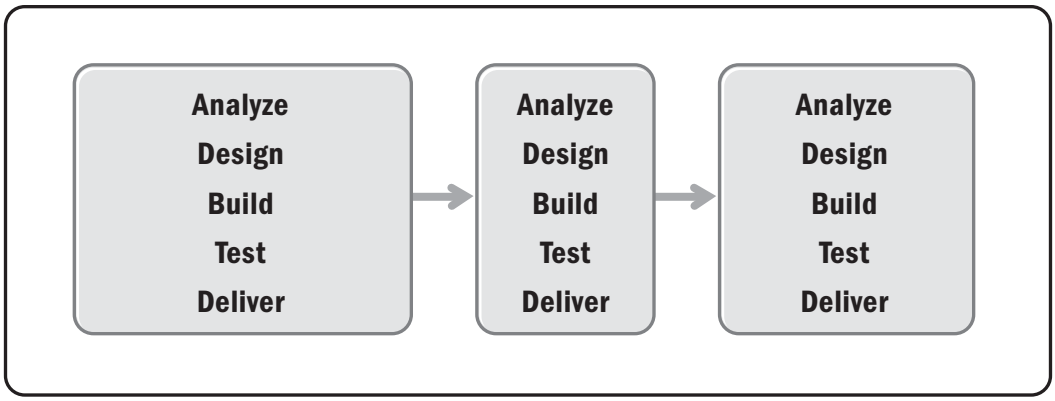


Figure 2-9. A Life Cycle of Varying-Sized Increments

Incremental life cycles optimize work for delivering value to sponsors, stakeholders, and customers more often than a single, final product. The final product of the project is considered complete only after the final phase (iteration) is complete.

In an incremental life cycle, the WBS is typically represented as follows:

- The project name, product name, or initiative name appears on the first level of the WBS.
- Project phases (also called iterations) are represented on the second level of the WBS. Every phase (iteration) analyzes, designs, builds, tests, and delivers value to the customer.
- The third level of the WBS and levels below can represent deliverables and/or work packages.
- The WBS decomposition continues, depending on the size and complexity of the project.
- The lowest levels of WBS components are called work packages.

Figure 2-10 represents these conventions in a phase-based WBS.

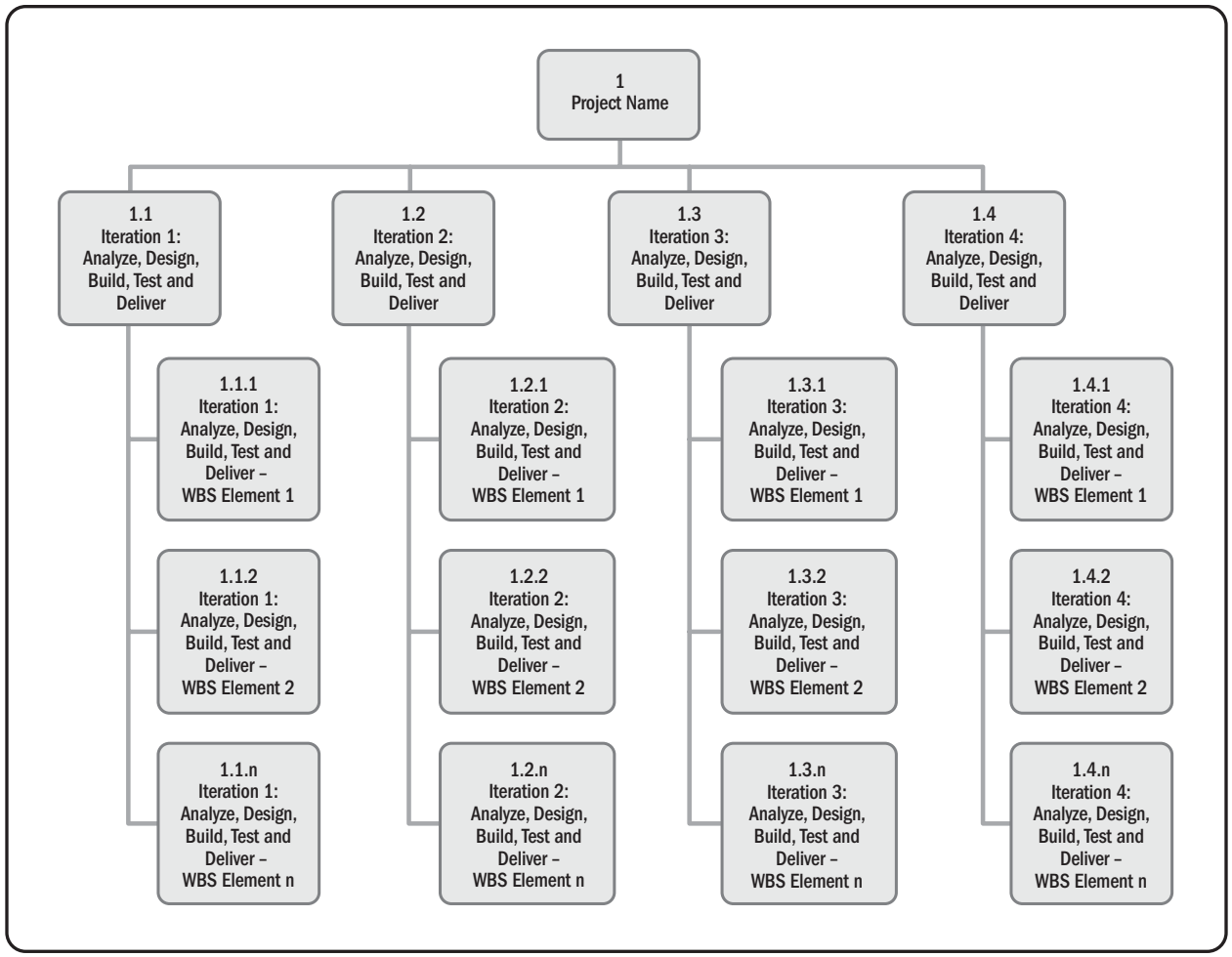


Figure 2-10. An Incremental Life Cycle WBS Example with Iterations on the Second Level of the WBS

The WBS iteratively evolves along with the progressive elaboration (rolling wave planning) of project scope up to the point the scope has been baselined separately for every phase (iteration).

In incremental life cycles, the scope baseline for the project is the approved version of the project scope statement, WBS, and its associated WBS dictionary for a specific iteration. A baseline changes only through formal change control procedures and serves as a basis for comparison during project implementation, as shown in Figure 2-11.

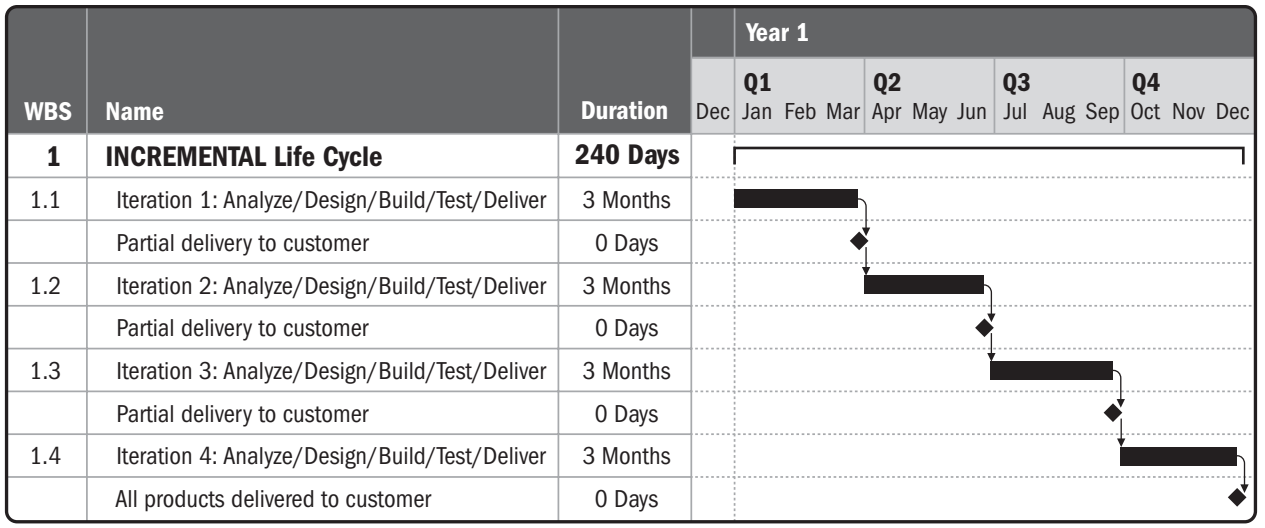


Figure 2-11. An Incremental Life Cycle Example in Gantt Chart Style

2.2.4 USING WBS IN AGILE LIFE CYCLES

In projects with evolving requirements or significant uncertainty, the scope is often not completely understood in the beginning of the project or it evolves during the project. Agile practices deliberately spend less time trying to define and agree on scope in the early stage of the project and spend more time establishing the process for its ongoing discovery and refinement. Many environments with emerging requirements find that there is often a gap between the expected business requirements and the originally stated business requirements.

Agile practices purposefully build and review prototypes and release versions to refine the requirements. As a result, scope is defined and redefined throughout the project. In agile approaches, the backlog constitutes the known requirements. Requirements in agile approaches represent epics, features, or user stories.

Product owners, with the help of the team, stakeholders, and business analysts, create the product backlog. The product backlog helps the team see how to deliver the highest value without creating waste.

In an agile life cycle, the sponsor and customer representatives regularly engage with the project to provide feedback on deliverables as they are created and ensure that the product backlog reflects current needs.

The WBS is often associated with predictive life cycles and supports the decomposition of the total scope of the project. When agile practices are adopted, the decomposition of the total scope into smaller parts supports a backlog or product backlog.

In an agile life cycle, the WBS encompasses business value items, commonly referred to as requirements, backlog items, or user stories. Every requirement, backlog item, or user story represents the work needed to deliver a user functionality described by this item. Every requirement, backlog item, or user story delivers a small increment of functionality, an output, or a deliverable. Work packages represent the lowest level of decomposition in a WBS. User stories are the lowest level of decomposition in an agile project. Both user stories and work packages deliver functionality to the customer. Both work packages and user stories are about the *what* and not the *how*. Work packages roughly equate to user stories.

In projects performed in an agile environment, the team expects requirements to change. The iterative and incremental approaches provide feedback to better plan the next part of the project. Figure 2-12 illustrates two possible ways to achieve incremental delivery, so the agile project aligns with customer needs and can be adapted as necessary: iteration-based agile and flow-based agile.

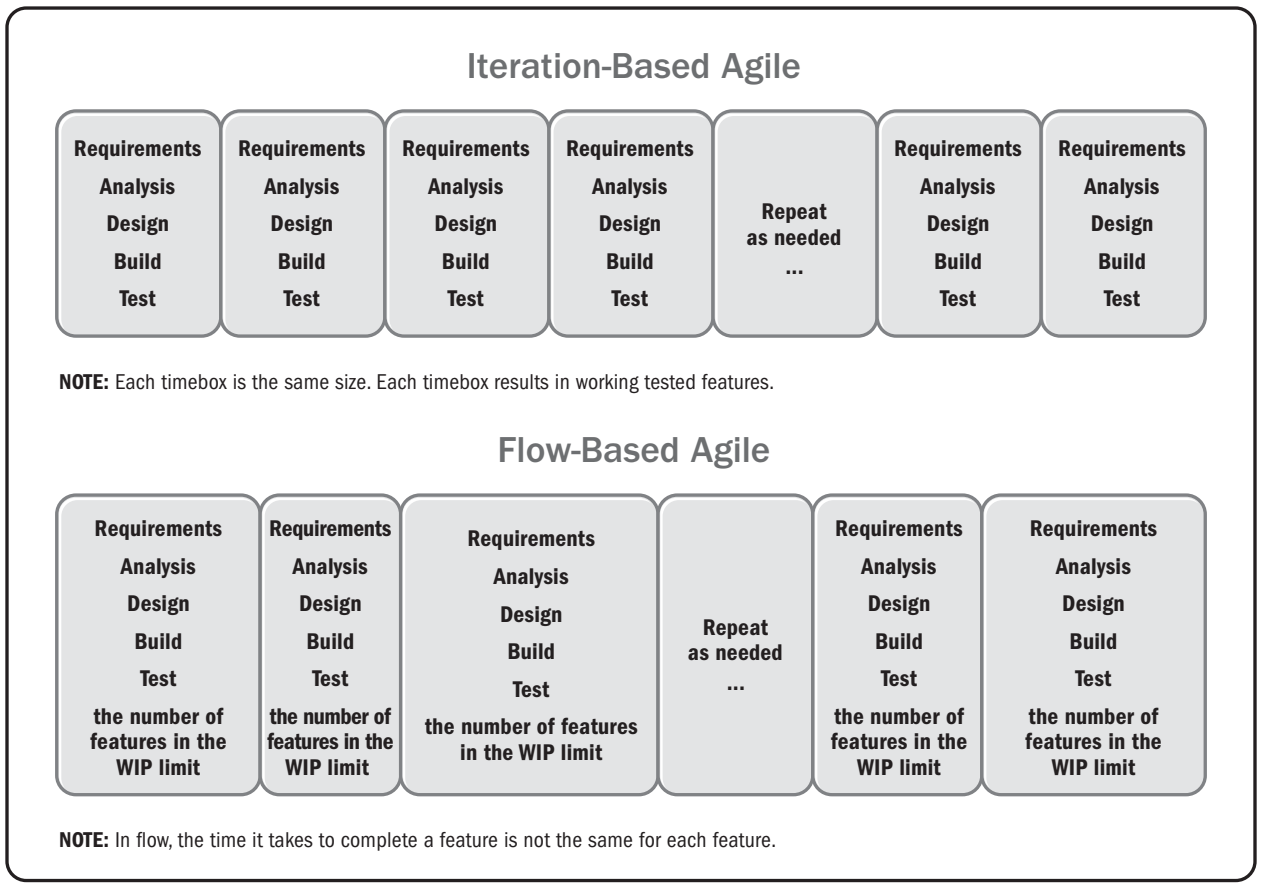


Figure 2-12. An Iteration-Based and a Flow-Based Agile Life Cycle

In iteration-based agile, the team works in iterations (sprints when the Scrum framework is used) (timeboxes of equal duration) to deliver completed features. In agile life cycles using iterations, there is a goal on the size of the user story (work package): The user story should be delivered in a single iteration (sprint). If the user story cannot be delivered in a single iteration (sprint), separate the user story into smaller user stories.

In flow-based agile, the team pulls features from the backlog based on its capacity to start work rather than on an iteration-based schedule.

Following are several different approaches to decomposing agile projects, but not limited to:

- Product, iterations, user stories
- Product, releases, iterations, user stories
- Product, releases, features, iterations, user stories
- Product, features, releases, iterations, user stories
- Product, epics, features, iterations, user stories
- Product, features, epics, iterations, user stories

Various WBS scenarios exist for agile projects.

The first scenario includes, as illustrated in Figure 2-13:

- The project name or product name appears on the first level of the WBS.
- Iterations (sprints) appear on the second level of the WBS (1.1, 1.2, 1.3, 1.4, 1.5, etc.).
- User stories appear on the third level of the WBS. User stories in agile projects are the lowest level of decomposition and have similar characteristics with work packages. Both user stories and work packages produce one or more deliverables or functionality.

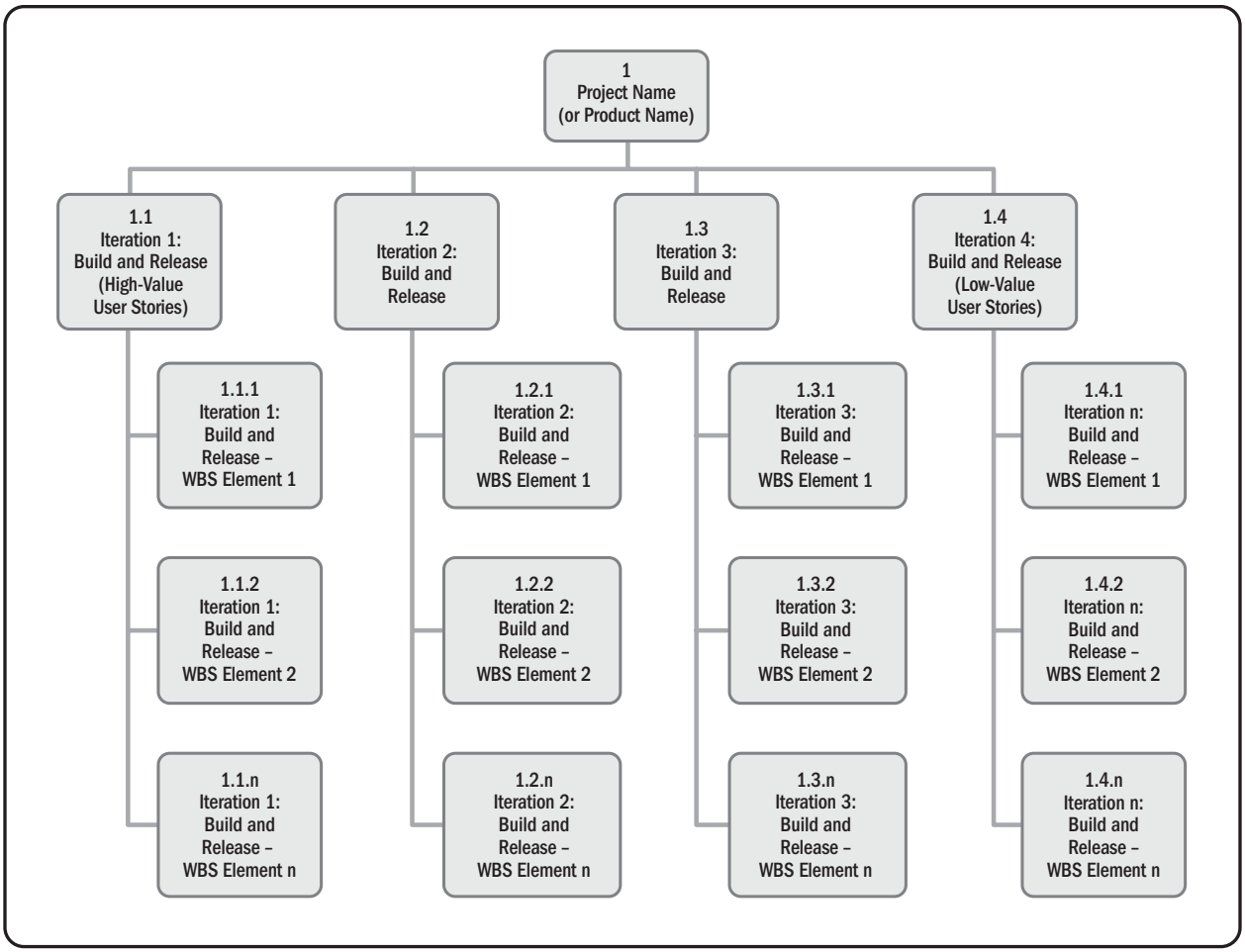


Figure 2-13. An Agile Life Cycle WBS Example with Iterations on the Second Level of the WBS

The second scenario includes, as shown in Figure 2-14:

- The project name or product name appears on the first level of the WBS.
- Releases appear on the second level of the WBS (Release 1, Release 2, Release 3, etc.).
- Iterations (sprints) appear on the third level of the WBS (1.1.x, 1.2.x, 1.3.x, 1.4.x, 1.5.x, etc.).
- User stories (equivalent to work packages) appear on the fourth level of the WBS.

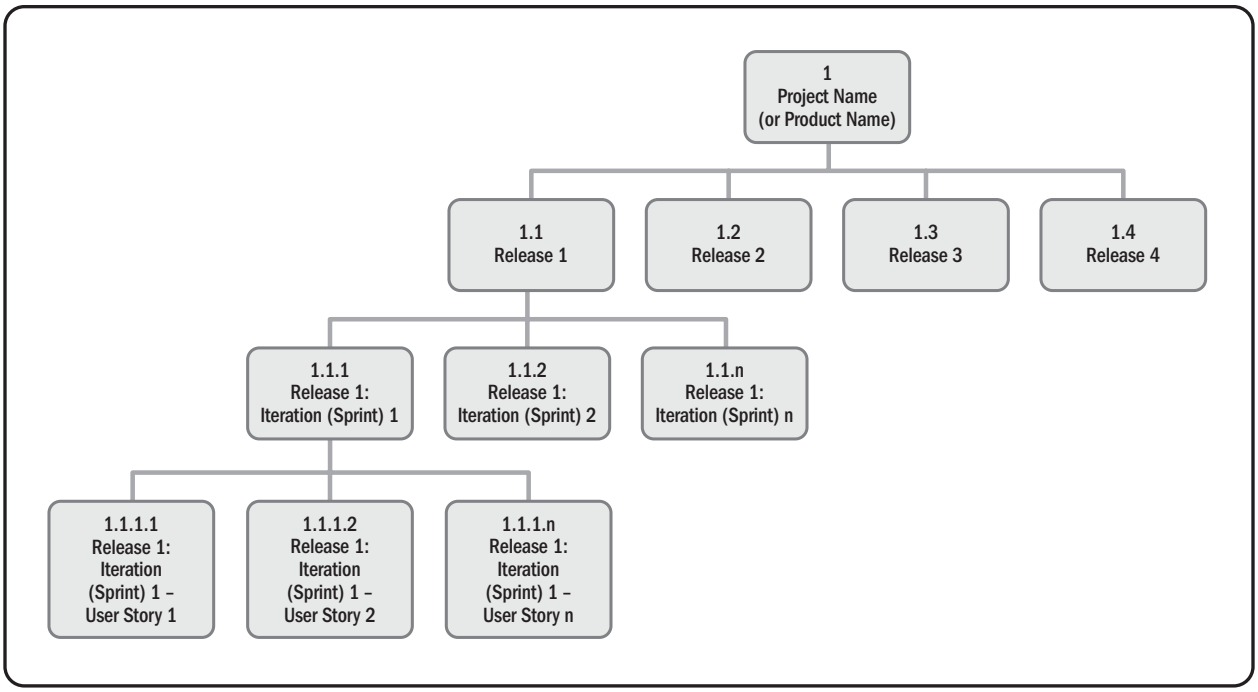


Figure 2-14. An Agile Life Cycle WBS Example with Releases on the Second Level of the WBS

Other combinations of releases, features, and iterations exist. In agile life cycle projects, the WBS evolves as requirements evolve, which means that the WBS baseline does not occur at the start of the project. The final version of the WBS is known only at project completion, as shown in Figure 2-15.

WBS	Name	Duration
1	**Iteration-Based AGILE Life Cycle**	**200 Days**
1.1	Iteration (Sprint) 1	2 Weeks
1.2	Iteration (Sprint) 2	2 Weeks
1.3	Iteration (Sprint) 3	2 Weeks
1.4	Iteration (Sprint) 4	2 Weeks
1.5	Iteration (Sprint) 5	2 Weeks
1.6	Iteration (Sprint) 6	2 Weeks
1.7	Iteration (Sprint) 7	2 Weeks
1.8	Iteration (Sprint) 8	2 Weeks
1.9	Iteration (Sprint) 9	2 Weeks
1.10	Iteration (Sprint) 10	2 Weeks

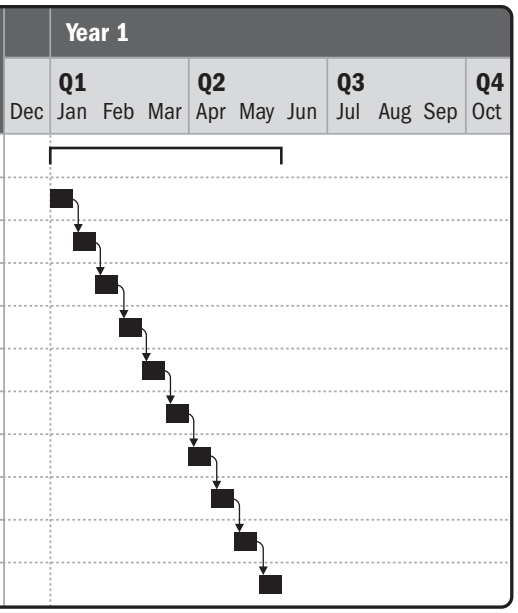


Figure 2-15. An Iteration-Based Agile Life Cycle Example in Gantt Chart Style

2.2.5 KEY CONCEPTS/CHARACTERISTICS

The following terms and definitions (in alphabetical order) represent WBS-related terms as defined in the *PMI Lexicon of Project Management Terms*, *PMBOK® Guide*, and *Agile Practice Guide*. These terms and others listed in the Glossary of this practice standard, facilitate understanding of the integral role the WBS plays in project management practice:

- **Activity.** A distinct, scheduled portion of work performed during the course of a project.
- **Control Account.** A management control point where scope, budget, actual cost, and schedule are integrated and compared to earned value for performance measurement.
- **Deliverable.** Any unique and verifiable product, result, or capability to perform a service that is required to be produced to complete a process, phase, or project.
- **Discrete Effort.** An activity that can be planned and measured and that yields a specific output. [Note: Discrete effort is one of three earned value management (EVM) types of activities used to measure work performance.]

- **Level of Effort.** An activity that does not produce definitive end products and is measured by the passage of time. [Note: Level of effort is one of three earned value management (EVM) types of activities used to measure work performance.]
- **Planning Package.** A control account may include one or more planning packages. A planning package is a work breakdown structure component below the control account and above the work package with known work content but without detailed schedule activities.
- **Scope.** The sum of the products, services, and results to be provided as a project.
- **Scope Baseline.** The approved version of a scope statement, work breakdown structure (WBS), and its associated WBS dictionary that can be changed using formal change control procedures and is used as a basis for comparison to actual results.
- **Work Breakdown Structure Component.** An entry in the *work breakdown structure* that can be at any level.
- **Work Breakdown Structure Element.** Any single *work breakdown structure* (WBS) component and its associated WBS attributes contained within an individual work breakdown structure.
- **WBS Dictionary.** A document that provides deliverable, activity, scheduling, and estimating information for each element in the work breakdown structure.
- **Work Package.** The work defined at the lowest level of the work breakdown structure for which cost and duration are estimated and managed.

There are several types of WBS decompositions in practice. Various sources identify the WBS as action-oriented, backlog-oriented, contract-oriented, deliverable-oriented, phase-oriented, product-oriented, program-oriented, or even a combination, which results in a hybrid approach. Though not specifically addressed in the types of decomposition, an emerging type of orientation considered is location-oriented.

A WBS of only one type of decomposition is rare. Typically, a WBS blends multiple types of decomposition. The seven types of decomposition represent the typical work breakdown structures found in practice. Table 2-1 provides focused descriptions that explain the type of decomposition along with WBS examples to assist in concept application.

Table 2-1. Types of Decomposition

Types of Decomposition	Focus	WBS Element Examples
Action-oriented	Behavior-based component, as in function, process, activity, task, or service	Project management, assembly, sanitary installation, electrical installation
Backlog-oriented	Iterative, incremental, or agile approach with customer backlog, part of project scope but not total scope	Epic, user story, next delivery is another portion of the backlog
Contract-oriented	Collecting cost components	Any deliverable, product, phase, program, or action WBS element
Deliverable-oriented	Any component that supports delivery of the final product	Project plan, project budget
Phase-oriented	Phase-based component	Plan, analyze, design
Product-oriented	Any component that is a part of the final product	Missile system, bicycle frame set
Program-oriented	Project planning-based component	Program ABC, project A, project B, system X

Regardless of the type of decomposition, the first level of the WBS represents the project name, product name, or initiative name. These types of decomposition apply to predictive, iterative, incremental, and agile life cycles or a hybrid approach. Later sections in this practice standard illustrate how to combine the different types of decomposition.

2.3 PRINCIPLES

2.3.1 THE 100 PERCENT RULE

The total of the work at the lowest levels of a WBS rolls up to the higher levels. This principle is known as the 100 percent rule.

The 100 percent rule ensures that a WBS captures all known scope and project deliverables. This principle applies to all levels of a WBS, so the sum of the work at the child level totals the work at the parent level.

2.3.1.1 MORE WBS RULES

Additional rules to keep in mind when creating a WBS:

- **Cost.** WBS elements do not contain costs.
- **Importance.** WBS elements do not imply importance.

- **Levels of decomposition:** The WBS has no limits on the levels of decomposition. However, when a parent results in only one child, that parent should not be decomposed further.
- **Mutually exclusive elements.** WBS elements do not overlap in order to increase clarity and avoid duplicate work and miscommunication.
- **Relationships:** WBS elements do not imply or show relationships.
- **Resources.** WBS elements do not assign resources.
- **Time.** WBS elements do not account for time or sequence.

Although a WBS element does not address the above characteristics, they are crucial to scheduling, estimating, and other related activities.

2.3.2 ACTIVITIES OUTSIDE THE WBS

It is important to remember that the 100 percent rule also applies at the activity level. The work represented by the activities in each work package shall add up to 100 percent of the work necessary to complete the work package. If work or activities exist outside of the WBS, reevaluate the WBS, incorporating all the work. It shall be made clear that activities are *not* part of the WBS, because activities represent the *how* and the WBS represents the *what*.

2.3.3 WBS NUMBERING

Numbering the WBS proceeds hierarchically from the top level (level 1) to the bottom level of decomposition (level x), as shown in Figure 2-16. The WBS decomposition and numbering continue, depending on the size and complexity of the project. In any case, the lowest level of WBS components are the work packages.

2.3.3.1 WBS NUMBERING FOR PROJECTS

- **Level 1—**This level comprises the full scope of work that is necessary to produce the product, service, or result. Level 1 represents the project or overall product designated by the number 1 or a project code (e.g., ProjX).
- **Level 2—**This is the first level of decomposition for the project. This level is the high-level breakdown of the major areas in the scope of work. The numbering on the second level is 1.1, 1.2, 1.3, . . . , 1.n. When using a project code for level 1, the numbering for the second level is ProjX.1, ProjX.2, ProjX.3, . . . , ProjX.n.

- **Level 3 and below—**In the same manner, each exclusive area in level 3 and levels below decompose further if applicable. The numbering on the third level is:

  1.1.1, 1.1.2, 1.1.3, . . . , 1,1,n,

  1.2.1, 1.2.2, 1.2.3, . . . , 1.2.n,

  1.3.1, 1.3.2, 1.3.3, . . . , 1.3.n, . . . ,

  1.y.1, 1.y.2, 1.y.3, . . . , 1.y.n.

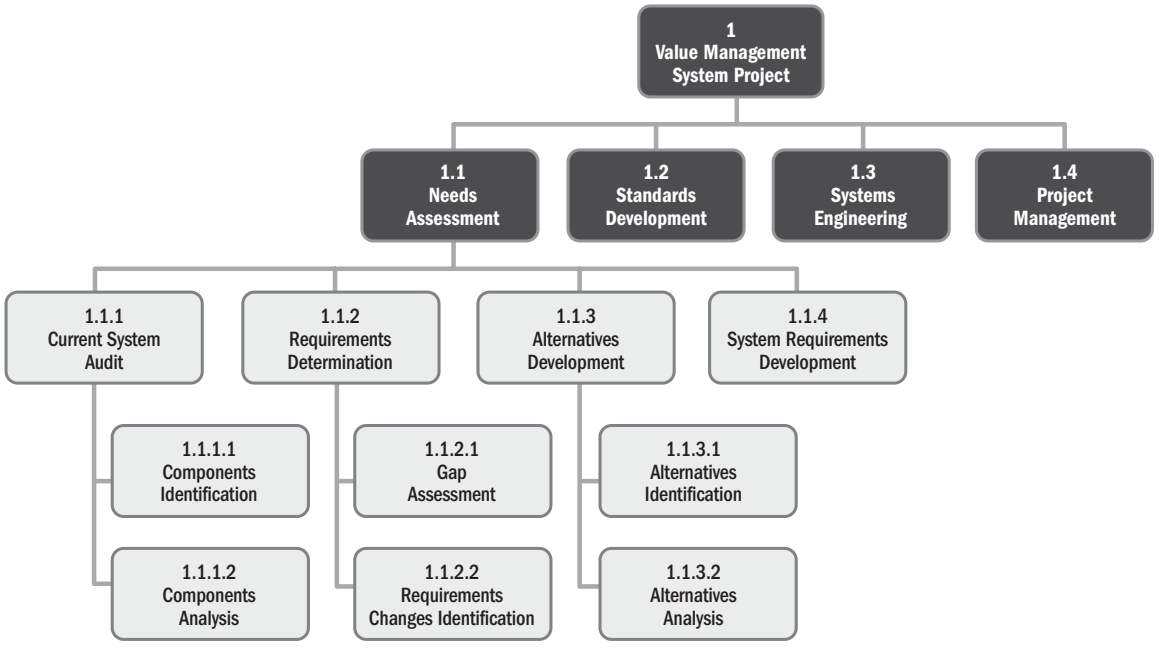
- In case a project code is used on level 1, the numbering on the third level is:

  ProjX.1.1, ProjX.1.2, ProjX.1.3, . . . , ProjX.1.n,

  ProjX.2.1, ProjX.2.2, ProjX.2.3, . . . , ProjX.2.n,

  ProjX.3.1, ProjX.3.2, ProjX.3.3, . . . , ProjX.3.n, . . . ,

  ProjX.y.1, ProjX.y.2, ProjX.y.3, . . . , ProjX.y.n



The WBS is illustrative only. It is not intended to represent the full project scope of any specific project, nor to imply that this is the only way to organize a WBS on this type of project.

Figure 2-16. Example WBS Decomposed down through Work Packages

2.3.3.2 WBS NUMBERING FOR PROGRAMS

- **Level 1—**This level comprises the full scope of work necessary to deliver the program. Level 1 represents the program name designated by the number 1 or a program code (e.g., ProgY).
- **Level 2—**This is the first level of decomposition of the program. This level shows the project names, the subsidiary programs, or program activities. The numbering on the second level is 1.1, 1.2, 1.3, . . ., 1.n. When using a program code on level 1, the numbering on the second level is ProgY.1, ProgY.2, ProgY.3, . . ., ProgY.n, ProgY.
- **Level 3 and below—**In the same manner, each exclusive area in level 3 and levels below decompose further for each project or subprogram. The numbering on the third level is:

  1.1.1, 1.1.2, 1.1.3, . . . , 1,1,n,

  1.2.1, 1.2.2, 1.2.3, . . . , 1.2.n,

  1.3.1, 1.3.2, 1.3.3, . . . , 1.3.n, . . . ,

  1.y.1, 1.y.2, 1.y.3, . . . , 1.y.n.

In case a program code is used on level 1, the numbering on the third level is:

ProgX.1.1, ProgX.1.2, ProgX.1.3, . . . , ProgX.1.n,

ProgX.2.1, ProgX.2.2, ProgX.2.3, . . . , ProgX.2.n,

ProgX.3.1, ProgX.3.2, ProgX.3.3, . . . , ProgX.3.n, . . . ,

ProgX.y.1, ProgX.y.2, ProgX.y.3, . . . , ProgX.y.n

2.4 METHODS

The WBS is a hierarchical decomposition of the total scope of work to be carried out by the project team to accomplish the project objectives and create the required deliverables. The depth of a WBS depends on the size and complexity of the project and the level of detail needed to plan and manage the project.

When decomposing the total scope of work, lower levels of the WBS show greater detail, culminating in work packages (or user stories in agile life cycles). Decomposition of the WBS to varying levels follows the conventions outlined as follows.

2.4.1 DECOMPOSITION

2.4.1.1 LEVEL 1

This level comprises the full scope of work necessary to produce the product, service, or result. It includes all direct and indirect work. Level 1 is the overall product, service, or result, which is always a single WBS element. Different project management information systems (PMIS) represent this element in various ways.

2.4.1.2 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. Project phases, major project deliverables, or releases (in agile life cycles) typically exist on the second level. This level often contains integration and project management work.

2.4.1.3 LEVEL 3

This level decomposes each level 2 WBS element as required. It is important to note that the WBS development adheres to the 100 percent rule. This level often focuses on specific, tangible deliverables of the project effort.

2.4.1.4 LEVEL 4

In the same manner, each level 3 WBS element decomposes as required. The complexity of the work drives the depth and number of levels of the WBS decomposition. Independently of the levels of decomposition, the lowest level of the WBS contains work packages.

2.4.2 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 is often developed early in the conceptual stage of the project. After project definition, requirement analysis, and specification preparation, development of a more detailed WBS occurs. Customization and tailoring of the WBS are based on the specific needs and requirements of the project. Removal of all non-required work and deliverables takes place, so that the WBS represents only the project's scope of work. The result is a WBS that represents the complete list of deliverables for the project.

The WBS assists the project manager and stakeholders in communicating a clear vision of the product(s) of the project and the overall process used to create those products. The WBS helps communicate the work to be accomplished as well as the interim and end-point deliverables to be completed. Table 2-2 provides questions to consider while creating a WBS.

Table 2-2. WBS Creation Questions

Question	Response
1. Is the product of the project part of another project?	
2. Is the project charter defined and issued?	
3. Which project life cycle is used? Predictive, iterative, incremental, agile, or hybrid?	
4. Is the project scope statement defined and issued?	
5. Have the project manager and the team formulated a vision of the final product(s), service(s), or result(s)?	
6. Have personnel who will do the work been assigned to develop the WBS?	
7. What are the project's component parts?	
8. How do the pieces work together?	
9. What are the needs and the expectations?	
10. Have the project's intended business objectives been defined? What is required to achieve the business value?	
11. Has the entire project been thought through? Have the high-level deliverables been sufficiently decomposed?	
12. Have both interim and final deliverables been identified? What is to be provided? What is required?	
13. Has the relationship of each component to the product been defined? How will this component contribute to the finished deliverables?	
14. Has the process for production of the deliverables been defined? What methods and practices will be employed? What special processes will be needed? What are the quality requirements? What kinds of inspections need to be done?	
15. Have the activities needed to support the deliverables been identified, including those that directly or indirectly facilitate their creation?	
16. 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?	
17. Does the project require any external sources to contribute to the project and have they been identified?	
18. Has all work associated with quality and risk management been identified?	
19. Have the risks associated with project assumptions been identified?	
20. Has all the work associated with project management been defined?	

These considerations and questions help guide the project manager to develop a clear statement of what the product(s) of the project is(are). Iteratively review all relevant questions and collect all pertinent information. Once completed, all the work packages (i.e., the lowest-level WBS elements) comprise the complete list of deliverables for the project. Together, all work packages represented in a WBS depict the project scope.

2.4.3 PREPARATION METHODS

Several methods and tools exist to create a WBS, including outlines, WBS guidelines or standards, WBS templates, organizational charts, brainstorming techniques, top-down and bottom-up development strategies, mind maps, and expert judgment. Project teams often leverage WBS templates, corporate guidelines, or standards to initiate WBS development.

There are many benefits to using tools to develop a WBS. For example, tools often promote consistency, repeatability, and reusability in the development of a WBS, especially if it is an organizational 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.

Several methods and tools exist to create a WBS, including outlines, WBS guidelines or standards, WBS templates, organizational charts, brainstorming techniques, top-down and bottom-up development strategies, mind maps, and expert judgment. The choice of appropriate method occurs, based on the specific project objectives, requirements, assumptions, and constraints. Table 2-3 highlights some advantages and challenges of these methods.

Table 2-3. WBS Creation Methods

WBS Creation Method	Advantages	Challenges
Top-Down	• Structures project conveniently for status reporting • Structures projects logically • Is valuable when brainstorming/discovering project deliverables • Can accommodate additional deliverables as they are uncovered • Creates the product roadmap	• Requires constant attention that no work packages are overlooked • Elaborate WBS sufficiently to permit management oversight and control
Bottom-Up	• Starts with all deliverables or user stories and works backward into a project • Confirms that all work packages or user stories are included	• Identify all deliverables or work packages before producing the WBS • Group work packages logically • Lose focus on the big picture
WBS Standards	• Leverage predefined formats • Enhances cross-project WBS consistency • Facilitates the implementation of principles and good practices	• 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 • Helps determine appropriate level of detail required • Enhances cross-project WBS consistency • Leverages predefined formats	• 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

2.4.3.1 TOP-DOWN APPROACH

The following steps describe the general top-down process for developing a WBS:

Step 1. Identify the final product(s), service(s), or result(s) of the project—what shall be delivered to achieve project success. A thorough review of high-level project scope documents (such as statement of work and technical requirements) helps ensure consistency between the WBS and the project requirements.

Step 2. Define the project's major or interim deliverables (such as a design specification).

Step 3. Decompose major deliverables to a level of detail appropriate for management and integrated control. These WBS elements typically tie in with clear and discrete identification of stand-alone deliverable products. The sum of the elements at each level represents 100 percent of the work in the element above it, as noted in the 100 percent rule. Each work package of the WBS contains one or more unique deliverables.

Step. 4. Review and refine the WBS until project stakeholders agree that project planning can be successfully completed, and that execution and control successfully produce the desired deliverables and results.

2.4.3.2 BOTTOM-UP APPROACH

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

Step 1. Identify all the deliverables (work packages or user stories) involved in the project. If participants propose activities, include the associated deliverables but not the activities (i.e., translate suggested activities into associated deliverables). This encompasses the entire output of the effort. Each work package typically contains only one deliverable.

Step 2. Logically group related work packages (deliverables or user stories) together.

Step 3. Aggregate deliverables to the next level, for instance, the parent level. The sum of the elements at each level represents 100 percent of the work below it, as noted in the 100 percent rule.

Step 4. Once a given group of related tasks has been aggregated to a parent level, analyze the subset again, ensuring that all the work has been encompassed.

Step 5. Repeat until all subelements aggregate to a single parent level representing the project. Ensure that the completed structure includes all 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 successfully produce the desired deliverables and results.

2.4.3.3 WBS ORGANIZATIONAL STANDARDS

An organizational WBS standard is a set of principles used to construct 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 work breakdown structures throughout the organization. Examples of WBS standards include the following:

- Project management shall be a level 2 WBS element.
- Graphical and textual WBS styles shall be developed and maintained.

2.4.3.4 WBS TEMPLATES

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

The use of WBS standards and WBS templates helps promote consistency through reuse of work breakdown structures or WBS components. When reusing existing components, be sure to customize the WBS to the specific needs, expectations, and requirements of the project by removing any non-required work or deliverables, so that the WBS aligns with the project scope. In addition, iterative review of the questions defined in Section 5.2 Applying the WBS of this practice standard occurs for these two approaches. The use of standards and templates in the creation of work breakdown structures 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 approaches in that top-down and bottom-up approaches create new work breakdown structures, whereas standards and templates involve the reuse of existing WBS materials.

2.4.4 MIND MAPS

The mind map is a diagram used to visually organize and group information. Mind maps help consolidate ideas created through individual brainstorming sessions into a single map to reflect commonality and differences in understanding and to generate new ideas.

In predictive life cycles, representation of a WBS through a mind map diagram might appear as shown in Figure 2-17.

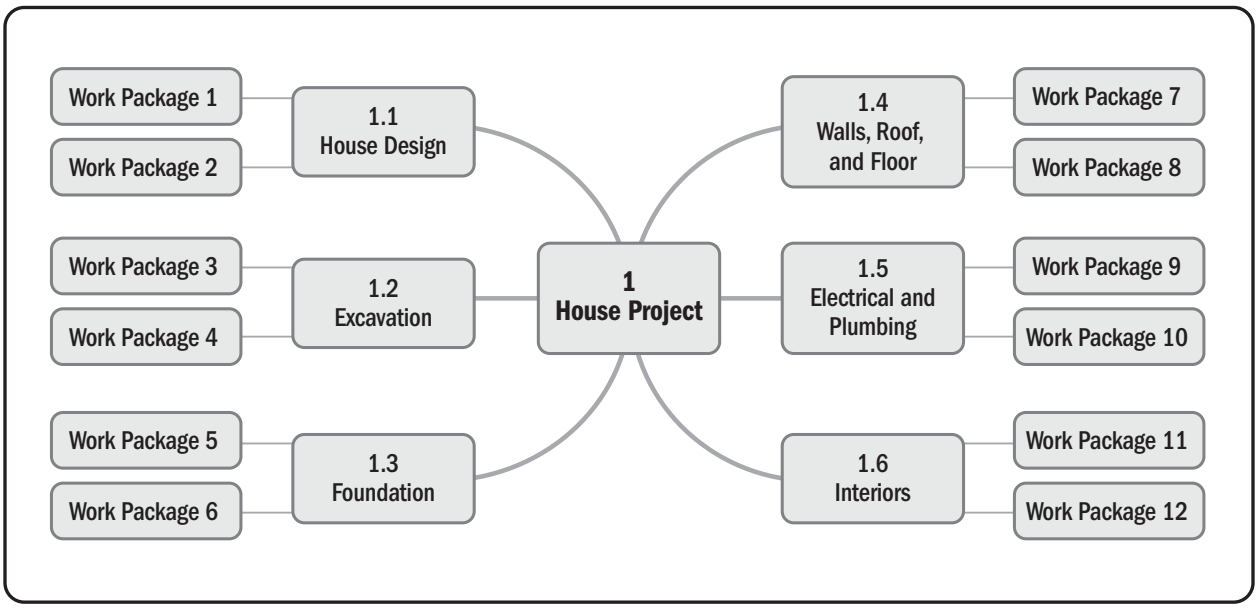


Figure 2-17. Predictive Life Cycle Mind Map Example

In agile life cycles, representation of a WBS through a mind map diagram might appear as shown in Figure 2-18.

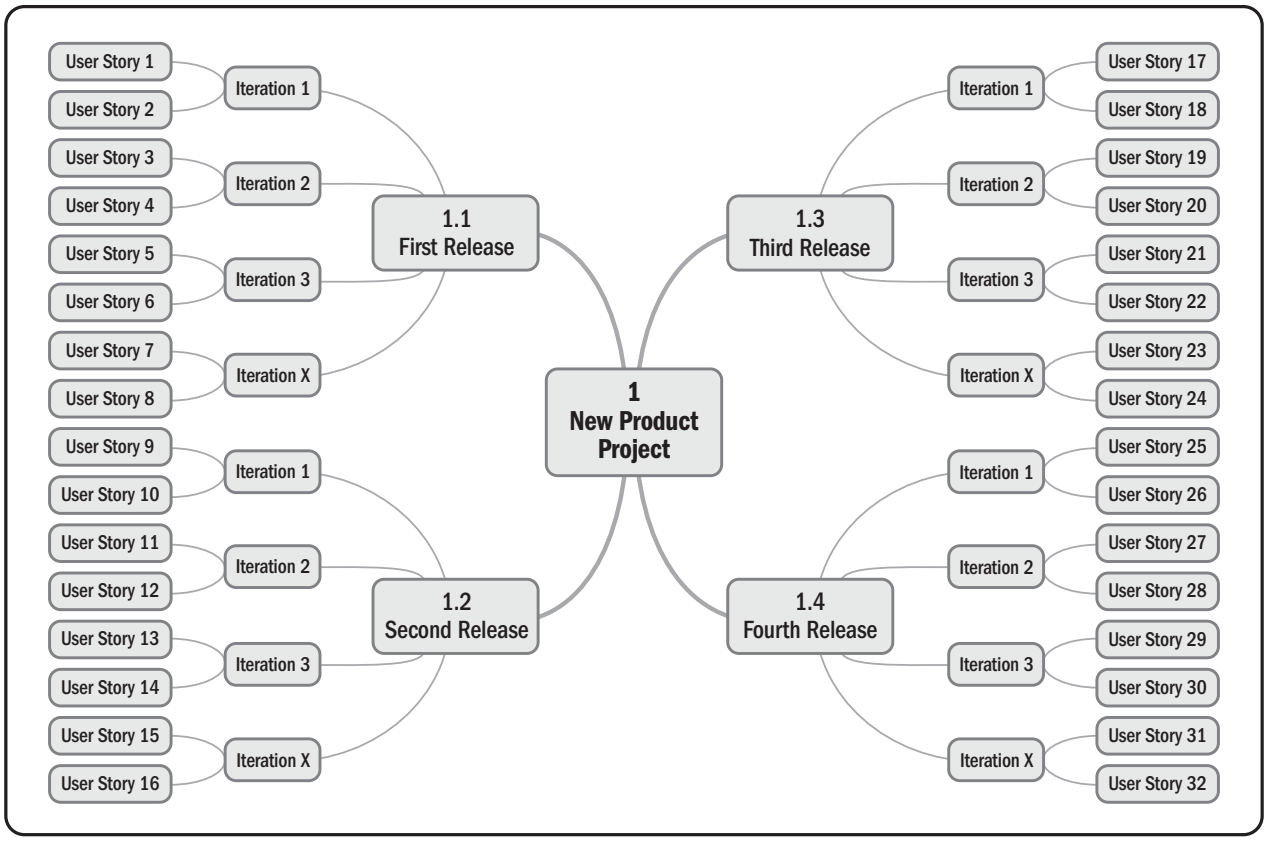


Figure 2-18. Iteration-Based Agile Life Cycle Mind Map Example

2.4.5 WBS DICTIONARY

The WBS dictionary is a document that provides deliverable, activity, scheduling, and estimating information for each element in the WBS. The WBS dictionary is a document that supports the WBS. As the WBS continuously develops, other processes add to the WBS dictionary.

Information in the WBS dictionary includes but is not limited to:

- WBS code;
- Description of work;
- Assumptions and constraints;

- Responsible individual, team, or organization;
- Schedule milestones;
- Associated schedule activities;
- Resources required;
- Cost estimates;
- Quality requirements;
- Acceptance criteria;
- Technical references; and
- Agreement information.

The WBS dictionary is a key document that accompanies the WBS and contains critical project information. The WBS dictionary defines, details, and clarifies the various elements of the WBS, ensuring that each component accurately articulates the content 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.

The WBS dictionary contains information about each element of the WBS, including detailed descriptions of the work, deliverables, activities, and milestones associated with each element. The WBS dictionary typically includes an indication of the type and number of resources required and contract control information, such as a charge number or other similar data. A WBS dictionary often includes traceability matrices linking the WBS to other scope control documents, such as statements of work or requirements documents. Section 3.3 contains sample WBS dictionaries.

2.5 STYLES

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 approaches for managing complex projects. The way the project manager decomposes the project (i.e., the logic used for decomposing the work) varies, depending on the needs and requirements of the performing organization and how the WBS will be used, as 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, if the work of the subunits is independent from each other, it may make sense to structure the decomposition in terms of the work and subdeliverables that each function independently contributes. In contrast, in a projectized organization without functional divisions, the same deliverable may 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 may 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 organization 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; whereas a centralized organization that subcontracts—for instance, building development, food sourcing, or marketing—may find it more useful to decompose the new restaurant program in terms of subsystems.

Depiction of the WBS occurs in a variety of ways, including graphical, textual, or tabular styles. Regardless of the representation used, the WBS enables the project team to predict and forecast costs, schedules, resource requirements, and allocations more accurately.

The most common WBS representations of styles are:

- Hierarchical
- Outline
- Tabular

2.5.1 HIERARCHICAL

One of the most common ways to represent a WBS is the graphic *hierarchical structure* or *organizational chart* structure. In this type of structure, a line in a box connects each *child* element 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 structure places the project at the top level with successive levels of decomposition as shown in Figure 2-19.

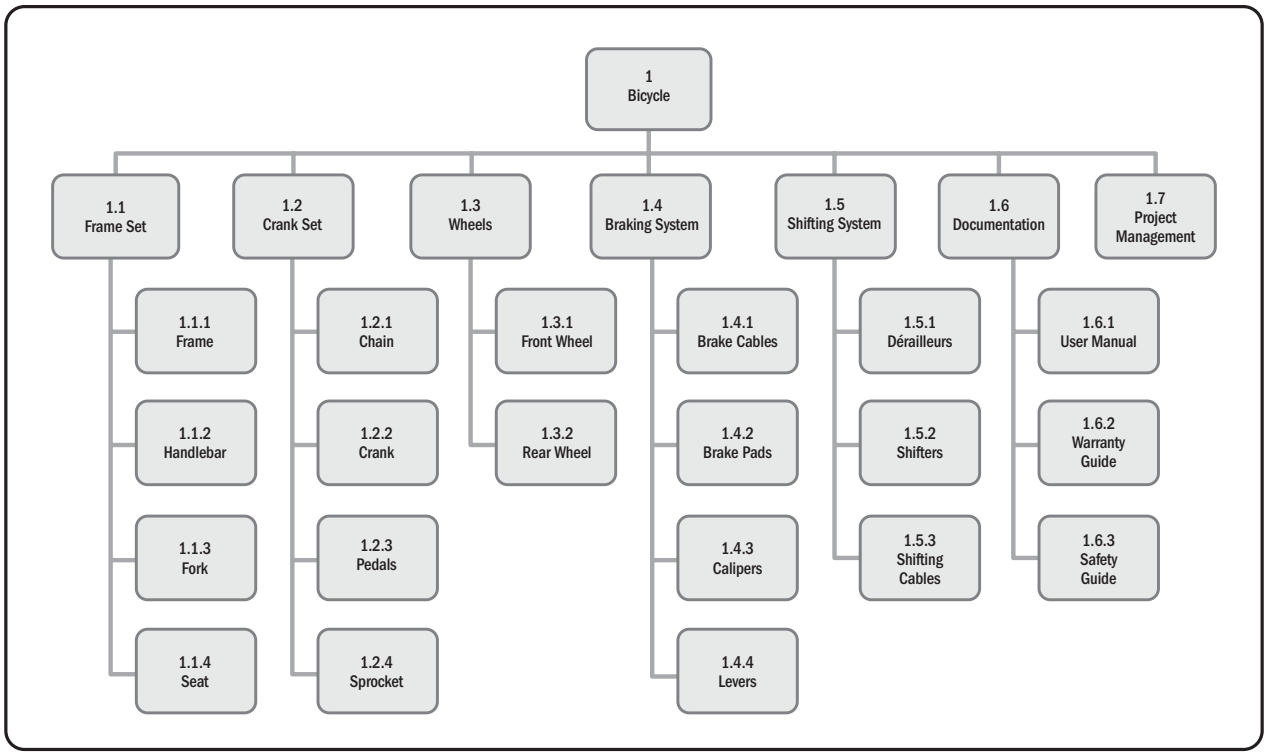


Figure 2-19. WBS Hierarchical Structure Style 1

2.5.2 OUTLINE

A very common representation of the WBS is the *outline style* 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. Several common tools, including word processors and spreadsheets, readily support development of outline styles (as shown in Tables 2-4 and 2-5).

Table 2-4. WBS—Basic Outline Style

WBS Element
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
1.2.1 Chain
1.2.2 Crank
1.2.3 Pedals
1.2.4 Sprocket
1.3 Wheels
1.3.1 Front Wheel
1.3.2 Rear Wheel
1.4 Braking System
1.4.1 Brake Cables
1.4.2 Brake Pads
1.4.3 Calipers
1.4.4 Levers
1.5 Shifting System
1.5.1 Dérailleurs
1.5.2 Shifters
1.5.3 Shifting Cables
1.6 Documentation
1.6.1 User Manual
1.6.2 Warranty Guide
1.6.3 Safety Guide
1.7 Project Management

Table 2-5. WBS—Indented Outline Style

WBS Element
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
1.2.1 Chain
1.2.2 Crank
1.2.3 Pedals
1.2.4 Sprocket
1.3 Wheels
1.3.1 Front Wheel
1.3.2 Rear Wheel
1.4 Braking System
1.4.1 Brake Cables
1.4.2 Brake Pads
1.4.3 Calipers
1.4.4 Levers
1.5 Shifting System
1.5.1 Dérailleurs
1.5.2 Shifters
1.5.3 Shifting Cables
1.6 Documentation
1.6.1 User Manual
1.6.2 Warranty Guide
1.6.3 Safety Guide
1.7 Project Management

For some purposes, the outline style might not use indentation, but simply show the hierarchical structure through the numbering scheme as shown in Table 2-6.

Table 2-6. WBS—Hierarchical Outline Style

Level	WBS Code	WBS Element Name
1	1	Bicycle
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
3	1.2.1	Chain
3	1.2.2	Crank
3	1.2.3	Pedals
3	1.2.4	Sprocket
2	1.3	Wheels
3	1.3.1	Front Wheel
3	1.3.2	Rear Wheel
2	1.4	Braking System
3	1.4.1	Brake Cables
3	1.4.2	Brake Pads
3	1.4.3	Calipers
3	1.4.4	Levers
2	1.5	Shifting System
3	1.5.1	Dérailleurs
3	1.5.2	Shifters
3	1.5.3	Shifting Cables
2	1.6	Documentation
3	1.6.1	User Manual
3	1.6.2	Warranty Guide
3	1.6.3	Safety Guide
2	1.7	Project Management

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

2.5.3 TABULAR

Another common representation of a WBS is the *tabular style*. Columns in a table represent the hierarchical structure in the tabular style. Tabular styles are common in situations where it may be difficult to use a more graphical format, such as a text document with limited formatting capability (as shown in Table 2-7).

Table 2-7. WBS—Tabular Outline Style

Level 1	Level 2	Level 3
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	
		1.2.1 Chain
		1.2.2 Crank
		1.2.3 Pedals
		1.2.4 Sprocket
	1.3 Wheels	
		1.3.1 Front Wheel
		1.3.2 Rear Wheel
	1.4 Braking System	
		1.4.1 Brake Cables
		1.4.2 Brake Pads
		1.4.3 Calipers
		1.4.4 Levers
	1.5 Shifting System	
		1.5.1 Dérailleurs
		1.5.2 Shifters
		1.5.3 Shifting Cables
	1.6 Documentation	
		1.6.1 User Manual
		1.6.2 Warranty Guide
		1.6.3 Safety Guide
	1.7 Project Management	

2.6 REPRESENTATIONS OF WORK

This section describes the various concepts, practices, and methods in work breakdown structures. Representation of a WBS occurs in a variety of ways to achieve a specific purpose in a specific situation. Depiction of a single WBS often occurs in more than one way in various situations in a given project.

Following are illustrated examples of several formats found in common practice today. These representations, as well as others not included here, detail the scope of a specific project. The following examples represent a variety of work breakdown structures for different projects.

2.6.1 EXAMPLE 1: BUILD A HOUSE

In this representation, the house project appears as the top level. Level 2 of the WBS represents the major deliverables of the house (Figure 2-20). This simplified version is not exhaustive and is for illustrative purposes.

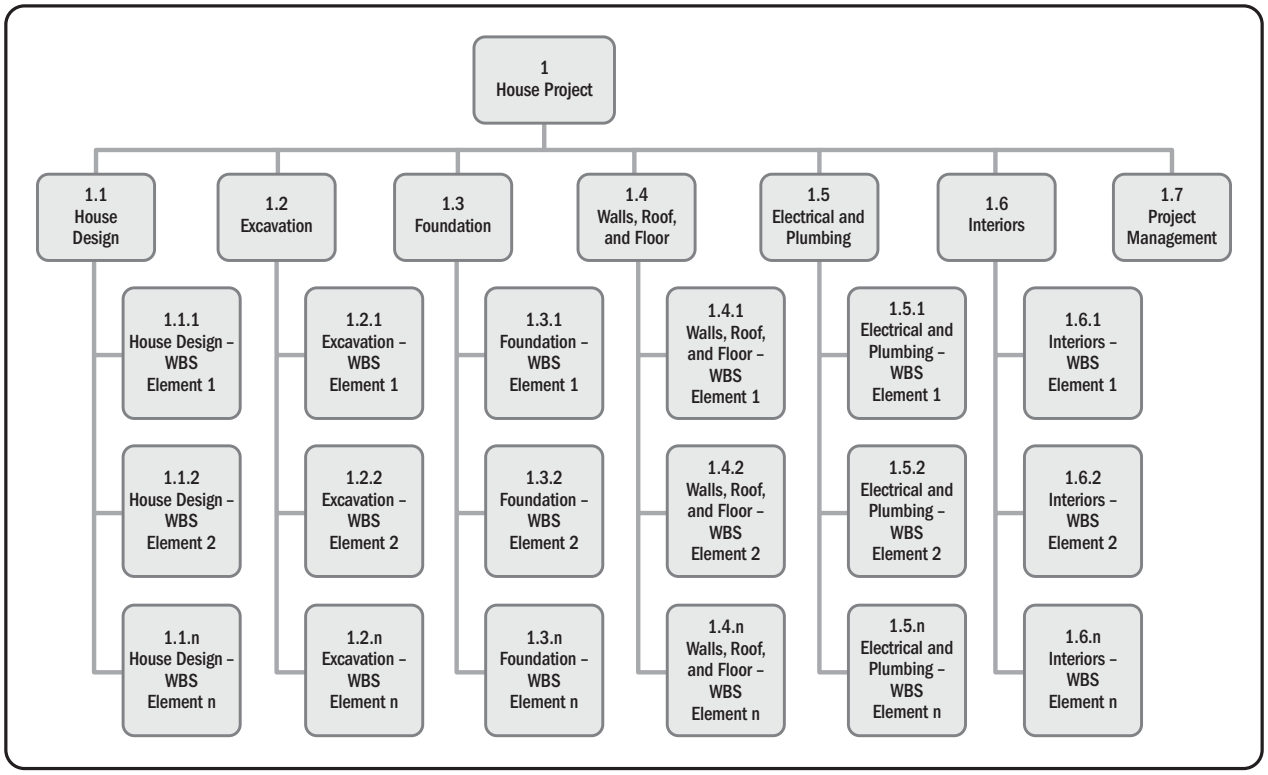


Figure 2-20. Example 1: Build a House

2.6.2 EXAMPLE 2: ORGANIZE A PARTY

In this representation, the party appears as the top level. Level 2 of the WBS represents the major components of the party (location, menu, drinks, invitations, and entertainment) (Figure 2-21).

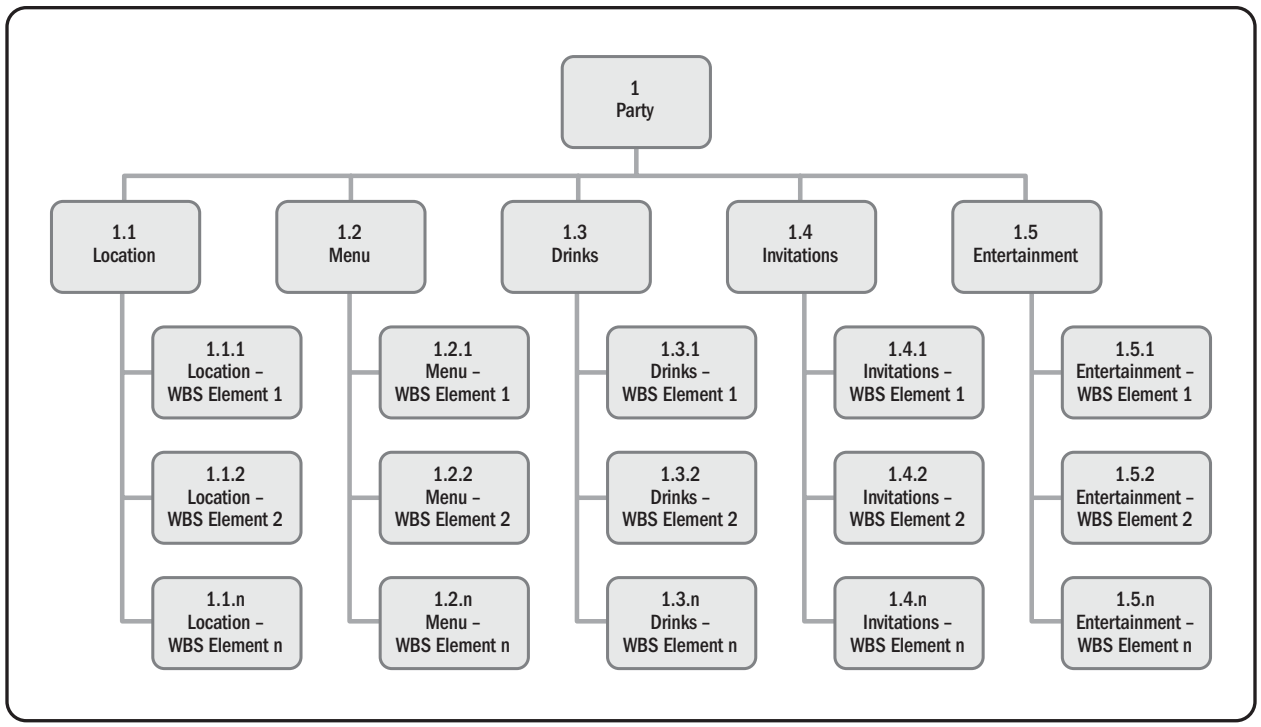


Figure 2-21. Example 2: Organize a Party

2.6.3 EXAMPLE 3: CONSTRUCT A CUSTOM BICYCLE

In this representation, the bicycle name appears as the top level. Level 2 of the WBS represents the major parts of the bicycle (frame set, crank set, wheels, braking system, shifting system, etc.) (Figure 2-22).

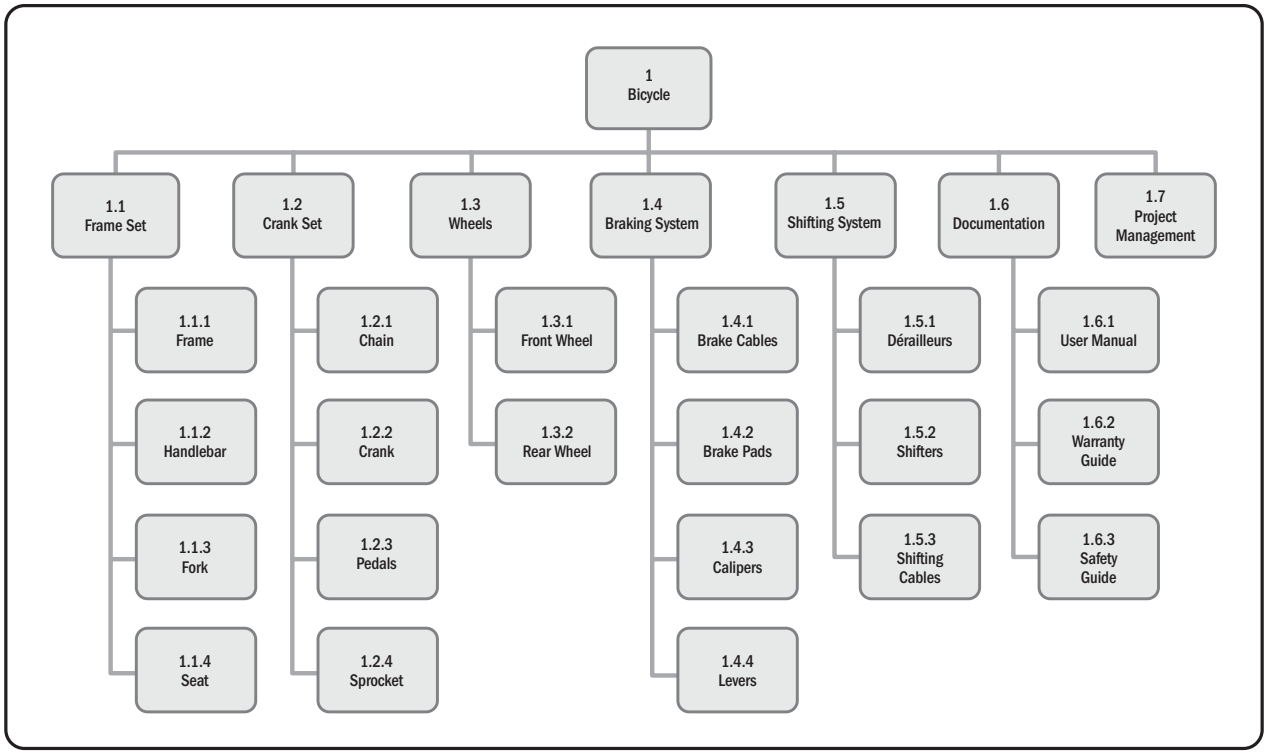


Figure 2-22. Example 3: Construct a Custom Bicycle

2.7 SUMMARY

In summary, the WBS:

- Defines the hierarchy of deliverables
- Facilitates interaction with different project stakeholders
- 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
- Serves as a mechanism 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
- Provides a strong foundation for risk identification
- Facilitates other project management processes
- Provides a tool for team brainstorming and collaboration
- Helps to improve communication with stakeholders
- Helps to avoid scope creep
- Provides a basis for procurement statement of work when outsourcing a work package

3

RELATIONSHIPS, INTEGRATION, AND CONTEXT

3.1 OVERVIEW

A WBS alone cannot 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 of work
- 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 organizational breakdown structure (OBS) yielding the responsibility assignment matrix (RAM)
- References other PMI standards, for example, the *PMBOK® Guide, The Standard for Program Management*, and the *Practice Standard for Earned Value Management* [5], 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 trace back to a poorly developed or nonexistent WBS.

A poorly constructed WBS often yields, among other things, 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;
- Unmanaged risk;
- Lack of communication;
- Lack of consistency in approach; and
- Failure to deliver on some elements of project scope.

The remaining subsections highlight in more detail the important role the WBS plays in program and project management planning:

- 3.2 Interaction with Other Standards
- 3.3 Creating the WBS
- 3.4 Summary

3.2 INTERACTION WITH OTHER STANDARDS

Scope management is integral to other PMI standards. These include, but are not limited to, the *PMBOK® Guide, The Standard for Program Management*, and the *Practice Standard for Earned Value Management*. The development of a quality WBS is critical to the successful execution of project management processes, as described in the *PMBOK® Guide*, as well as in the other aforementioned standards.

Standards that take advantage of the WBS typically fall into one of three categories. The first category focuses on using the content output of the WBS as an input. PMI's *Practice Standard for Earned Value Management* and *Practice Standard for Scheduling* [6] 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*.

The second category includes standards that incorporate the WBS (as defined by this practice standard) as the preferred tool to develop the scope definition. For example, the *PMBOK® Guide* uses the *Practice Standard for Work Breakdown Structures* to develop the program and project scopes. These standards recognize the *Practice Standard for Work Breakdown Structures* as representing good practice. For example, a work package with estimates and a level of detail available to begin work from the WBS practice standard provides input to the *Practice Standard for Scheduling* for scheduling the work.

The third category includes standards that receive content output of the WBS as an input and return content output back to the WBS practice standard, such as the *Practice Standard for Project Estimating* [7], *The Standard for Risk Management in Portfolios, Programs, and Projects* [8], and the *Project Manager Competency Development Framework*. In these interactions, the WBS practice standard sends the WBS to the *Practice Standard for Project Estimating* to estimate the work, then sends it back to the *Practice Standard for Work Breakdown Structures* for creation of work packages.

Development of the WBS defines carefully what is *in* the project scope and, by implication, what is *out* of scope. The *Practice Standard for Scheduling* assumes that a quality WBS exists using good practice, correctly defining project scope. When developing a project schedule, each high-level (summary) task corresponds 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.

3.2.1 PMI STANDARDS RELATIONSHIP DIAGRAM

Figure 3-1 presents the relationships between the *Practice Standard for Work Breakdown Structures* and the other documents comprising the PMI Standards Library:

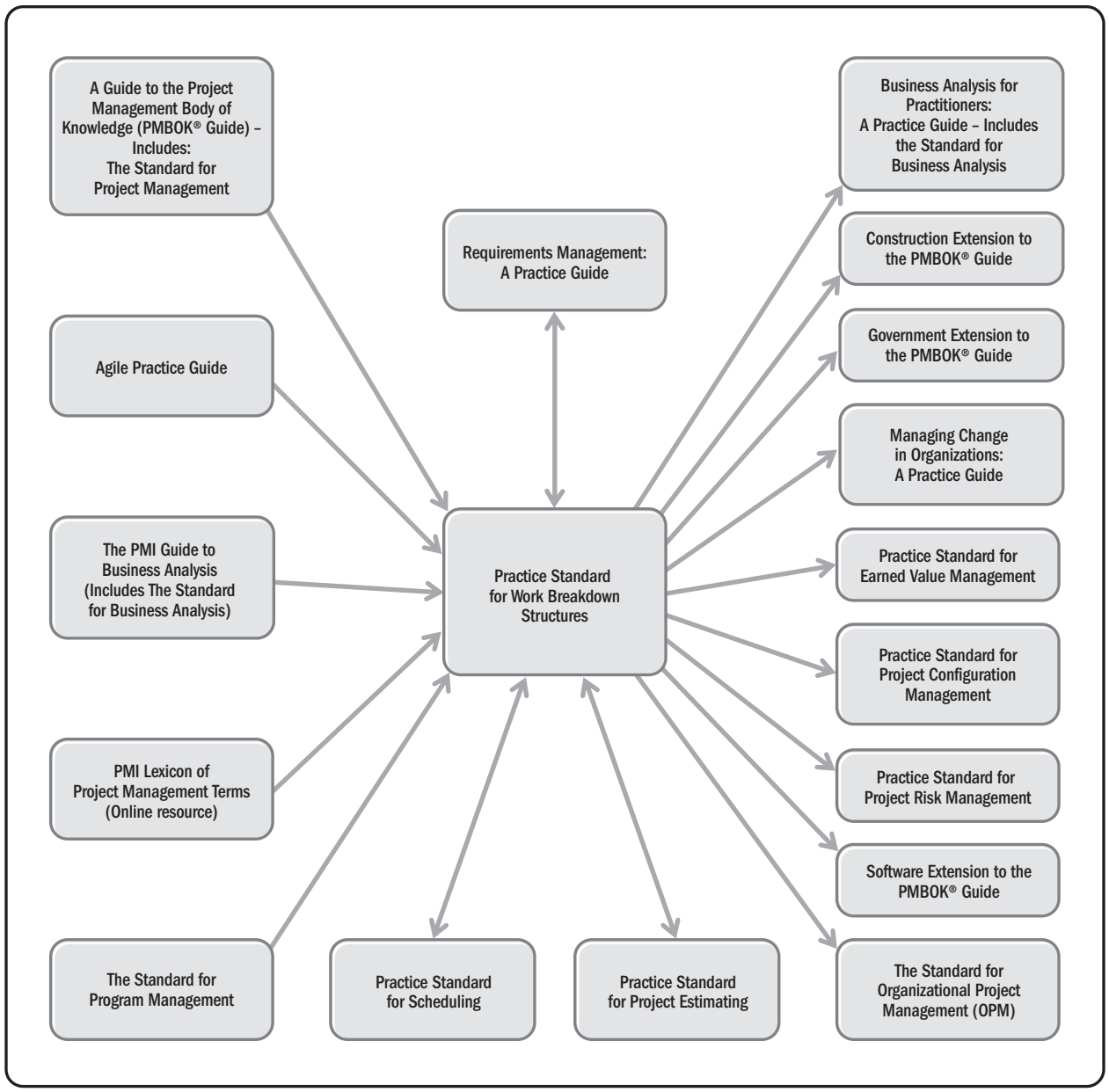


Figure 3-1. WBS Relationship Diagram

This diagram helps to establish how work relates among documents comprising the library of PMI standards. As shown in the diagram, the library contents listed on the left pass information into development of the WBS. The PMI library contents listed on the right receive information from the WBS. In some instances, such as the PMI library content listed above and below the *Practice Standard for Work Breakdown Structures*, information passes to and from the WBS. This is unique, as the WBS aligns with requirements and applies estimates for scheduling.

Explanations for each of the interactions in Figure 3-1 help the reader understand what happens.

- *PMBOK® Guide*: The project scope statement, scope management plan, and requirements document provide information to the WBS practice standard.
- *Agile Practice Guide*: A WBS assists in breaking down all the work during backlog preparation and backlog refinement.
- *Requirements Management: A Practice Guide* [9]: As previously discussed, the high-level or preliminary requirements flow into the WBS to establish the scope baseline to manage to.
- *PMI Lexicon of Project Management Terms*: The WBS practice standard receives definitions for words used in the project management profession and ensures alignment across all PMI publications.
- *The Standard for Program Management*: Requirements and benefits pass to the WBS to ensure all the work of the program delivers the expected benefits.
- *Practice Standard for Project Estimating*: The WBS provides information to the *Practice Standard for Project Estimating* to determine estimates of the work and return estimates for effort and duration to contribute to the creation of work packages.
- *The Standard for Risk Management in Portfolios, Programs, and Projects*: The WBS provides information to *The Standard for Risk Management in Portfolios, Programs, and Projects* to evaluate risk and return risks to be logged into the risk register to help ensure successful delivery. This could result in additional work being identified on the WBS itself.
- *Practice Standard for Scheduling*: The *Practice Standard for Scheduling* receives the WBS as the scope baseline—an approved version of the WBS now under scope control—with the work packages to be scheduled with dependencies.
- *Software Extension to the PMBOK® Guide* [10]: The WBS provides information to the *Software Extension to the PMBOK® Guide* similarly to the *PMBOK® Guide* accounting for all decomposed work.

- *Business Analysis for Practitioners: A Practice Guide* [11]: The WBS provides information to the business analyst for traceability and monitoring in the requirements traceability matrix. Business analysts develop and define requirements for solutions based on organizational needs and capabilities (*Business Analysis for Practitioners: A Practice Guide*, 2015, p. 141).
- *Practice Standard for Project Configuration Management* [12]: The WBS provides information to the *Practice Standard for Project Configuration Management* to help structure the information repository (*Practice Standard for Project Configuration Management*, 2007, Chapter 5.1).
- *Practice Standard for Earned Value Management*: The WBS provides information to the *Practice Standard for Earned Value Management* and is used in various ways to evaluate, monitor, and control various aspects of EVM.
- *Construction Extension to the PMBOK® Guide* [13]: The WBS provides information to the *Construction Extension to the PMBOK® Guide,* similarly to the *PMBOK® Guide* accounting for all decomposed work.
- *Government Extension to the PMBOK® Guide* [14]: The WBS provides information to the *Construction Extension to the PMBOK® Guide* similarly to the *PMBOK® Guide* accounting for all decomposed work.
- *The PMI Guide to Business Analysis* (includes *The Standard for Business Analysis*) *[15]:* During business analysis, this is used for formulation of information relevant to the creation of a WBS results.

At a macro level, these are the interactions among the standards that are relevant to executing the project processes described in the *PMBOK® Guide* (*PMBOK® Guide* – Sixth Edition, Table 1-4, p. 25). The details and definitions provided in a practice standard enable the practitioner to hone skills and gain a deeper understanding of each topic. Each process in this table has inputs and outputs, and anywhere the scope baseline occurs is the confirmed WBS. When the WBS occurs, it is in the stages of developing the scope baseline, known as the WBS. The work packages mentioned in these processes are also an output of the WBS.

3.2.2 THE *PMBOK® GUIDE*

The *PMBOK® Guide*, PMI's project management global standard, discusses the project management practice. 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.

3.2.2.1 RELATIONSHIP TO PROCESS GROUPS

The Create WBS Planning process (*PMBOK® Guide*) yields the WBS. The WBS also plays an integral role in other project management processes. Table 3-1 illustrates typical, though not exhaustive, examples. The cross-references in Table 3-1 are to sections in the *PMBOK® Guide*.

Table 3-1. WBS Importance in the *PMBOK® Guide* Process Groups

Process Group	Process	Section	Importance of WBS in Process
Planning	Create WBS	5.4	• The WBS further defines the entire scope of the project.
	Define Activities	6.2	• The WBS is an input to this process because it is a component of the scope baseline.
	Sequence Activities	6.3	• The WBS is an input to this process.
	Estimate Activity Durations	6.4	• The WBS is an input to this process.
	Develop Schedule	6.5	• The WBS is an input to this process.
	Determine Budget	7.3	• The WBS is an input to this process. • The WBS identifies project deliverables to which costs will be allocated.
	Plan Quality Management	8.1	• The WBS is an input to this process. If updates to the WBS are identified during this process, the WBS is also an output of this process.
	Plan Resource Management	9.1	• The WBS is an input source to this process and is a key component of a project plan.
	Estimate Activity Resources	9.2	• The WBS is an input source to this process and is a key component of a project plan.
	Identify Risk	11.2	• The WBS identifies project deliverables that must be evaluated for risk events.
	Perform Quantitative Risk Analysis	11.4	• The WBS might be updated to include work and deliverables required for risk management.
	Plan Risk Responses	11.5	• The WBS is an output to this process if the process requires updates to the WBS.
	Plan Procurement Management	12.1	• The WBS is an input to this process.
Executing	Manage Quality	8.2	• The WBS part of the project management plan to ensure all scope is delivered as required, and updates are made to the WBS as needed to ensure alignment with quality expectations.
	Conduct Procurement	12.2	• The WBS is part of the project management plan to ensure all the work expected is delivered.
	Direct and Manage Project Work	4.3	• The WBS part of the project management plan helps develop the work performance data as a status report showing the current status of the project.
Monitoring and Controlling	Perform Integrated Change Control	4.6	• The WBS is an input to this process. If updates are made to the WBS due to this process, then it is also an output of the process. This process is how changes are made to the scope baseline.
	Validate Scope	5.5	• The WBS facilitates the process of formally accepting completed deliverables.
	Control Scope	5.6	• 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.
	Control Schedule	6.6	• The WBS is an input and, when updated, an output of this process.

3.2.2.2 RELATIONSHIP TO INPUTS, TOOLS, TECHNIQUES, AND OUTPUTS

Many project management processes use the WBS or its components as input or update it (see Section 5 of the *PMBOK® Guide*). Following are some of the artifacts that use these processes:

- **Project Charter—**The project charter is the starting point for the WBS. The highest-level element in the WBS represents 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 examines the charter for sufficient definition.
- **Project Scope Statement—**The scope statement for the project clearly and succinctly describes what the project is and intends 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. Use of the WBS dictionary further documents and clarifies each deliverable (see Section 3.3.1.6).
- **Program WBS—**The WBS helps define the scope for programs and projects. For example, establishing program management offices typically enables the sharing of tools, techniques, methodologies, practices, and resources in managing one or more collections of related projects as program(s). The project WBS must illustrate a clear understanding of the relationships among highly decomposed work packages within individual program and project scope definitions. When making strategic changes, it is important to consider the impact on programs and projects, given the WBS accurately reflects current strategic plans.
- **Resource Breakdown Structure (RBS)—**The resource breakdown structure (RBS) describes the project's resource organization and when used with the WBS, work package assignments are completed. The link between work packages and the RBS helps verify that all members of the project team have been properly assigned work packages, and that all work packages have owners.

In Figure 3-2, the bicycle project example presented in Section 5 utilizes an example RBS to show team composition required for the work package illustrated in Table 5-1. The project acquires these resources from the organization's functional areas.

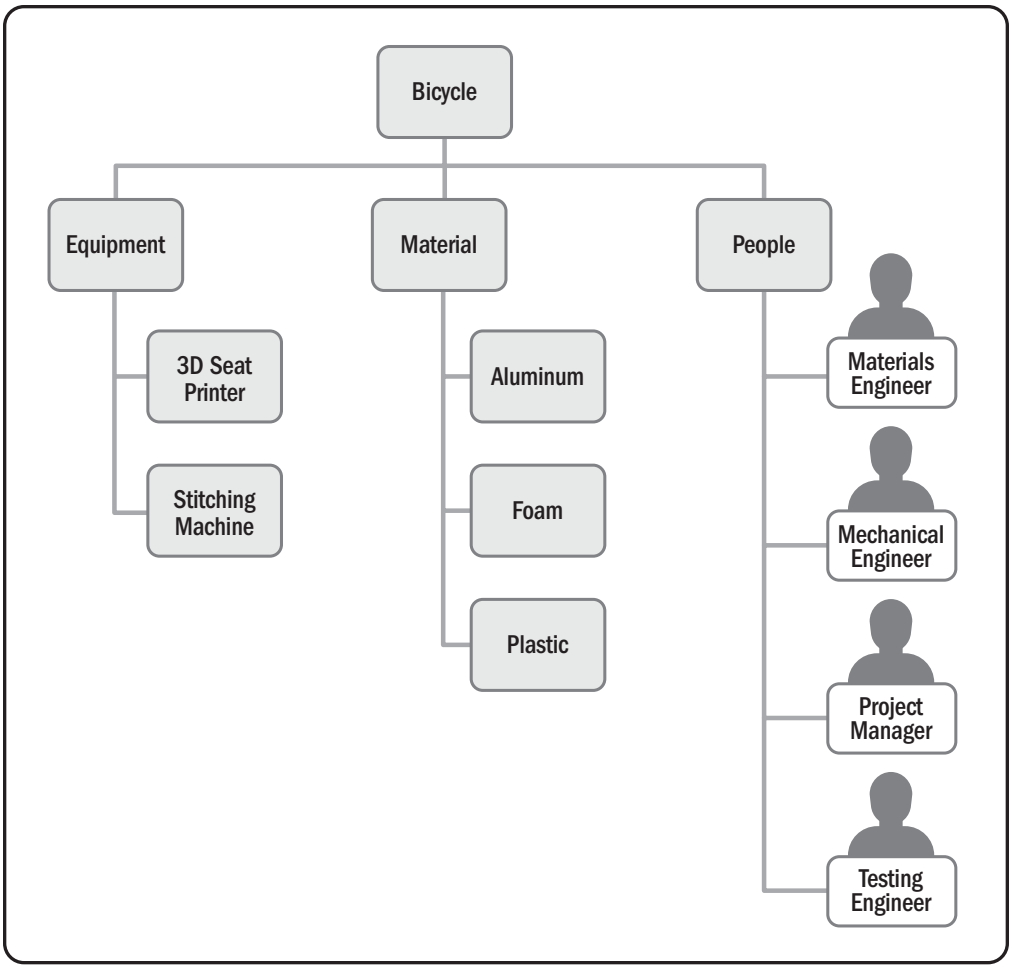


Figure 3-2. Example RBS for XYZ Corporation

- **Organizational Breakdown Structures (OBS)—**The organizational breakdown structure (OBS) loosely relates to the WBS. The OBS depicts the organizational 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 strictly organizes by deliverables.

Figure 3-3 illustrates an example organization called XYZ Corporation. Projects draw from these functional pools such as a project management office, engineering, or quality to staff the RBS of a project or a work package.

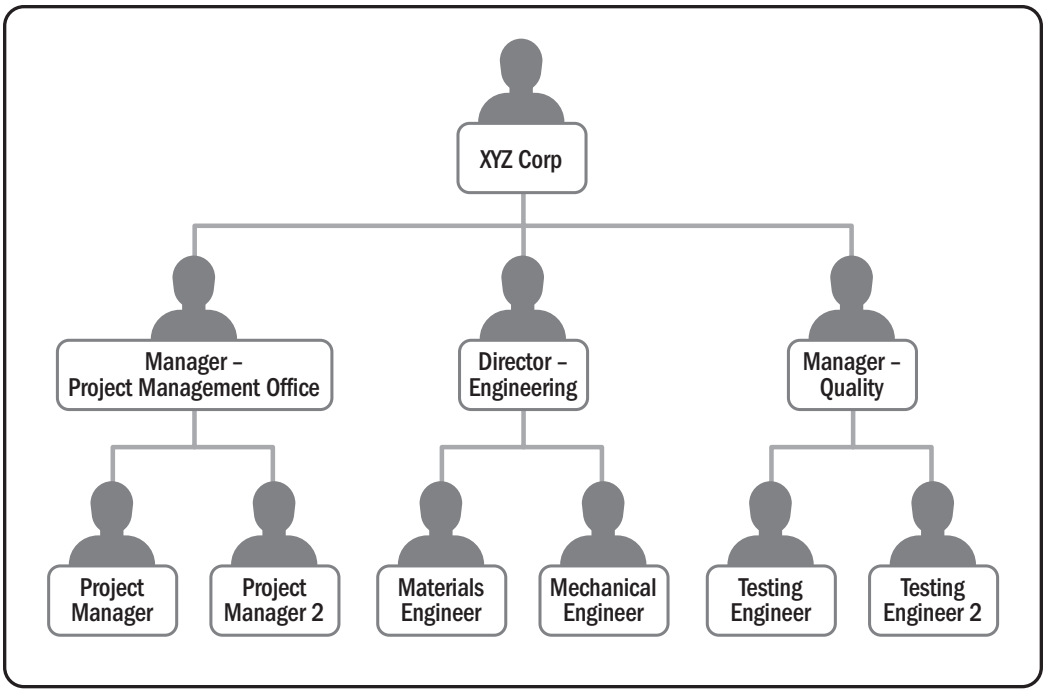


Figure 3-3. Example OBS for XYZ Corporation

- **WBS Dictionary—**The WBS dictionary is a key document that accompanies the WBS and contains critical project information. The WBS dictionary defines, details, and clarifies the various elements of the WBS to ensure that each component of the WBS accurately articulates 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 detailed descriptions of the work, deliverables, activities, and milestones associated with each element. The WBS dictionary often includes 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 includes traceability matrices linking the WBS to other scope control documents, such as statements of work or requirements documents.

The WBS dictionary often includes cost control and resource assignment information. Definitions of the WBS dictionary components are provided in Table 3-2. The components of the work package are defined for use in examples later in the section.

Table 3-2. Descriptions of the WBS Dictionary Components

WBS Dictionary Component	WBS Dictionary Component Description
Level	Relative position in the decomposition; every descending level of the WBS represents an increasingly detailed definition of the project work
WBS Code	Unique identifier assigned to each WBS element
Element Name	Label to define the decomposition of work
Definition	Description of the work to be done
Cost Control Number	Unique financial identifier assigned to each WBS element
Responsible Organization	Primary legal entity executing the work

The work package is the lowest level of the WBS. The dictionary components described in Table 3-2, combined with the information in Table 3-3, detail a work package, which can then be used to drive scheduling, estimating, managing work, and controlling work. This is not an exhaustive list. However, it is representative of typical content and provides guidance on how to create a successful work package.

Table 3-3. Descriptions of the Work Package Components

Work Package Component	Work Package Component Description
WBS code	1.1.2
Assumption and constraints	Standard build from supplier
Schedule milestones	Delivery three months from date of order
Associated schedule activities	Design required to complete 10 days post order
Resources required	Standard suppliers
Cost estimates	$9.00 per handlebar per vendor agreement
Quality requirements	As defined in quality manuals X-46 and X-49
Acceptance criteria	As defined with supplier contracts
Technical references	As defined in supplier contracts
Agreement information	Not required per master agreement

- **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. Arrangement of the activities within the WBS work packages 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.

The network diagram is an output of information from the schedule model that shows the sequential arrangement of the activities defined to produce the deliverables from the WBS. Analyzing this information can uncover project dependencies, risks, and 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.

- **Project Schedule—**Usage of the various elements of the WBS establishes starting points for defining the activities included in the schedule model. Generally, assumptions would be recorded in a log when scheduling completes so that other resources understand the context under which the schedule was created.

Recording implied dependencies in the WBS dictionary, as well as the activities as described in the WBS dictionary, are critical details in the schedule model.

3.2.3 *AGILE PRACTICE GUIDE*

For iterative, incremental, or agile projects, the WBS and product backlog help keep the work visible. When using a backlog, the budget and resources required to do the work may not be estimated. Eventually, the budget and resources will end at the agreed-upon amount with the sponsor, resulting in additional funds being added to complete the work or the work ending at that point. When managing scope, it is important to keep the work visible during project execution. Visibility keeps alignment between the team and product owner regarding delivery expectations.

In agile projects, managing the backlog aids in development of epics and user stories to divide the work. Ranking backlog items based on business value facilitates execution via a prioritized queue. Once the cycle begins to deliver the selected user stories, the work usually does not stop or change while in cycle. Reprioritization often occurs for the next cycle, once a release completes.

3.2.4 *PRACTICE STANDARD FOR EARNED VALUE MANAGEMENT*

Earned value management (EVM) is a management methodology used for integrating scope, schedule, and resources, and for objectively measuring project performance and progress. The data used in EVM depend on developing WBS elements using good practice. If WBS elements are poorly defined, too large in scope (or duration), or are in some other manner not appropriately decomposed or developed, measuring the project's earned value becomes difficult. The *Practice Standard for Earned Value Management* relies upon a quality WBS as a key input.

3.2.5 *THE STANDARD FOR ORGANIZATIONAL PROJECT MANAGEMENT (OPM)* [16]

When setting out to implement OPM, it is important to have a complete scope and understanding of what the project requires. A complete WBS captures a comprehensive definition to establish a project management office or project management methodology including processes, technology, and organizational changes. OPM implementations are organizational transformation initiatives typically conducted as programs.

3.2.6 *THE STANDARD FOR PROGRAM MANAGEMENT*

The Standard for Program Management describes how to best manage collections of related projects. This standard assumes that the development of a WBS for each relevant project happens according to good practice and accurately describes the scope of the project.

3.3 CREATING THE WBS

Given the conceptual interactions among the standards, the following section covers putting them to work and shows the application of the effort. For simplicity and consistency, the following sections use the example of building a bicycle. The bicycle example is appropriate because it (a) is well understood by populations across the globe, (b) is a relatively simple mechanical model, and (c) can still be viewed as a system of subassemblies and parts.

Decomposition represents the core of the WBS. Creation of a traditional WBS contains purely nouns, with no verbs, and typically encompasses a waterfall or predictive life cycle. Section 2 describes the different types of decomposition, along with examples of multiple types of work breakdown structures. Finally, there is an introduction on how to look at a bicycle WBS, while considering predictive, iterative, incremental, and agile life cycles. The emphasis here guides the reader to create a complete view of the work using the types of decomposition and life cycles that apply to their specific industry.

3.3.1 BREAKING THE WORK DOWN

Decomposition is a technique used for dividing and subdividing the project scope and project deliverables into smaller, more manageable parts. The work package is the work defined at the lowest level of the WBS for which cost and duration can be estimated and managed. The degree of control needed to effectively manage the project typically guides the level of decomposition. The level of detail for work packages varies with the size and complexity of the project. Decomposition of the total project work into work packages generally involves the following activities:

- Identifying and analyzing the deliverables and related work,
- Structuring and organizing the WBS,
- Decomposing the upper WBS levels into lower-level detailed components,
- Developing and assigning identification codes to the WBS components, and
- Verifying that the degree of decomposition of the deliverables is appropriate.

Various approaches apply when creating a WBS structure. Some of the popular approaches include the top-down approach, the use of organization-specific guidelines, and the use of WBS templates. A bottom-up approach typically groups subcomponents. Representation of the WBS structure takes on several forms, such as:

- Using phases of the project life cycle as the second level of decomposition, with the product- and project-level deliverables inserted at the third level;
- Using major deliverables as the second level of decomposition; and

- Incorporating subcomponents that may be developed by organizations outside the project team, such as contracted work. The contractor then develops the supporting contract WBS as part of the contracted work.
- Decomposition of the upper-level WBS components requires subdividing the work for each of the deliverables or subcomponents into its most fundamental components, where the WBS components represent verifiable products, services, or results. When using an agile approach, epics decompose into user stories. Structuring the WBS often appears as an outline, an organizational chart, or other approach that identifies a hierarchical breakdown. Verifying the correctness of the decomposition requires determining that the lower-level WBS components are those that are necessary and sufficient for completion of the corresponding higher-level deliverables. Different deliverables can have different levels of decomposition.

To arrive at a work package, the decomposition of some deliverables only needs to proceed to the next level, whereas others need additional levels of decomposition. Decomposing the work to greater levels of detail enhances the ability to plan, manage, and control the work. However, excessive decomposition occasionally leads to non-productive management effort, inefficient use of resources, decreased efficiency in performing the work, and difficulty aggregating data over different levels of the WBS.

Decomposition may not be possible for a deliverable or subcomponent planned. The project management team typically waits until attaining agreement on deliverables or subcomponents before detailed development of the WBS. Decomposition is a form of progressive elaboration applicable to work packages, planning packages, and release planning when using an agile or waterfall approach. This technique is sometimes known as rolling wave planning.

The WBS represents all the product or project work, including the project management work. Work at the lower levels rolls up to the higher levels to avoid work omission or addition, as covered in Section 2.3.1 on The 100 Percent Rule.

3.3.2 LIFE CYCLES AND TYPES OF DECOMPOSITION EXAMPLES

The following examples apply the predictive, iterative, incremental, and agile life cycles. The examples use types of decomposition to help the practitioner see how these differ in practice. Appendix X3 contains WBS examples from a variety of industries, representing starting points or as ideas on how others organize the work while adhering to the 100 percent rule.

3.3.2.1 PREDICTIVE

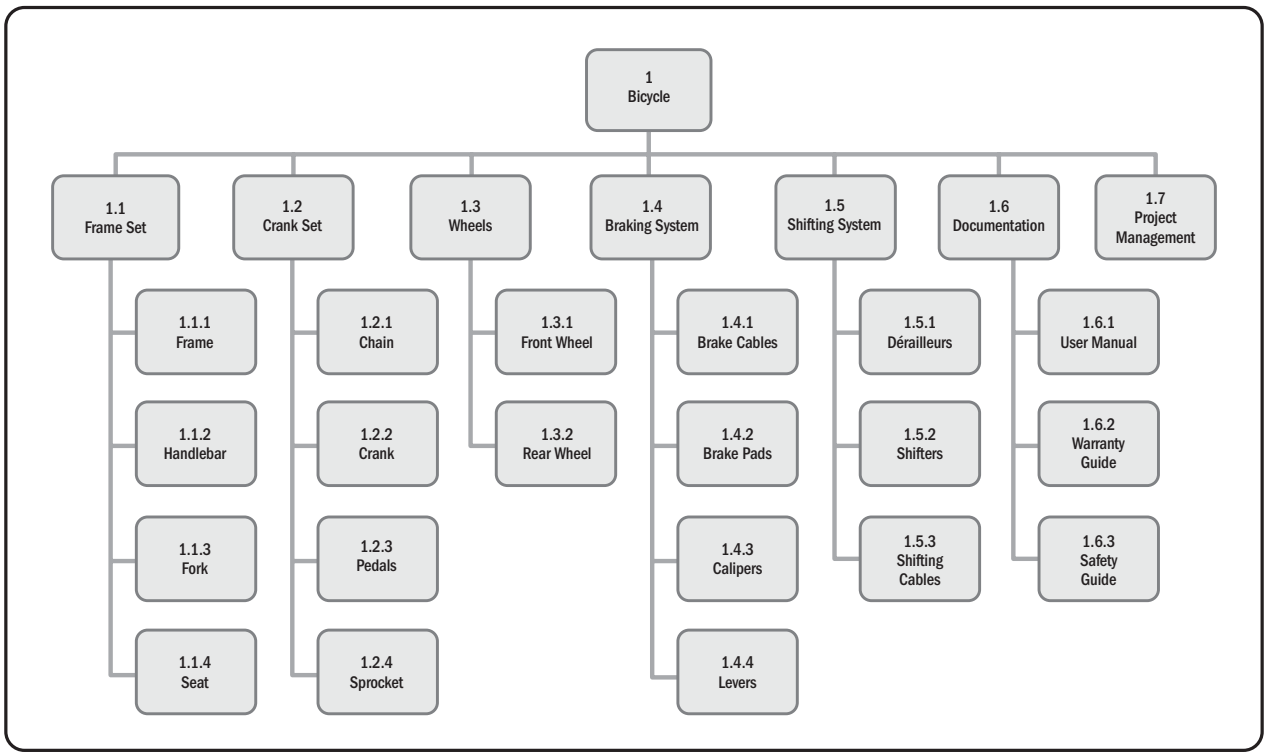


Figure 3-4. Predictive Life Cycle Example—Product-Oriented Type of Decomposition

Figure 3-4 illustrates the traditional WBS and begins with level 1 at the product level for a bicycle. Level 2 establishes the various systems that compose the bicycle. Notice that level 2 includes the project management work. This accounts for all the work, addresses key project management practices, and captures the produced deliverables. Applying the types of decomposition from Section 2.2.5 on Key Concepts/Characteristics, illuminates that this decomposition contains product-oriented items. Level 3 breaks the work down into smaller work packages produced by the internal manufacturing team. Again, applying the types of decomposition to level 3 reveals more product-oriented items.

Tables 3-4 and 3-5 apply the WBS dictionary and work package criteria to the bicycle example shown in Figure 3-4. These tables are in a tabular format for readability but would typically be in a form layout as required by the business. In this case, the example illustrates the level 3 handlebar represented in the WBS dictionary and the work package and does not represent the complete dictionary.

Table 3-4. Example of Bicycle WBS Dictionary

WBS Dictionary	WBS Dictionary Example
Level	3
WBS Code	1.1.2
Element Name	Handlebar
Definition	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.
Cost Control Number	CC2019-111
Responsible Organization	Vendor Gamma

Table 3-5. Example of Bicycle Work Package

Work Package	Work Package Example
WBS code	1.1.2
Assumption and constraints	Standard build from supplier
Schedule milestones	Delivery three months from date of order
Associated schedule activities	Design required to complete 10 days post order
Resources required	Standard suppliers
Cost estimates	$9.00 per handlebar per vendor agreement
Quality requirements	As defined in quality manual X-46 and X-49
Acceptance criteria	As defined with supplier contracts
Technical references	As defined in supplier contracts
Agreement information	Not required per master agreement

As shown in Figure 3-5, an alternate WBS adds the phase-oriented type to Figure 3-4, which creates the phase segments at level 2. Segmenting the work into phase segments of a life cycle allows analysis within managed cycles. One is not preferred over the other, but the goal here ensures accountability and visibility of all the work.

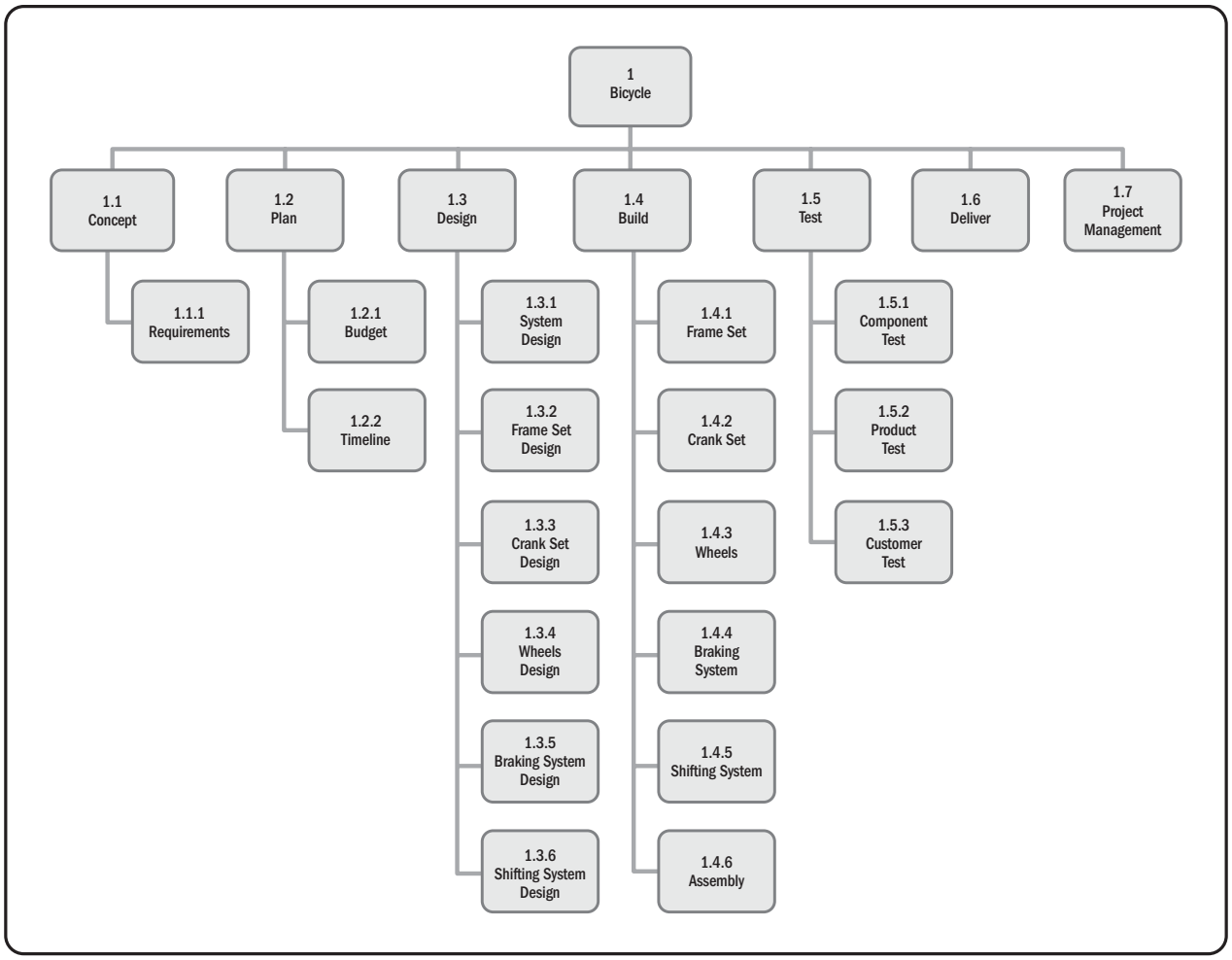


Figure 3-5. Predictive Life Cycle Example—Product-Oriented and Phase-Oriented Types of Decomposition

As shown in Figure 3-5, level 1 is the product or bicycle. Level 2 is a phase-oriented cycle with project management work at the end, thus ensuring estimating, planning, and scheduling of all work. After collection and customer approval early in the process, the next cycle of planning begins. During planning, establishing the budget and timeline occurs for creating the product. Next, the design cycle starts, resulting in development of the bicycle design with the customer. Once approved, the build cycle starts and manufacturing of the designed components of the bicycle occurs. Upon parts approval, testing ensures the manufactured components operate as designed at the component and system levels. Then, the customer product testing and preparation for customer delivery transpire. The project management work occurs during each cycle to manage the work.

3.3.2.2 ITERATIVE

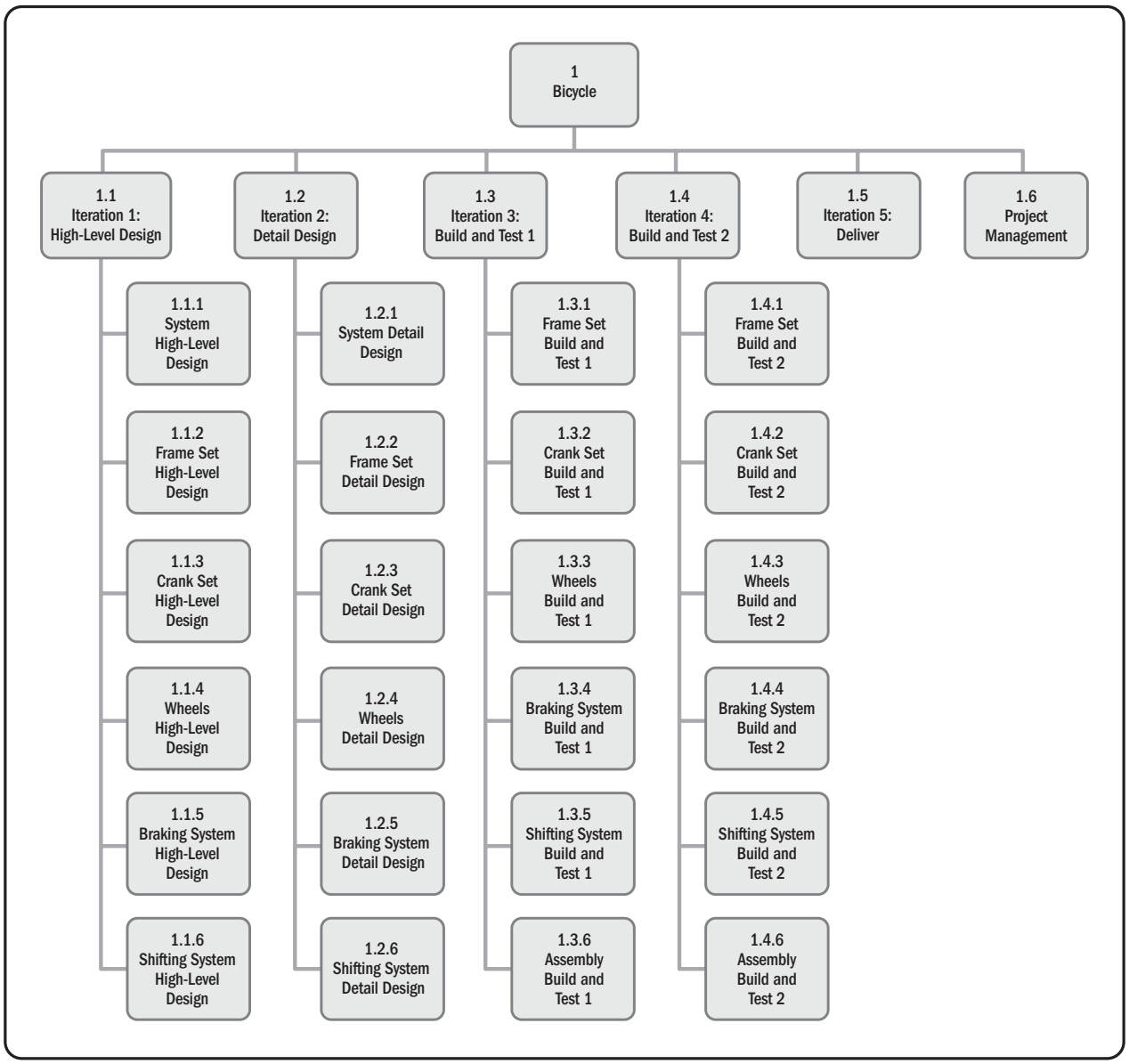


Figure 3-6. Iterative Life Cycle Example—Backlog-Oriented Type of Decomposition

As shown in Figure 3-6, level 1 is the product, a bicycle. Level 2 breaks down into iterations: iterations of design, then iterations of building and testing the components of the product. Project management exists at level 2, ensuring accounting of all the work occurs. Depending on the scenario encountered, perhaps marketing and communications or other functions needed for success become a leg of the work. This is not meant to be the only solution but is the solution for the scenario at hand. In this scenario, the plan includes two iterations and, if additional scenarios arise, inclusion of additional iterations to the WBS results. This scenario illustrates a high-level design for the bicycle and associated documentation for the components. The details of the design, tightness of specifications, and exact paint colors are determined during the detailed design. Build and test of the detailed design follows. Each subsequent build and test is another iteration of the detailed design.

3.3.2.3 INCREMENTAL

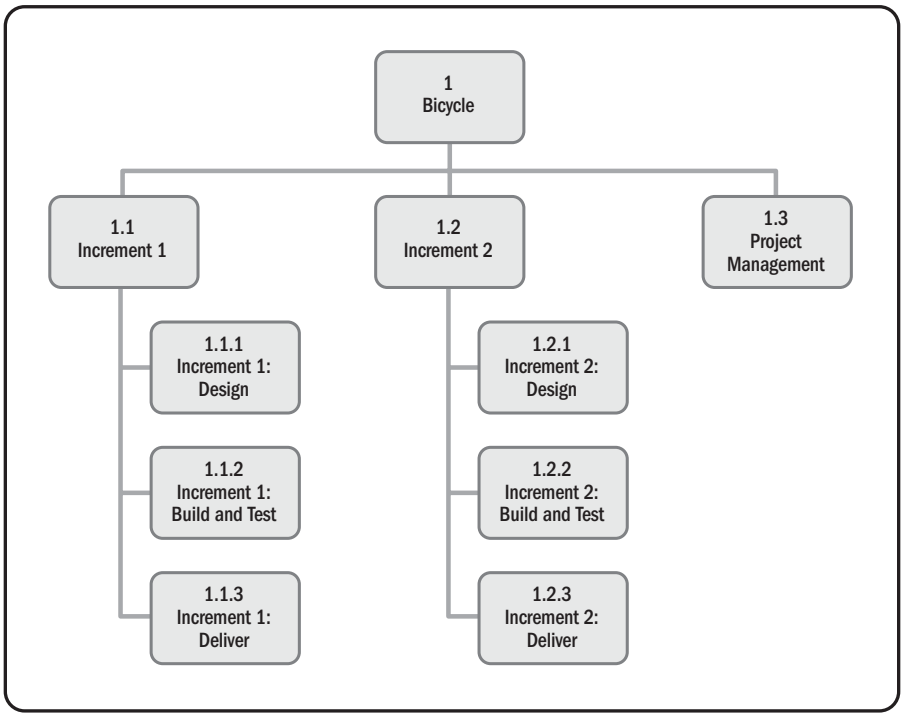


Figure 3-7. Incremental Life Cycle Example—Backlog-Oriented and Phase-Oriented Types of Decomposition

As shown in Figure 3-7, level 1 is the product, a bicycle. The bicycle breaks down at level 2 into an incremental life cycle. This represents two incremental releases and project management, which ensures visibility of all the work and proper planning and accounting for budgeting, resourcing, and scheduling. The first increment designs, builds, tests, and delivers a bicycle. The second increment adds a different handlebar to the bicycle, an incremental change available for customers preferring a higher handle grip. Figure 3-5 builds upon the first increment and shows the details under the design of each component, followed by the build and test of each component.

3.3.2.4 AGILE

For the agile life cycle example, leveraging the bicycle example assists the reader's understanding of how things might look differently when using an agile approach.

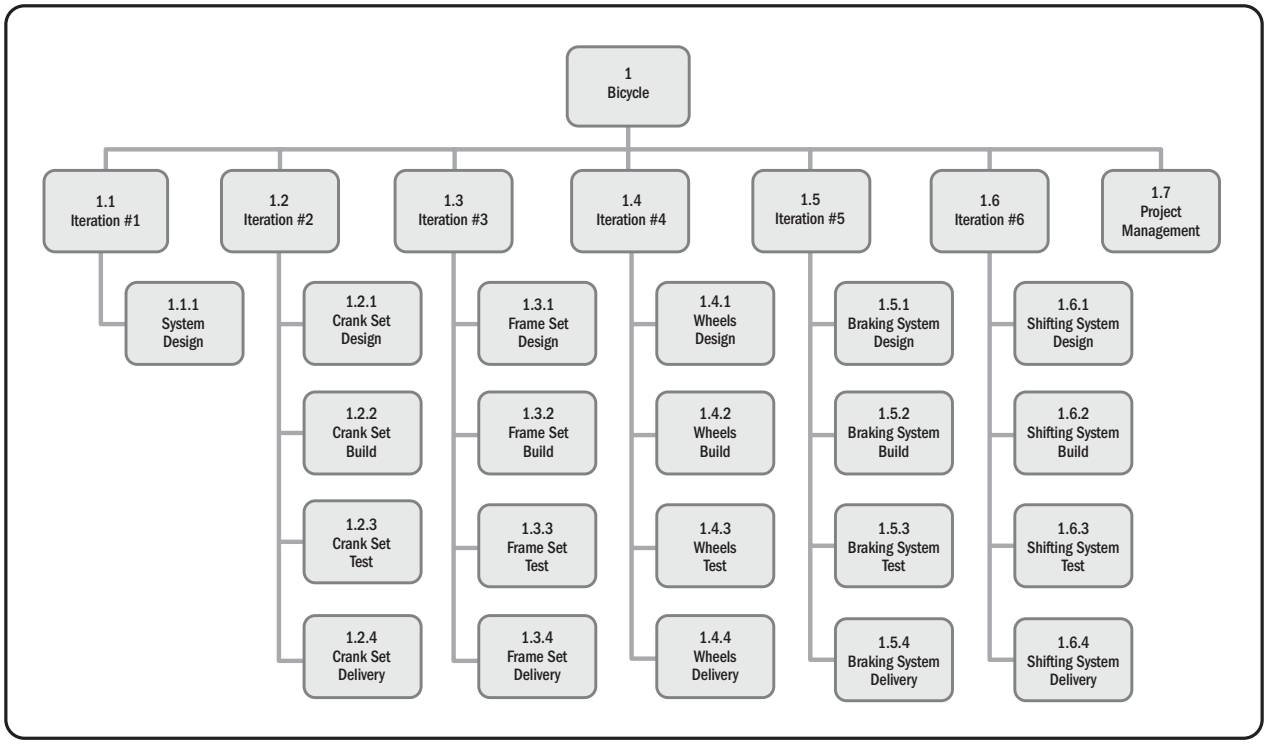


Figure 3-8. Agile Life Cycle Example—Backlog-Oriented Type of Decomposition

For the agile life cycle iteration 1, as shown in Figure 3-8, design of the system begins. Here the backlog and user stories use story points for sizing the effort. The team then prepares future iterations by assigning user stories to each release. The team decided to build each functional part of the bicycle and release it for use. After creation of the full bicycle, the agile process enables new usable components for the bicycle very quickly and keeps pace with market tastes and preferences. Level 1 continues to the product, while level 2 consists of iterations with functionality being deployed after each iteration. The project management WBS element exists to ensure accounting of all the work.

3.4 SUMMARY

The WBS is an important tool used in the planning and execution of a successful project. Many project cost, schedule, and quality failures trace directly to flaws in the development of the project's WBS. A project's success is less likely without the existence of a quality WBS. In contrast, developing and applying a quality WBS significantly increase the likelihood of successful project completion. Section 4 provides insights into the characteristics and components that make up a quality WBS.

4

WBS QUALITY

4.1 OVERVIEW

The WBS quality section describes in detail the degree to which a set of inherent guidelines of a quality WBS fulfills standard requirements. This standard considers the definition of quality as: "the degree to which a set of inherent characteristics fulfills requirements" (*PMBOK® Guide* – Sixth Edition, p. 718). This conformance to requirements and fitness for use satisfies the intended purpose of a quality WBS.

This section identifies and describes the guidelines of a quality WBS. It also illustrates the negative effects of a poorly constructed WBS and provides evaluation tools for project managers. The remaining subsections are as follows:

- 4.2 Using the Quality Guidelines
- 4.3 Annotated Examples of a WBS
- 4.4 Diagnostic Checklist for a Quality WBS
- 4.5 Summary

4.2 USING THE QUALITY GUIDELINES

There are numerous reasons why a quality and complete WBS is valuable to the overall success of a project. Following are some of the key reasons:

- Assures completeness of the work needed to be done to meet the objectives of the project;
- Provides a framework for managing and controlling the work packages;
- Serves as the framework for project schedule development;
- Provides a process for decomposing large packages of work;

- Provides a textual, graphical, or tabular breakdown of the project scope;
- Assists stakeholders' understanding and communicating of the scope;
- Avoids duplicate work packages; and
- Assists in verifying scope consistency and completeness and requirements compliance.

In the following subsections, this practice standard details the core guidelines to which every WBS adheres, tailoring considerations for a quality WBS when used in different life cycles of projects, and how the guidelines slightly differ when using a WBS for programs.

4.2.1 CORE ATTRIBUTES OF A QUALITY WBS

Core attributes are required for every WBS, as these properties enable the WBS to satisfy project needs present in most projects, most of the time.

With respect to core quality attributes, a WBS either has them or it does not. These attributes represent the minimum set of specific attributes a WBS needs to be an effective tool in a successful project. When evaluating or developing a WBS, the absence or presence of these core attributes dictates whether it is a quality WBS. A WBS with the following core quality attributes reflects sufficient and complete quality:

- Defines the scope of the project by containing 100 percent of the work defined by the scope; each level of decomposition contains 100 percent of the work in the parent level
- Clarifies the work at different levels and allows the project scope to be communicated accurately to stakeholders
- Allows easier review and audit of the WBS work packages
- Captures internal, external, and interim deliverables in terms of work to be completed, including project management
- Contains work packages that clearly support the identification of the tasks performed to deliver the work package
- Provides a graphical and hierarchical breakdown of the project scope
- Contains elements that are defined using nouns and adjectives—not verbs
- Arranges 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

- Comprises two levels, with at least one level of decomposition
- Created by individuals performing the work, not just one expert
- 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 and fixed
- Updated in accordance with a project change control process

4.2.2 TAILORING METHOD FOR A QUALITY WBS

In projects that represent an iterative or agile life cycle with evolving requirements, high risk, or significant uncertainty, the scope is not always known completely at the beginning of the project. Therefore, it is critical to revisit the WBS frequently to ensure fulfillment of quality attributes, and that the WBS represents the current total package of delivered work for a successful project outcome. When applying an agile life cycle, it is important to address each of the above core attributes. It is important to apply the 100 percent rule and complete the WBS with the project members performing the work. For agile life cycles, it is common practice to use a medium to develop the WBS that is easily adaptable in team environments, such as using sticky notes to represent work packages. Arranging the sticky notes using affinity diagram techniques is a common tailoring method used to create work breakdown structures in an agile life cycle.

Agile life cycles intentionally spend less time on scope definition and WBS decomposition in the early stages of the project and focus more on setting up processes for discovery and refinement later in the project. However, establishing a quality WBS is crucial for project success in the four project life cycles regardless of the time available for project initiation and planning. Also, revisiting the WBS after each approved change, through the change control process board, is critical to the success of the project to reconfirm the WBS reflects 100 percent of the work.

4.2.3 QUALITY METHODS FOR PROGRAMS

Work breakdown structures are crucial for projects, as well as for programs. Use of the WBS at these levels is a growing practice. There is no conceptual difference between a program WBS and a project WBS. A quality WBS developed at any of these broader levels possesses precisely the same characteristics and attributes as a quality WBS developed at the individual project level. The essential difference between a program WBS and a project WBS is only the scope.

Use of the WBS defines the scope for programs and projects. For example, establishing program management offices enables management of one or more collections of related projects as program(s) by sharing of tools, techniques, methodologies, practices, and resources. The project WBS shall illustrate a clear understanding of the relationship among highly decomposed work packages within individual program and project (or higher-order) scope definitions. If strategic changes are made, easier calculation of the impact on projects, resources, and budgets occurs, assuming a correctly constructed project WBS with consideration of these higher-order factors.

A quality program WBS provides an overview of the program and details how each of the components contributes to the objectives of the program. A quality program WBS, decomposed to the proper level, provides the program manager with control over the work performed in that component. Typically, this is in the first two levels of a component of the program but can vary by project. A quality program WBS will have sufficient depth to manage and control the program. A quality program WBS should be the baseline framework for the program master schedule and not the detailed schedule for each of the project components. A quality program WBS will also have the full scope of program work included, such as, but not limited to: program artifacts, procedures, plans, standards, processes, deliverables, program management office support deliverables, etc. Items that are not in the program WBS are not in the scope of the program.

The core attributes defined in Section 4.2.1 that apply to a project WBS also apply to a program WBS. The difficulty in verifying definitions of the total work and deliverables increases significantly as the scope increases.

4.3 ANNOTATED EXAMPLES OF A WBS

These WBS examples describe a hypothetical organization building bicycles to a customer's specifications. The examples represent four different life cycles: predictive, incremental, iterative, and agile. The annotations refer to specific characteristics of a quality WBS. Figure 4-1 illustrates a simplified WBS as it pertains to a sample project. The project is the designing and building of a bicycle, and is an example of a WBS to encompass the work for this sample project.

4.3.1 PREDICTIVE LIFE CYCLES

Figure 4-1 is an annotated example of a WBS using the predictive life cycle.

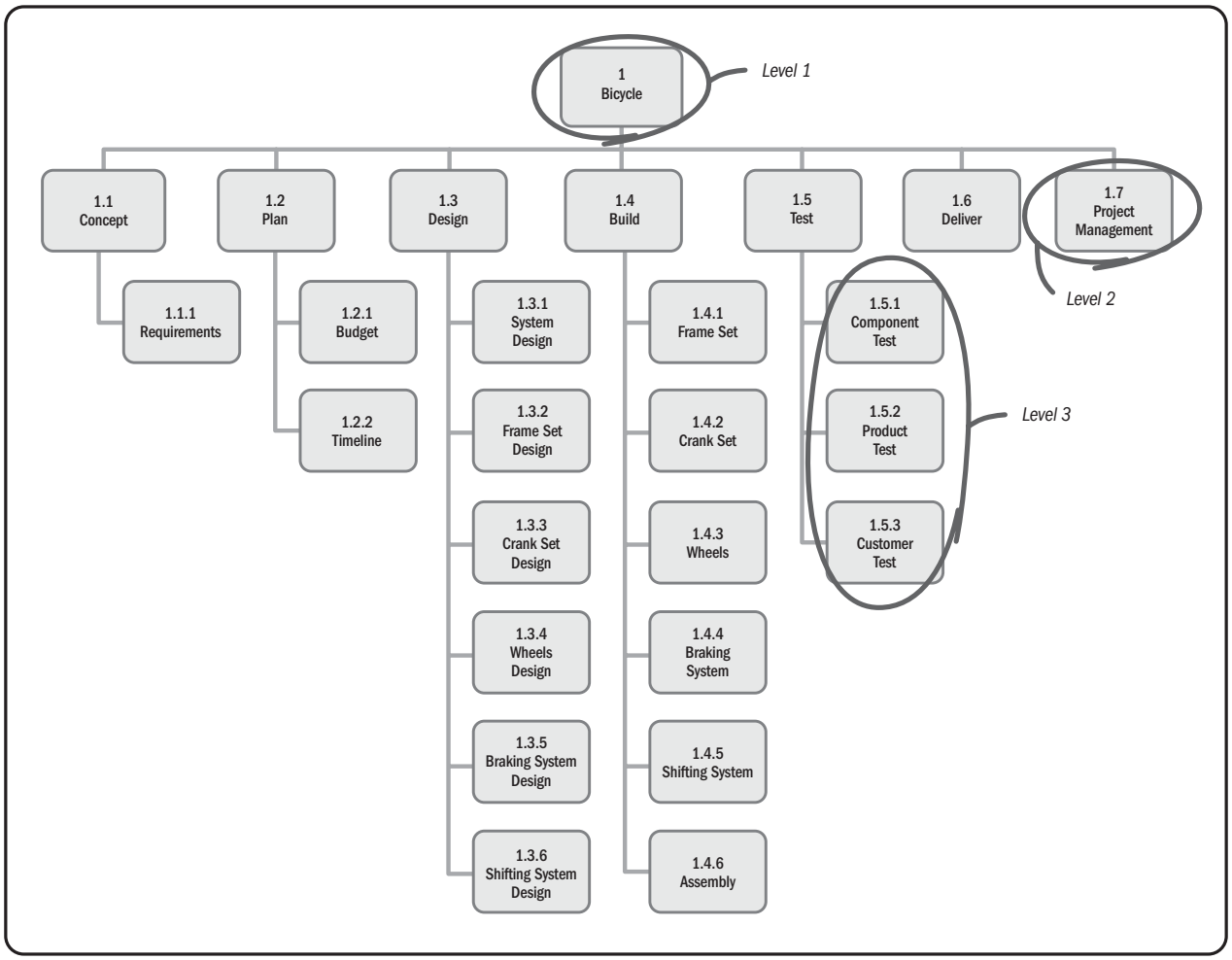


Figure 4-1. Annotated Example of a Predictive Life Cycle WBS

Level 1: This level comprises the full scope of work necessary to produce the bicycle and includes the direct and indirect work. Level 1 represents the project or the overall product. In this example, the top level depicts both a name and a WBS identifier to differentiate it from other work breakdown structures in a program 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. Numbering for the remaining WBS levels adjusts accordingly when omitting the top-level identifier.

Level 2: This is the first level of decomposition. Adherence to the principle known as the 100 percent rule applies throughout the development of a WBS, including not only this level.

Level 3: This level decomposes each major area from level 2 into its constituent parts. 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 for sitting, steering, and attaching 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* includes the front and rear shift mechanisms, cables, and levers. Numbering of this level follows the format #.#.#. For example, the frame set is 1.4.1. This level tends to target specific, tangible deliverables of the project effort.

Level 4: Not shown in the illustration, this level decomposes each exclusive area from level 3 further, if applicable. Again, the complexity of the work drives the depth and number of levels of the WBS decomposition. Numbering of this level follows the format #.#.#.#.

4.3.2 INCREMENTAL LIFE CYCLES

Figure 4-2 is an annotated example of a WBS using the incremental life cycle.

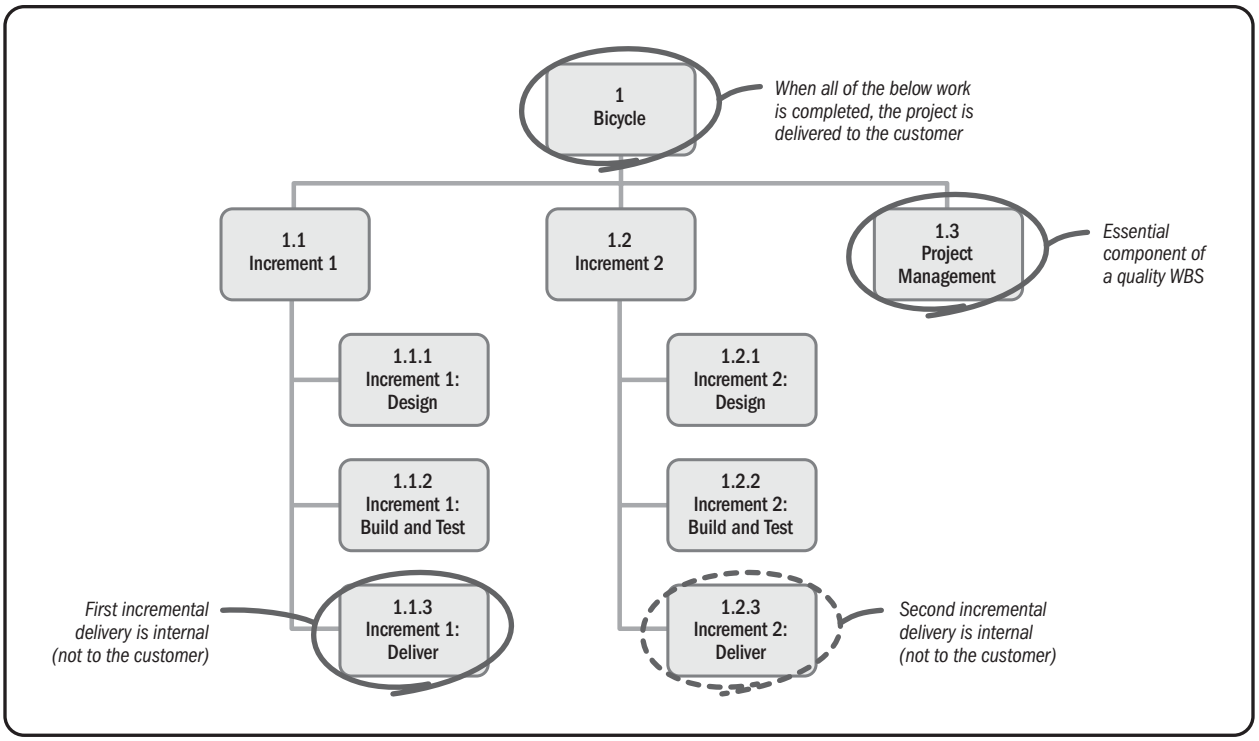


Figure 4-2. Annotated Example of an Incremental Life Cycle WBS

Level 1: Similar to the predictive life cycle, this level comprises the full scope of work necessary to produce the bicycle and includes all direct and indirect work. Level 1 is the overall product, which is in the end delivered to the customer (product or service) regardless of the number of increments it takes to be completed. A quality WBS will have all the increments required to satisfy the agreed-upon and documented scope of the portfolio, program, or project.

Level 2: A quality WBS always contains an element in the second level representing the work needed for project management. This is a core concept needed to fulfill the principle known as the 100 percent rule.

4.3.3 ITERATIVE LIFE CYCLES

Figure 4-3 is an annotated example of a WBS using the iterative life cycle.

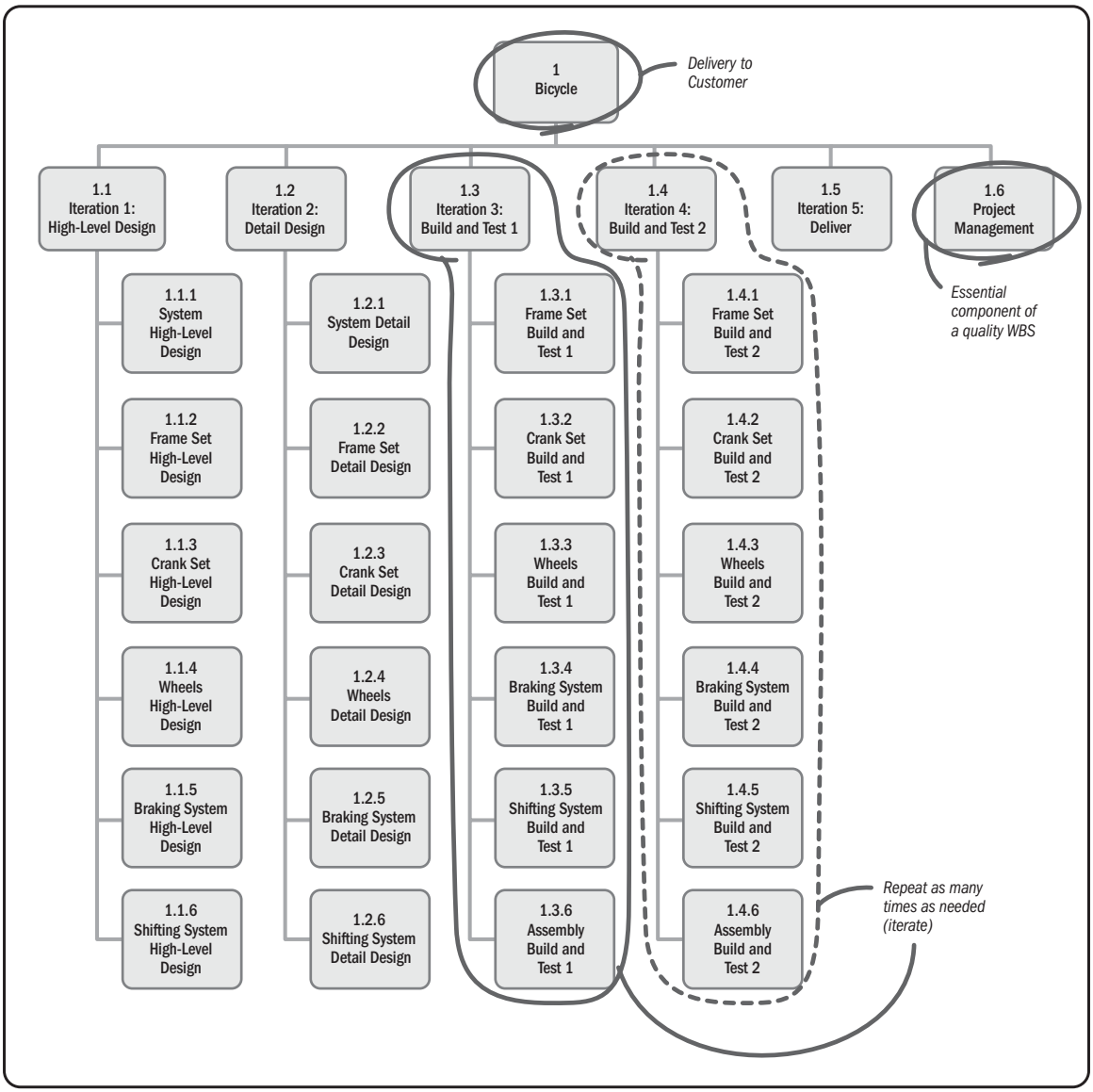


Figure 4-3. Annotated Example of an Iterative Life Cycle WBS

Level 1: Similar to the predictive and incremental life cycles, this level comprises the full scope of work necessary to produce the bicycle and includes the entire direct and indirect work to be performed using an iterative approach. Level 1 is the overall product that, in the end, is delivered to the customer (product or service) regardless of the number of iterations performed, which are designated in the center of the illustration. A quality WBS has the iterations required to satisfy the agreed-upon and documented scope.

Level 2: A quality WBS contains an element in the second level representing the work needed for project management. This core concept fulfills the 100 percent rule.

4.3.4 AGILE LIFE CYCLES

Figure 4-4 is an annotated example of a WBS using the agile life cycle.

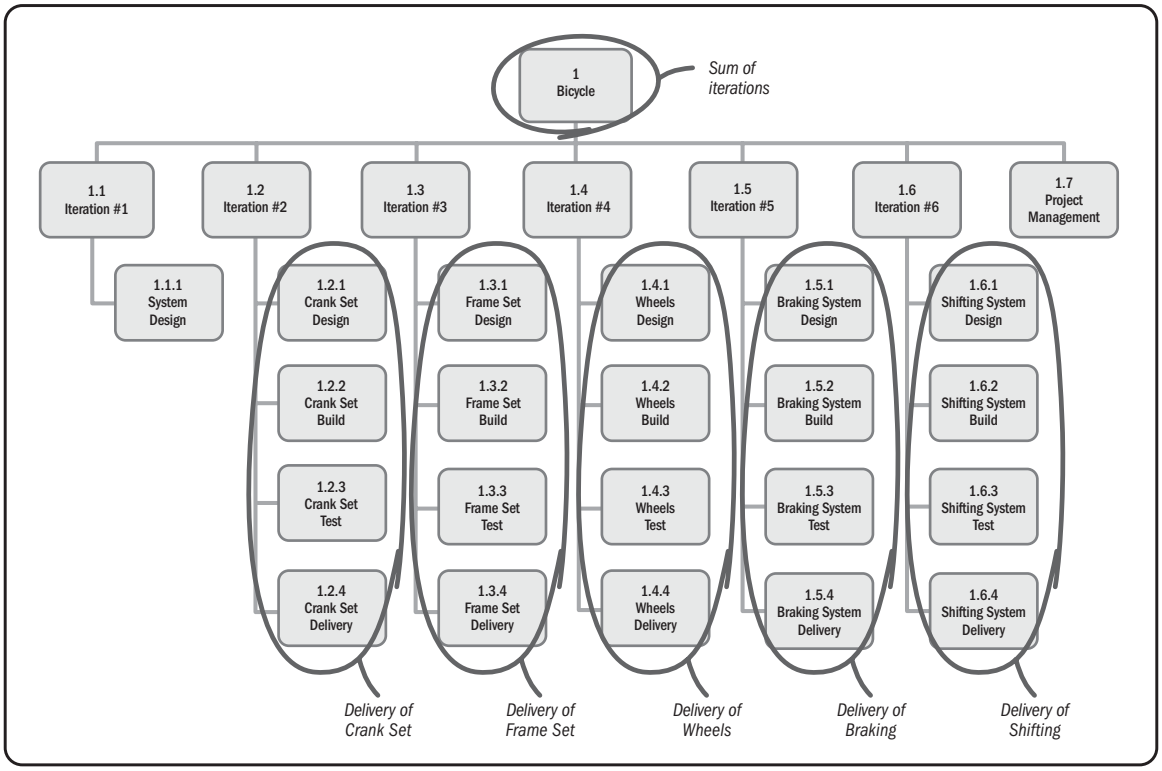


Figure 4-4. Annotated Example of an Agile Life Cycle WBS

Level 1: Delivery in an agile life cycle to the customer occurs at level 1. It also includes direct and indirect work to be performed at this level element. A quality agile life cycle WBS releases deliveries to the customers, critical in receiving feedback to the quality and accuracy of the delivered product to the intended scope.

Level 2: A quality WBS contains 100 percent of the known work at the time of WBS creation, allowing delivery of the product or service to the customer for use and feedback throughout the life of the project. The process of updating and maintaining a WBS is dynamic, and WBS updates occur as new work packages become known.

4.4 DIAGNOSTIC CHECKLIST FOR A QUALITY WBS

Projects not adhering to the core attributes of a quality WBS often result in a variety of issues. The following subsections outline several challenges that projects experience along with a series of investigative questions.

4.4.1 SCOPE

- 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 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 the training and implementation deliverables defined?
  - Has the project scope changed and become 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?
  - Does the WBS include a closeout stage or plan?
  - Is the endeavor 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-making authorities agreed upon beforehand?
  - Do the WBS elements reflect work with specific, tangible deliverables?
  - Have 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?
  - Was the WBS organized around deliverables rather than process steps?
  - Was decomposition completed before dependencies and durations were defined?

4.4.2 SCHEDULE

- There are frequently missed deadlines and an extended schedule.
  - Have all major and minor deliverables been included? Failure to include deliverables within the initial WBS increases project schedules when identifying missing deliverables.
  - 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?
  - Do the deliverables realize the intended benefits of the program or project?
  - Does flexibility fit within the scheduling checklist?
  - Have the required activity-level constraints been included?

4.4.3 COST

- The 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?

4.5 SUMMARY

As demonstrated in this section, there are several core characteristics that need to be present to be considered a quality WBS. For a WBS to be considered of high quality, it requires attainment of the purpose for which it was originally intended, plus inclusion of the complete work represented by the scope of a program or project.

Program and project work breakdown structures shall have these four important core characteristics:

- Key elements necessary to represent the full scope of work;
- Elements that are defined using nouns and adjectives, not verbs;
- Close coordination with the members performing the work represented by the scope; and
- Graphical and hierarchical breakdowns of the project scope.

5

WBS APPLICATION AND USAGE

5.1 OVERVIEW

5.1.1 SECTION OVERVIEW

This section discusses how to apply and use a WBS, as well as some considerations during WBS development and evolution. The subsections of this section present guides for use during the WBS development process, while some subsections serve as informal checklists for the development and refinement of the WBS.

There are many ways to create a WBS. Development of the WBS occurs entirely as a new document, built by leveraging components from existing work breakdown structures, based on a template, or following pre-defined WBS standards. When reusing existing components, the sources of WBS elements come from similar projects or from standard project templates that the organization determines support accepted good practices.

5.1.2 PMI LIBRARY CONTEXT REVIEW

- The WBS is integral to a variety of standards and guides (see Figure 3-1 WBS Relationship Diagram in Section 3.2.1 on the PMI Standards Relationship Diagram).
- The WBS represents the core component of the *PMBOK® Guide's* Create WBS process.
- The WBS goes through stages and iterations during project estimating and project risk management.
- The WBS serves as a key input to project scheduling and earned value management.

5.2 APPLYING THE WBS

This section outlines several examples of how to apply the WBS.

5.2.1 SCHEDULING EXAMPLE

The schedule model is a dynamic representation of the plan for executing the project activities developed by the project stakeholders, applying a selected scheduling method to a scheduling tool using project-specific data. Processing the schedule model via a scheduling tool produces various schedule model instances. A schedule model typically applies to projects, but the premise transcends program management as well.

Defined activities, based on the project WBS, require clear and unique identification, starting with a verb, including at least one unique specific object, and clarifying adjectives when necessary. Also required are activities sequenced with appropriate logical relationships. Consideration of the quantity, skill level, and capabilities of the resources required to complete each activity and consulting the activity performers when determining the duration of each activity, apply. The schedule model creation provides a baseline to permit comparison of progress with the approved plan.

The project's scope documents provide the background, information, and understanding needed to develop the schedule model. The project team reviews and understands the project's scope documents with emphasis given to the WBS. The goal ensures that key aspects of the project execution have been adequately defined and included in the schedule model. Activities in the schedule model represent the work that produces the deliverables or work packages identified in the WBS. Therefore, work packages in the WBS should be directly traceable to a schedule activity or group of activities. Organization of the schedule activities often aligns with the hierarchy of the WBS. Conversely, each activity typically rolls up into only one WBS element.

Fundamentally, development of the schedule leverages the WBS as a foundation, augmenting the activities with the following:

- What: Deliverables
- Who: Resources
- When: Durations, milestones
- Why: Scope
- How Much: Effort
- Where: Geography

Table 5-1 is a seat work package schedule example (based on Figure 5-1).

Table 5-1. Seat Work Package Scheduling Example (Based on Figure 5-1)

Work Package Attribute Name	Work Package Attribute Value
WBS Code	1.1.4
WBS Element Name	Seat
Start Date	1-Sep-2020
End Date	1-Dec-2020
Duration	3 Months
Description of Work	Design/Build/Test Bicycle Seat to Specifications
Assumption and Constraints	Assumption: Seat will be used under normal operating conditions Constraint: Weight not to exceed 18 oz.
Schedule Milestones	Milestone 1: Design Complete 30-Sep-2020 Milestone 2: Build Complete 31-Oct-2020 Milestone 3: Test Complete 30-Nov-2020
Associated Schedule Activities	Align schedule milestones with Frame Set
Resources Required	Engineers (3); Project Manager (1)

For more information, refer to the *Practice Standard for Scheduling*.

5.2.2 ESTIMATING EXAMPLE

Project estimates involve assumptions, uncertainty, and risk perceptions. Therefore, the confidence level of estimates directly relates to the activity definition and available information. Refinement of project estimates occurs as information becomes available, making project estimating an iterative and evolving process, aligned with the concepts of progressive elaboration.

Projects early in the life cycle have a limited definition of scope and a limited amount of available information, resulting in reduced confidence and accuracy of the estimate, thereby requiring a larger confidence range. As the project planning evolves, creation of the WBS occurs. As more information becomes available about the requirements and desired deliverables, adjust the estimates associated with the WBS accordingly.

Leveraging the WBS as a foundation, development of estimates often happens in iterations. For example, a project in the initiation phase could have a rough order of magnitude (ROM) estimate in the range of + 50%. Later in the project, as more information is known, estimates could narrow to a range of + 10%. Each WBS element could have a resource, budget, and duration estimate assigned.

Table 5-2 is a seat work package estimating example (based on Figure 5-1).

Table 5-2. Seat Work Package Estimating Example (Based on Figure 5-1)

Work Package Attribute Name	Work Package Attribute Value
WBS Code	1.1.4
WBS Element Name	Seat
Duration	3 Months
Work	160 Hours X 3 Months X 4 Resources
Description of Work	Design/Build/Test Bicycle Seat to Specifications
Cost Control Number	XYZ-2020-Bicycle-R01
Assumption and Constraints	Assumption: Seat will be used under normal operating conditions Constraint: Weight not to exceed 18 oz.
Resources Required	Engineers (3); Project Manager (1)
Cost Estimates	$30,000.00

For more information, refer to the *Practice Standard for Project Estimating*.

5.2.3 PREDICTIVE LIFE CYCLE WBS EXAMPLE

Table 5-3 is an example of a predictive life cycle WBS.

The predictive life cycle, often referred to as waterfall, is typically a blend of product-, phase-, and action-oriented WBS elements. The predictive life cycle WBS represents the logical evolution of the product development process and readily transitions into a milestone-based schedule.

Table 5-3. Example of a Predictive Life Cycle WBS

WBS Element
1 Bicycle
1.1 Concept
1.1.1 Requirements
1.2 Plan
1.2.1 Budget
1.2.2 Timeline
1.3 Design
1.3.1 System Design
1.3.2 Frame Set Design
1.3.3 Crank Set Design
1.3.4 Wheels Design
1.3.5 Braking System Design
1.3.6 Shifting Design
1.4 Build
1.4.1 Frame Set
1.4.1.1 Frame
1.4.1.2 Handlebar
1.4.1.3 Fork
1.4.1.4 Seat
1.4.2 Crank Set
1.4.2.1 Chain
1.4.2.2 Crank
1.4.2.3 Pedals
1.4.2.4 Sprocket
1.4.3 Wheels
1.4.3.1 Front Wheel
1.4.3.2 Rear Wheel
1.4.4 Braking System
1.4.4.1 Brake Cables
1.4.4.2 Brake Pads
1.4.4.3 Calipers
1.4.4.4 Levers
1.4.5 Shifting System
1.4.5.1 Dérailleurs
1.4.5.2 Shifters
1.4.5.3 Shifting Cables
1.4.6 Assembly
1.5 Test
1.5.1 Component Test
1.5.2 Product Test
1.5.3 Customer Test
1.6 Deliver
1.7 Project Management

5.2.4 ITERATIVE LIFE CYCLE WBS EXAMPLE

Table 5-4 is an example of an iterative life cycle WBS. Like the predictive life cycle WBS example, the iterative life cycle WBS is typically a blend of product-, phase-, and action-oriented WBS elements. The differentiating characteristic is that each branch of the hierarchy often represents a mini life cycle, yielding a discrete, evolving product as an output. The expected duration is not fixed and can span a substantial period.

Table 5-4. Example of an Iterative Life Cycle WBS

WBS Element
1 Bicycle
1.1 Iteration 1: High-Level Design
1.1.1 System High-Level Design
1.1.2 Frame Set High-Level Design
1.1.3 Crank Set High-Level Design
1.1.4 Wheels High-Level Design
1.1.5 Braking System High-Level Design
1.1.6 Shifting High-Level Design
1.2 Iteration 2: Detail Design
1.2.1 System Detail Design
1.2.2 Frame Set Detail Design
1.2.3 Crank Set Detail Design
1.2.4 Wheels Detail Design
1.2.5 Braking System Detail Design
1.2.6 Shifting Detail Design
1.3 Iteration 3: Build and Test 1
1.3.1 Frame Set Build and Test 1
1.3.2 Crank Set Build and Test 1
1.3.3 Wheels Build and Test 1
1.3.4 Braking System Build and Test 1
1.3.5 Shifting System Build and Test 1
1.3.6 Assembly Build and Test 1
1.4 Iteration 4: Build and Test 2
1.4.1 Frame Set Build and Test 2
1.4.2 Crank Set Build and Test 2
1.4.3 Wheels Build and Test 2
1.4.4 Braking System Build and Test 2
1.4.5 Shifting System Build and Test 2
1.4.6 Assembly Build and Test 2
1.5 Iteration 5: Deliver
1.6 Project Management

5.2.5 INCREMENTAL LIFE CYCLE WBS EXAMPLE

Table 5-5 is an example of an incremental life cycle WBS. Like the predictive life cycle WBS and iterative life cycle WBS examples, the incremental life cycle WBS is typically a blend of product-, phase-, and action-oriented WBS elements. The differentiating characteristic is that each branch of the hierarchy often represents progressive refinement but doesn't necessary yield a discrete product as an output.

Table 5-5. Example of an Incremental Life Cycle WBS

WBS Element
1 Bicycle
1.1 Increment 1
1.1.1 Increment 1: Design
1.1.1.1 Increment 1: System Design
1.1.1.2 Increment 1: Frame Set Design
1.1.1.3 Increment 1: Crank Set Design
1.1.1.4 Increment 1: Wheels Design
1.1.1.5 Increment 1: Braking System Design
1.1.1.6 Increment 1: Shifting Design
1.1.2 Increment 1: Build and Test
1.1.2.1 Increment 1: Frame Set Build and Test
1.1.2.2 Increment 1: Crank Set Build and Test
1.1.2.3 Increment 1: Wheels Build and Test
1.1.2.4 Increment 1: Braking System Build and Test
1.1.2.5 Increment 1: Shifting Build and Test
1.1.2.6 Increment 1: Integration and Assembly
1.1.3 Increment 1: Deliver
1.2 Increment 2
1.2.1 Increment 2: Design
1.2.1.1 Increment 2: System Design
1.2.1.2 Increment 2: Frame Set Design
1.2.1.3 Increment 2: Crank Set Design
1.2.1.4 Increment 2: Wheels Design
1.2.1.5 Increment 2: Braking System Design
1.2.1.6 Increment 2: Shifting Design
1.2.2 Increment 2: Build and Test
1.2.2.1 Increment 2: Frame Set Build and Test
1.2.2.2 Increment 2: Crank Set Build and Test
1.2.2.3 Increment 2: Wheels Build and Test
1.2.2.4 Increment 2: Braking System Build and Test
1.2.2.5 Increment 2: Shifting Build and Test
1.2.2.6 Increment 2: Integration and Assembly
1.2.3 Increment 2: Deliver
1.3 Project Management

5.2.6 AGILE LIFE CYCLE WBS EXAMPLE

Table 5-6 is an example of an agile life cycle WBS. Like the predictive life cycle WBS, iterative life cycle WBS, and incremental life cycle WBS examples, the agile life cycle WBS is typically a blend of product-, phase-, and action-oriented WBS elements. The differentiating characteristic is that each branch of the hierarchy often represents a mini life cycle, yielding a discrete, evolving product as an output. The expected duration is typically fixed, spanning a relatively short period of time.

Table 5-6. Example of an Agile Life Cycle WBS

WBS Element
1 Bicycle
1.1 Iteration #1
1.1.1 System Design
1.2 Iteration #2
1.2.1 Crank Set Design
1.2.2 Crank Set Build
1.2.3 Crank Set Test
1.2.4 Crank Set Delivery
1.3 Iteration #3
1.3.1 Frame Set Design
1.3.2 Frame Set Build
1.3.3 Frame Set Test
1.3.4 Frame Set Delivery
1.4 Iteration #4
1.4.1 Wheels Design
1.4.2 Wheels Build
1.4.3 Wheels Test
1.4.4 Wheels Delivery
1.5 Iteration #5
1.5.1 Braking System Design
1.5.2 Braking System Build
1.5.3 Braking System Test
1.5.4 Braking System Delivery
1.6 Iteration #6
1.6.1 Shifting Design
1.6.2 Shifting Build
1.6.3 Shifting Test
1.6.4 Shifting Delivery
1.7 Project Management

5.2.7 RISK MANAGEMENT EXAMPLE

Project risk management leverages the WBS to categorize risks by the area of the project affected. The WBS, coupled with the estimate and schedule components, provides the foundation for project risk management. Once assembled, risks are often categorized into priorities. The basis of these priorities typically aligns with the risk's probability of occurring and its potential impact on specific project objectives or on the whole project. Each identified risk receives a priority, perhaps by objective or for the entire project. Segmentation of risks judged to have a high priority often occurs for further frequent analysis and response planning. Placing low-priority project risks on a watch list requires less frequent review.

The WBS also provides the framework for the risk identification process. Use of the WBS to identify risks for the project ensures all elements of project scope are considered, provides for risks related to different levels of project detail, and excludes risks not related to WBS elements. Table 5-7 is a seat work package risk management example (based on Figure 5-1).

Table 5-7. Seat Work Package Risk Management Example (Based on Figure 5-1)

Work Package Attribute Name	Work Package Attribute Value
WBS Code	1.1.4
WBS Element Name	Seat
Description of Work	Design/Build/Test Bicycle Seat to Specifications
Assumption and Constraints	Assumption: Seat will be used under normal operating conditions Constraint: Weight not to exceed 18 oz.

For more information, refer to *The Standard for Risk Management in Portfolios, Programs, and Projects.*

5.2.8 EARNED VALUE MANAGEMENT EXAMPLE

After scheduling the work and identifying resources, focus turns to integrating and recording the work scope, schedule, approved change requests, cost, and project management plan into a time-phased budget known as the performance measurement baseline. Use of this time-phased budget plan measures project performance. In the planning process, documenting the means for assessing physical work progress and assigning earned value occurs. In addition to routine project management planning, the selection of earned value management (EVM) techniques happens. Application of these techniques to each work package based on scope, schedule, and cost considerations follows.

In the project execution process, EVM requires the recording of resource utilization (e.g., labor, materials) for the work performed within each of the work elements in the project management plan. Capturing actual costs and earned values (measures of work performed) in such a way that permits their comparison with the performance measurement baseline arises. Collection of actual costs and earned values occurs at the control account level or below. Table 5-8 is a seat work package earned value management example (based on Figure 5-1).

Table 5-8. Seat Work Package Earned Value Management Example (Based on Figure 5-1)

Work Package Attribute Name	Work Package Attribute Value
WBS Code	1.1.4
WBS Element Name	Seat
Start Date	1-Sep-2020
End Date	1-Dec-2020
Duration	3 Months
Work	160 Hours X 3 Months X 4 Resources
Description of Work	Design/Build/Test Bicycle Seat to Specifications
Cost Control Number	XYZ-2020-Bicycle-R01
Cost Estimates	$30,000.00

For more information, refer to the *Practice Standard for Earned Value Management*.

5.3 EVOLVING THE WBS

The WBS evolves through progressive elaboration 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. Development of a high-level WBS occurs early in the conceptual stage of the project. After the project definition and specifications preparation, development of a more detailed WBS results, customized to the specific needs and requirements of the project. Removal of non-required work and deliverables takes place so that the WBS represents only the project's scope. The result is a WBS that represents the complete list of deliverables for the project.

5.3.1 PROJECT WBS EVOLUTION

The WBS, often referred to as the project WBS (Figure 5-1), represents the defined scope of the project at a point in time. Over the life of the project, the WBS undergoes progressively more detailed elaboration. A variety of factors impact the evolution, including scope, schedule, and resource changes. Risk and earned value also influence the WBS evolution.

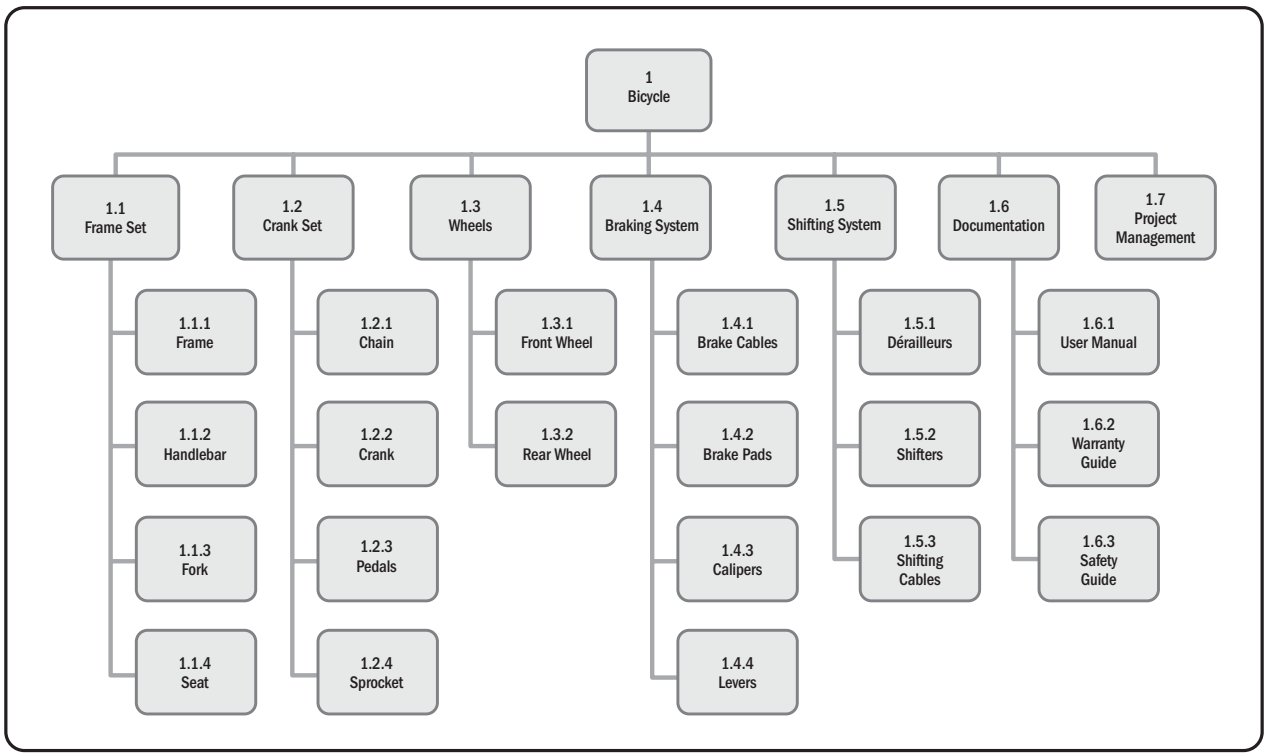


Figure 5-1. Project WBS Example

After a successful change control process, the project WBS evolves to include 1.8 Accessories as shown in Figure 5-2.

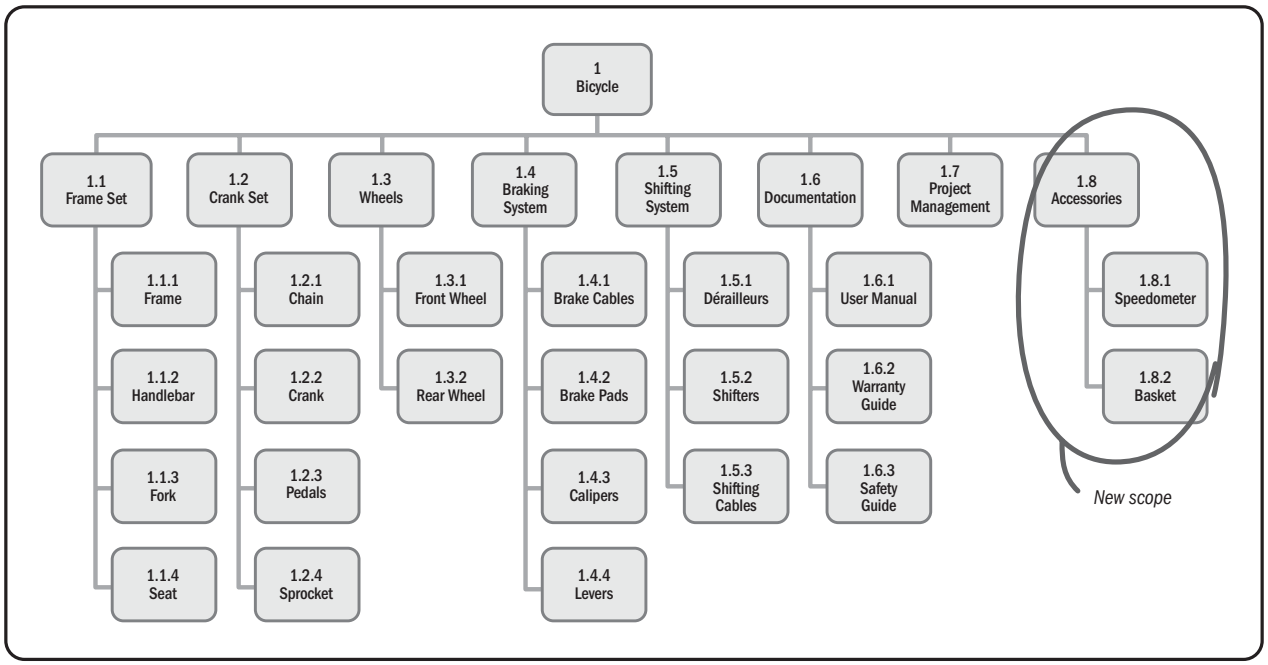


Figure 5-2. Project WBS Example after Scope Change

5.3.2 PROGRAM WBS EVOLUTION

The program WBS (Figure 5-3) encompasses an entire program, including projects, systems, program activities, and other programs as required. The program manager and contractor often use the program WBS as a basis or extension for a contract WBS. The program WBS evolves as the scope, schedule, and resource dimensions change.

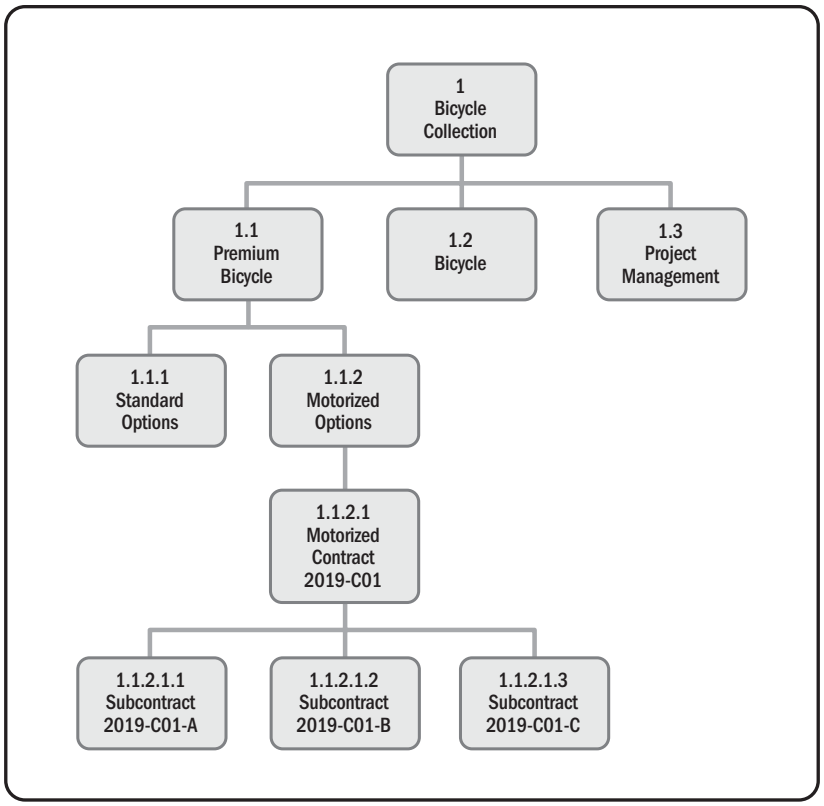


Figure 5-3. Program WBS Example

5.3.3 CONTRACT WBS EVOLUTION

The contract WBS is the complete WBS, often extended to the agreed-upon contract reporting level, based on cost, risk, or complexity dimensions. The contract WBS defines these lower-level components as to what needs to be procured and includes product items such as hardware, software, services, data, and facilities. The contract WBS typically stipulates the contractor's key responsibilities. Figure 5-4 illustrates where the contract WBS ties to the project WBS via the documentation WBS element.

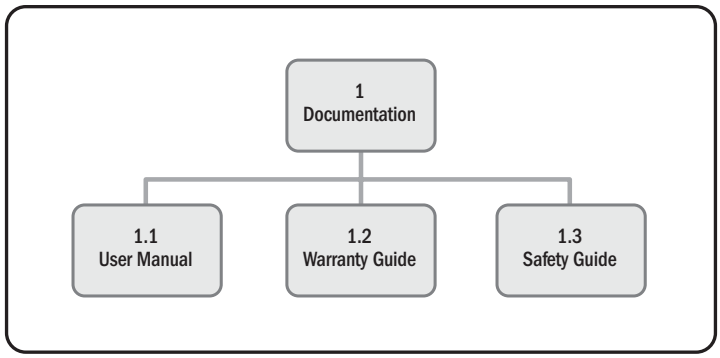


Figure 5-4. Contract WBS Example

5.4 SUMMARY

This section illustrated how the WBS is integral to several project management processes. Also demonstrated were how a WBS applies to a variety of examples and how a WBS evolves over time.

5.4.1 SECTION RECAP

The four subsections of this section covered the following topics:

- 5.1 Overview—General context and scope
- 5.2 Applying the WBS—Concrete examples of how to apply the WBS
- 5.3 Evolving the WBS—Scenarios of how the WBS evolves through use
- 5.4 Summary—Recap of the section

5.4.2 PMI LIBRARY CONTEXT REFERENCES

The WBS plays an integral role in a wide variety of PMI standards and guides. See Figure 1-1, WBS Relationship Diagram, for further details.

REFERENCES

[1] Project Management Institute. 2017. *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)* – Sixth Edition. Newtown Square, PA: Author.

[2] Project Management Institute. 2017. *The Standard for Program Management* – Fourth Edition. Newtown Square, PA: Author.

[3] Project Management Institute. 2017. *Agile Practice Guide.* Newtown Square, PA: Author.

[4] Project Management Institute. 2017. *Project Manager Competency Development Framework* – Third Edition. Newtown Square, PA: Author.

[5] Project Management Institute. 2018. *Practice Standard for Earned Value Management* – Third Edition. Newtown Square, PA: Author.

[6] Project Management Institute. 2019. *Practice Standard for Scheduling* – Third Edition. Newtown Square, PA: Author.

[7] Project Management Institute. 2019. *Practice Standard for Project Estimating* – Second Edition. Newtown Square, PA: Author.

[8] Project Management Institute. 2019. *The Standard for Risk Management in Portfolios, Programs, and Projects*. Newtown Square, PA: Author.

[9] Project Management Institute. 2016. *Requirements Management: A Practice Guide*. Newtown Square, PA: Author.

[10] Project Management Institute. 2013. *Software Extension to the PMBOK® Guide*. Newtown Square, PA: Author.

[11] Project Management Institute. 2015. *Business Analysis for Practitioners: A Practice Guide*. Newtown Square, PA: Author.

[12] Project Management Institute. 2007. *Practice Standard for Project Configuration Management*. Newtown Square, PA: Author.

[13] Project Management Institute. 2017. *Construction Extension to the PMBOK® Guide.* Newtown Square, PA: Author.

[14] Project Management Institute. 2002. *Government Extension to the PMBOK® Guide.* Newtown Square, PA: Author.

[15] Project Management Institute. 2017. *The PMI Guide to Business Analysis* (includes *The Standard for Business Analysis*). Newtown Square, PA: Author.

[16] Project Management Institute. 2017. *The Standard for Organizational Project Management (OPM)*. Newtown Square, PA: Author.

BIBLIOGRAPHY

Besner, Claude, and Brian Hobbs. "Contextualized Project Management Practice: A Cluster Analysis of Practices and Best Practices." *Project Management Journal* 44, no. 1 (2013): 17–34. doi:10.1002/pmj.21291.

Botherton, Shelly A., Robert T. Fried, George A. Ksander, and Eric S. Norman. "*The Work Breakdown Structure: A Brief Synopsis*." (April 2006). Retrieved from https://docuri.com/download/wbsa-brief-synopsis_59c1db9ef581710b286849e5_pdf

Commonwealth of Australia Department of Defence. "DEF(AUST)5664 – Work Breakdown Structures For Defence Materiel Projects. [Australian Defence Standard]." (June 2004). Retrieved from http://www.microplanning.com.au/wp-content/uploads/downloads/2011/10/DRAFT_DEF_AUST_5664_WBS_.pdf

Commonwealth of Australia Department of Defence. "DEF(AUST)5664 Issue A – Work Breakdown Structures for Defence Materiel Projects.[Australian Defence Standard Draft]." (1995).

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

The National Aeronautics and Space Administration (NASA). "NASA/SP-2010-3404 – Work Breakdown Structure (WBS) Handbook." (January 2010). Retrieved from https://www.nasa.gov/pdf/420297main_NASA-SP-2010-3403.pdf

Norman, Eric S., Shelly A. Brotherton, and Robert T. Fried. *Work Breakdown Structures: The Foundation for Project Management Excellence*. Hoboken, NJ: John Wiley & Sons, 2008.

U.S. Department of Defense. "Military Standard Work Breakdown Structures for Defense Materiel Items (MIL-STD-881C)." Washington, D.C. (September 1, 2011). Retrieved from https://www.secnav.navy.mil/rda/OneSource/Documents/New%20MIL-STD-881C%20Work%20Breakdown%20Structures%20for%20Defense%20Materiel%20Items.pdf

U.S. Department of Energy. "DOE WBS Handbook 2012-08-16, Work Breakdown Structure Handbook." (August 16, 2012). Retrieved from https://www.energy.gov/sites/prod/files/DOE%20WBS%20Handbook%20%202012-08-16.pdf

U.S. Government Accountability Office. "GAO Schedule Assessment Guide: Best Practices for Project Schedules GAO-16-89G." (December 22, 2015). Retrieved from https://www.gao.gov/products/GAO-16-89G

APPENDIX X1
THE *PRACTICE STANDARD FOR WORK BREAKDOWN STRUCTURES* – THIRD EDITION CHANGES

This appendix provides a high-level overview of the changes made to the *Practice Standard for Work Breakdown Structures* – Third Edition to help the reader understand changes from the previous edition and to provide historical continuity.

Committee members were selected based on global representation, industry, and experience. The team was chartered to update the practice standard to reflect current practice and new trends, ensuring alignment with the current edition of the *PMBOK® Guide*.

The core team worked collaboratively with the PMI market research team to conduct a survey, learning more about how individuals utilize a WBS. The survey was sent to 1,500 PMI members and 161 members responded to the survey. Survey results concluded that:

- Forty-six percent of respondents consulted the *Practice Standard for Work Breakdown Structures* published by PMI.
- Seventy-five percent of respondents updated their work breakdown structures throughout the project life cycle.
- Over half of respondents noted that the WBS contained 100 percent of their work at the end of the project.
- Two-fifths of respondents noted that the WBS is presented as a project artifact to management and stakeholders most or all of the time.

The team documented seven types of decomposition, including action-oriented, backlog-oriented, contract-oriented, deliverable-oriented, phase-oriented, product-oriented, and program-oriented. To capture how a WBS is represented, styles were established to guide users on how one could be styled, including hierarchical, outline, and tabular styles.

To help the reader understand the context of the *Practice Standard for Work Breakdown Structures* in the realm of standards, the team established a graphical view of the PMI Standards Library. This graphic provides general guidance on the material that exists in the current library. Then the team generated a relationship diagram to show the passing of information between the *Practice Standard for Work Breakdown Structures* and other standards.

References made to the *PMBOK® Guide* were updated to align with the current edition of that standard to avoid confusing the reader. Section 4 includes a quality checklist created to allow the reader to quickly assess his or her WBS.

Examples provided in the *Practice Standard for Work Breakdown Structures* – Third Edition were varied to show how this would look with different life cycles, including agile, applied to project work.

In the updated edition, the Chair and Vice-Chair engaged the Lexicon Team to ensure words align with the Lexicon and across other PMI standards. Committee members from each of the in-progress practice standards worked together to standardize examples and discuss content toward the goal of consistency and congruence.

The examples in the appendix section were updated to include a common header with the following information: type(s) of decomposition, life cycle(s), and industry. The team also presents these examples in different styles to represent the real world.

APPENDIX X2
CONTRIBUTORS AND REVIEWERS OF THE *PRACTICE STANDARD FOR WORK BREAKDOWN STRUCTURES* – THIRD EDITION

This appendix lists, within groupings, those individuals who have contributed to the development and production of the *Practice Standard for Work Breakdown Structures* – Third Edition.

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

X2.1 THE *PRACTICE STANDARD FOR WORK BREAKDOWN STRUCTURES* – THIRD EDITION CORE COMMITTEE

The following individuals served as members, were contributors of text or concepts, and served as leaders with the Core Committee:

Timothy A. MacFadyen, MBA, PMP, Chair
Gregory Hart, Vice Chair
Uriel Fliess, PMI-RMP, PMP
Theofanis Giotis, PhD, PMI-ACP, PMI-PBA, PMP
Nicholas J. Holdcraft, PMP, PgMP
Ashley Wolski, MBA, Standards Project Specialist

X2.2 REVIEWERS

X2.2.1 SME REVIEW

The following individuals were invited subject matter experts who reviewed the draft and provided recommendations through the SME review.

Ángel Águeda Barrero, PMI-ACP, PMP
Emad E. Aziz, PgMP, PfMP
Bridget Fleming, PMI-SP, PMP
Michael Frenette, SMC, PMP
Mike Griffiths, PMI-ACP, PMP
Andrea Innocenti, CGEIT, PMP
Ariel Kirshbom, PMI-ACP, PMP
Halley Hernandez
Sandy Hoath Lawrence, PgMP, PfMP
Eric S. Norman, PgMP, PMI Fellow
David W. Ross, PMP, PgMP
Cindy Shelton, PMI-ACP, PMP
Cristian Soto, MPM, PMP
Langeswaran Supramaniam, MSc, PMP
Dave Violette, MPM, PMP

X2.2.2 PUBLIC EXPOSURE DRAFT REVIEW

In addition to members of the Core Committee, the following individuals provided recommendations for improving the public exposure draft of the *Practice Standard for Work Breakdown Structures* – Third Edition:

Habeeb Abdulla, MS, PMP
Charles D. Ackerman, PMI-ACP, PMP
Anmar Luay Alani, Resident engineer, PMP
Abdulrahman Alulaiyan, MBA, PMP
Jaime Andres Alvarez Ospina, PMI-RMP, PMP
Nahlah A. Alyamani, PMI-RMP, PMP
Ashwani Anant, PMI-RMP, PMI-SP
Sarang Bhand, SCPM, PMP
Nigel Blampied, PE, PMP
David Borja Padilla, PMI-ACP, PMI-RMP
Farid F. Bouges, PhD, PfMP
Bernd Brier
Paulo Guilherme Coda A. Dias
Guillermo Arturo Cepeda Lopez
Panos Chatzipanos, PhD, Dr. EUR ING
Williams Chirinos, MSc, PMP
Dariusz Ciechan, PMI-RMP, PMP
Sergio Luis Conte, PhD, PMP
Saju Devassy, SAFe POPM, PMP
Vahid Dokhtzeynal, PMI-RMP, PMP
Phillip Doyle, PMP
Christopher Edwards, MBA, PMP
Mohamed MH El-fouly, PMI-RMP, PMP
Francis Gárate Vacacela, MPM
Ivo Gerber, PMI-ACP, PgMP
Peter Gilliland, PMP
Akram Hassan, PhD, PMP
Jaden Hodgins, PMP

Collin Howell, MAIPM, CPPM
Michele Jones
Yves Jordan
Rami M. W. Kaibni, B.Eng., PMP
Nils Kandelin, PhD, PMP
Dorothy L. Kangas, PMP
Varan Suppiah Karunakaran, RPEQ (Civil/Mechanical), PMP
Brian W. Kellum, MM ED
Suhail Khaled, PMI-ACP, PMP
Diwakar Killamsetty, PMP
Taeyoung Kim, PMP
Visswanathan KKN
Rima Kobeissi A. Jalil
Maciej Koszykowski, PMP, PgMP
Wayne Kremling, PMP
Anuj Kulkarni, CSM, PMP
Avinash Kumar
Pramit Kumar, PMP, PgMP
P. Ravikumar, PMP, PgMP
G. Lakshmi Sekhar, PMI-PBA, PMI-SP
Janette Lean, MAppSci, DipPM
Adeel Khan Leghari, PMP, PgMP
Marisa Andrea Lostumbo, PhD Candidate, PMP
Mirela Miresan, PhD
Aravind M. K., MBA, PMP
Anas Mohamed Hassan, MSc, PMP
Mohamed Mohsen Mohamed, PMP
Anand D. Nagarkatti, PMP
Asaya Nakasone, PMP
Ali Navidi, PhD, PMP
Fernando Souza, MSc, PMP
Peter O'Driscoll, PMI-ACP, PMP
Habeeb Omar, PgMP, PfMP
Mozhgan Pakdaman, PMI-RMP, PMP
Hariyo D. Pangarso, MT, PMP
Darendra Mark Persaud, CSM, PMP
Truc Pham, PMI-ACP, PMP
Loretta Pierfelice, PMP
Sriramasundararajan Rajagopalan, PhD, PfMP
Jaime Andres Salazar Cabrera, PMI-RMP, PfMP
Ahmed Saleh Bahakim, P3O, PMP
Risa Salsburg, MSHS, PMP
Abubaker Sami, PfMP, PgMP
Paul Santilli, MBCS, PMP
Arun Seetharaman, MBA, PMP
Luqman Shantal, TOGAF, PMP
Joseph A. Sopko, MSP-AP, PMP
Mauro Sotille, PMI-RMP, PMP
Fernando Souza, MSc, PMP
Chris Stevens, PhD
Varun Tandon, CPSM, PMP
Gaitan Marius Titi, PMI-PBA, PMP
Biagio Tramontana, Eng, PMP
Narayanan Venkatesan
Gorakhanath Wankhede
Darius White, PMP
Michal P. Wieteska, ICP-ACC, PMP
Emanuele Zanotti

X2.2.3 PMI STANDARDS PROGRAM MEMBER ADVISORY GROUP (SMAG)

The PMI Standards Program Member Advisory Group (SMAG) works under the leadership of the standards manager. We extend out sincerest thanks to them for their compelling and helpful guidance throughout the development process.

During the course of the committee's work, the following distinguished members of the PMI community served with distinction on the SMAG:

Maria Cristina Barbero, CSM, PMI-ACP, PMP
Michael J. Frenette, I.S.P., SMC, MCITP, PMP
Brian Grafsgaard, CSM, PMP, PgMP, PfMP
David Gunner, MSc, PMP, PfMP
Hagit Landman, MBA, PMI-SP, PMP
Vanina Mangano, PMI-RMP, PMP
Yvan Petit, PhD, MEng, MBA, PMP, PfMP
Carolina Gabriela Spindola, MBA, SSBB, PMP

X2.2.4 CONSENSUS BODY REVIEW

The following individuals served as members of PMI Standards Program Consensus Body:

Nigel Blampied, PE, PMP
Chris Cartwright, MPM, PMP
John Dettbarn, DSc, PE
Charles Follin, PMP
Michael Frenette, SMC, PMP
Dana Goulston, PMP
Brian Grafsgaard, PMP, PgMP
Dave Gunner, PMP
Dorothy Kangas, MS, PMP
Thomas Kurihara
Hagit Landman, PMI-SP, PMP
Timothy A. MacFadyen, MBA, PMP
Vanina Mangano, PMI-RMP, PMP
Mike Mosley, PE, PMP
Nanette Patton, MSBA, PMP
Yvan Petit, PhD, PMP
Crispin ("Kik") Piney, PgMP, PfMP
Mike Reed, PMP, PfMP
David Ross, PMP, PgMP
Paul Shaltry, PMP
C. Gabriela Spindola
Chris Stevens, PhD
Judi Vincent
David J. Violette, MPM, PMP

X2.2.5 PRODUCTION STAFF

Special mention is due to the following employees of PMI:

Linda R. Garber, Product Editor
Donn Greenberg, Manager, Publications
Payal Kondisetty, Market Researcher
Evan Krieg, Market Researcher
Kim Shinners, Publications Production Associate
Barbara Walsh, Publications Production Supervisor

X2.2.6 HARMONIZATION TEAM

Core Team:

Bridget Fleming, PMI-SP, PMP
Gregory Hart
Hagit Landman, PMI-SP, PMP
Vanina Mangano, PMP-RMP, PMP
Timothy A. MacFadyen, MBA, PMP
Mike Mosley
John Post, PMP
David W. Ross, PMP, PgMP
Cindy Shelton, PMI-ACP, PMP
Gary Sikma, PMI-ACP, PMP
Dave Violette, MPM, PMP

PMI Staff:

M. Elaine Lazar, MA, AStd
Marvin R. Nelson, MBA, SCPM
Lorna Scheel, MSc
Roberta Storer
Kristin Vitello, CAPM
John Zlockie, MBA, PMP

APPENDIX X3
THE *PRACTICE STANDARD FOR WORK BREAKDOWN STRUCTURES* – THIRD EDITION EXAMPLES

This appendix provides WBS examples with general illustrations and guidance for various types of industries. No claim of completeness is made for any specific project. All examples reflect the quality principles expressed in this practice standard.

Preceding each example is a table that summarizes the WBS characteristics. The table contains three sections: industry, type of decomposition, and the life cycle.

The WBS examples are shown both in hierarchical and outline styles. These examples typically represent decomposition to Level 3 in the hierarchical style. Due to the amount of detail within a specific WBS example, some examples show decomposition to Level 2, whereas others may show decomposition to Level 4.

The WBS examples in this appendix are as follows:

Section X3.1 Production Platform Project Example

Section X3.2 Bioventing Test Project Example

Section X3.3 New Compound Development Project Example

Section X3.4 Process Plant Construction Project Example

Section X3.5 Outsourcing Project Example

Section X3.6 Web Design Project Example

Section X3.7 Telecommunications Project Example

Section X3.8 Design-Bid-Build Project Example

Section X3.9 Software Implementation Project Example

Section X3.10 International Car School Competition Project Example

Section X3.11 Subway Line Program 1 Example

Section X3.12 Subway Line Program 2 Example

Section X3.13 Subway Line Program 3 Example

X3.1 PRODUCTION PLATFORM PROJECT EXAMPLE

Table X3-1 provides WBS characteristics of a production platform project, followed by a WBS hierarchical example (Figure X3-1) and a WBS outline example (Table X3-2).

Table X3-1. Production Platform Project—WBS Characteristics

Industry	Type of Decomposition				Life Cycle	
Oil, Gas, and Petrochemical	Action-oriented	X	Phase-oriented		Predictive	X
	Backlog-oriented		Product-oriented	X	Iterative	
	Contract-oriented		Program-oriented		Incremental	
	Deliverable-oriented	X			Agile	

This example WBS, from the owner's point of view, represents the detailed design, fabrication, and installation of an offshore production platform. The detailed engineering, fabrication, and installation are distinct phases of the work, so these are placed at Level 2 of the WBS. This fits with the progression of the work, but also with the contracting strategy, leveraging different contractors for engineering, fabrication, etc. The logic of decomposition at the next level varies with the deliverable. Not all branches of the WBS decompose to the same level of detail. The WBS is generic and serves as a WBS template customizable for specific projects. Certain WBS elements decompose to a greater level of detail, as more information for a specific project becomes known. It is also possible that a subcontractor decomposes certain WBS elements.

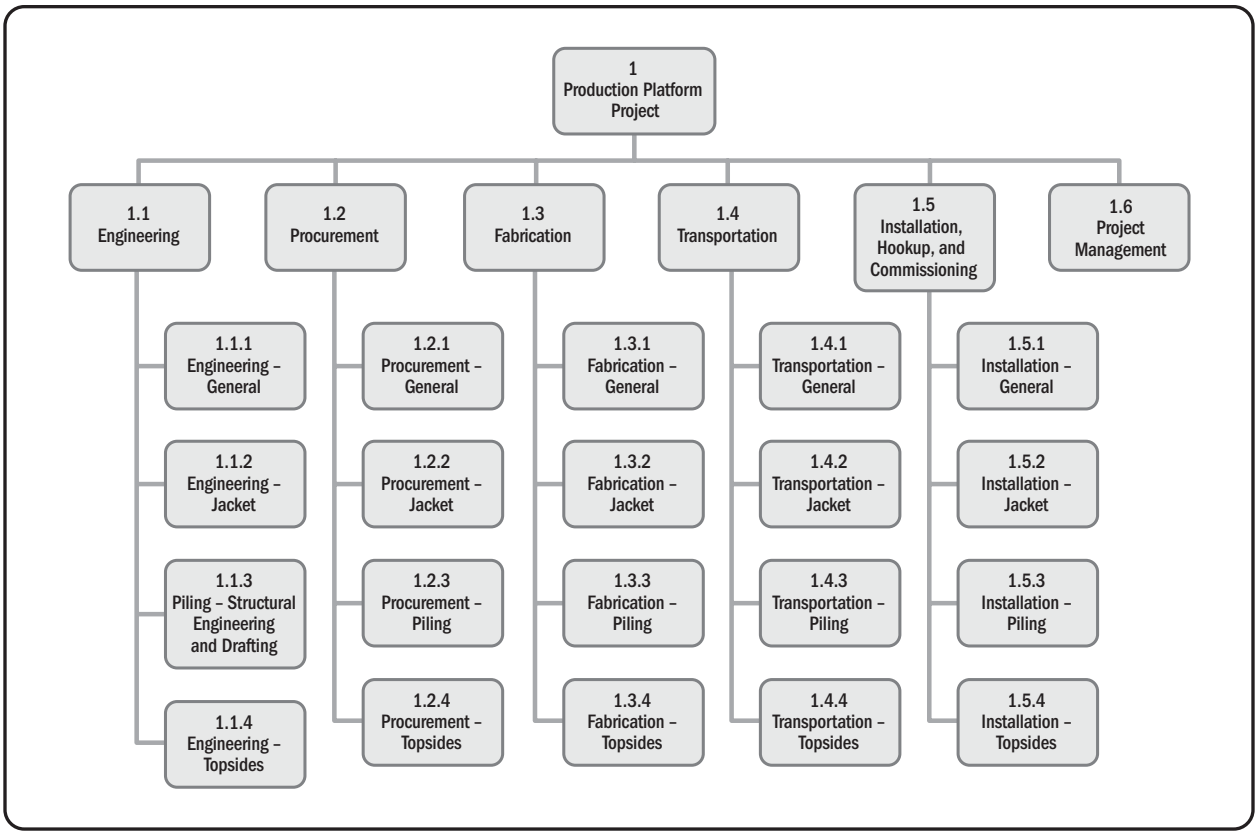


Figure X3-1. Production Platform Project—WBS Hierarchical Example

Table X3-2. Production Platform Project—WBS Outline Example

WBS Element
1 Production Platform Project
1.1 Engineering
1.1.1 Engineering - General
1.1.1.1 Preliminary Engineering Acceptance
1.1.1.2 Design Basis and Specifications
1.1.1.3 Calculations and Engineering Data Books
1.1.1.4 Summary Reports
1.1.1.5 Platform Equipment Manuals
1.1.2 Engineering - Jacket
1.1.2.1 Engineering - Jacket Structural Engineering and Drafting
1.1.2.1.1 Jacket In-Service Analyses
1.1.2.1.2 Jacket Pre-Service Analyses
1.1.2.1.3 Jacket Design Details
1.1.2.1.4 Jacket Cathodic Protection
1.1.2.1.5 Jacket Weights and Material Takeoffs
1.1.2.1.6 Jacket Approved for Construction (AFC) Drawings
1.1.2.1.7 Jacket Detailed Engineering and Design Report
1.1.2.2 Mechanical Engineering and Drafting
1.1.2.2.1 Flood and Vent System
1.1.2.2.2 Grouting System
1.1.3 Piling—Structural Engineering and Drafting
1.1.3.1 Piling In-Service Analyses

(continued)

Table X3-2. *(Continued)*

WBS Element
1.1.3.2 Piling Pre-Service Analyses
1.1.3.3 Piling Design Details
1.1.3.4 Piling Weights and Material Takeoffs
1.1.3.5 Piling AFC Drawings
1.1.3.6 Piling Detailed Engineering and Design Report
1.1.4 Engineering - Topsides
1.1.4.1 Engineering - Topsides - Structural Engineering and Drafting
1.1.4.1.1 Deck In-Service Analyses
1.1.4.1.2 Deck Pre-Service Analyses
1.1.4.1.3 Deck Design Details
1.1.4.1.4 Deck Weights and Material Takeoffs
1.1.4.1.5 Deck AFC Drawings
1.1.4.1.6 Deck Detailed Engineering and Design Report
1.1.4.2 Mechanical/Process Engineering and Drafting
1.1.4.2.1 Process Simulation/Calculations
1.1.4.2.2 Equipment Design/Sizing
1.1.4.2.3 Pipe Stress Analysis
1.1.4.2.4 Hazard Analysis
1.1.4.2.5 Specifications, Data Sheets, and Request for Quotations
1.1.4.2.6 Mechanical - Vendor Data Reviews
1.1.4.2.7 Mechanical - Weight, Material Takeoffs, Bill of Materials

(continued)

Table X3-2. *(Continued)*

WBS Element
1.1.4.2.8 Mechanical - AFC Drawings for:
1.1.4.2.8.1 Process Flow Diagrams/Utility Flow Diagrams
1.1.4.2.8.2 Mechanical Flow Diagrams/Piping and Instrument Drawings
1.1.4.2.8.3 Equipment Layouts/Arrangements/ Skid Layouts
1.1.4.2.8.4 Piping Supports
1.1.4.2.8.5 Piping General Arrangements, Elevations, and Isometrics
1.1.4.2.8.6 Mechanical - Other AFC Drawings
1.1.4.2.9 Mechanical Data Books, Equipment Manuals, Engineering and Design Report
1.1.4.3 Electrical Engineering and Drafting
1.1.4.3.1 Electrical Engineering and Design
1.1.4.3.2 Electrical Specifications, Data Sheets, and Request for Quotations
1.1.4.3.3 Electrical Load Study/List
1.1.4.3.4 Electrical - Vendor Data Reviews
1.1.4.3.5 Electrical - Weight, Material Takeoffs, Bill of Materials
1.1.4.3.6 Electrical - AFC Drawings for:
1.1.4.3.6.1 Area Classifications
1.1.4.3.6.2 Electrical Symbol Legend
1.1.4.3.6.3 Electrical One-Line Drawings
1.1.4.3.6.4 Schematics/Schedule/Plans
1.1.4.3.6.5 Buildings and Equipment Layouts
1.1.4.3.6.6 Electrical Arrangement and Cable Tray Routing
1.1.4.3.6.7 Electrical Installation Details
1.1.4.3.6.8 Electrical - Other AFC Drawings

(continued)

Table X3-2. ***(Continued)***

WBS Element
1.1.4.3.7 Electrical - Data Books, Equipment Manuals, Engineering and Design Report
1.1.4.4 Instrument Engineering and Drafting
1.1.4.4.1 Instrument Engineering and Design
1.1.4.4.2 Fire - Safety Engineering and Design
1.1.4.4.3 Relief Systems Sizing Calculations
1.1.4.4.4 Instrument Specification, Data Sheets, and Request for Quotations
1.1.4.4.5 Instrument Index
1.1.4.4.6 Instrument - Vendor Data Reviews
1.1.4.5 Engineering - Topsides - Weight, Material Takeoffs, Bill of Materials
1.1.4.6 Engineering - Topsides - AFC Drawings for:
1.1.4.6.1 SAFE Charts/PSFDs
1.1.4.6.2 Control Panels
1.1.4.6.3 PLC System
1.1.4.6.4 Tubing Tray Routing
1.1.4.6.5 Loop Diagrams
1.1.4.6.6 Instrument Installation Details
1.1.4.6.7 Fire and Safety
1.1.4.6.8 Pressure Relief Systems
1.1.4.6.9 Engineering - Topsides - Other AFC Drawings
1.1.4.7 Data Books, Equipment Manuals, Engineering and Design Reports
1.2 Procurement
1.2.1 Procurement - General
1.2.1.1 Procurement Procedures

(continued)

Table X3-2. *(Continued)*

WBS Element
1.2.1.2 Expediting and Inspection Procedures
1.2.2 Procurement - Jacket
1.2.2.1 Procurement - Jacket - Owner Furnished Equipment (OFE)
1.2.2.2 Procurement - Jacket - Contractor Furnished Reimbursable Equipment (CFRE)
1.2.2.3 Procurement - Jacket - All Other Contractor Supplied Equipment
1.2.2.4 Procurement - Jacket - Bulk Materials—Contractor Supplied
1.2.2.4.1 Procurement - Jacket - Bulk Materials - Structural
1.2.2.4.2 Anodes
1.2.3 Procurement - Piling
1.2.3.1 Procurement - Piling - Bulk Materials—Contractor Supplied
1.2.3.1.1 Procurement - Piling - Bulk Materials - Structural
1.2.4 Procurement - Topsides
1.2.4.1 Procurement - Topsides - Owner Furnished Equipment (OFE)
1.2.4.1.1 Procurement - Topsides - OFE - Rotating Equipment
1.2.4.1.2 Procurement - Topsides - OFE - Pressure Vessels
1.2.4.1.3 Electrical Generation
1.2.4.2 Procurement - Topsides - Contractor Furnished Reimbursable Equipment (CFRE)
1.2.4.2.1 Procurement - Topsides - CFRE - Rotating Equipment
1.2.4.2.2 Procurement - Topsides - CFRE - Pressure Vessels
1.2.4.2.3 Other CFRE
1.2.4.3 Procurement - Topsides - All Other Contractor Supplied
1.2.4.4 Procurement - Topsides - Bulk Materials—Contractor Supplied
1.2.4.4.1 Procurement - Topsides - Bulk Materials - Structural

(continued)

Table X3-2. *(Continued)*

WBS Element
1.2.4.4.2 Piping, Valves, and Fittings
1.2.4.4.3 Procurement - Topsides - Bulk Materials - Electrical
1.2.4.4.4 Instrument
1.3 Fabrication
1.3.1 Fabrication - General
1.3.1.1 Fabrication - General - Safety Manual and Plan
1.3.1.2 Yard and Work-Force Mobilization
1.3.1.3 Fabrication - General - Qualification of Welding Procedures and Welders
1.3.1.3.1 Fabrication - General - Qualification - Structural
1.3.1.3.2 Fabrication - General - Qualification - Piping
1.3.1.4 Shop Drawings
1.3.1.4.1 Shop Drawings - Structural
1.3.1.4.2 Piping Isometrics
1.3.1.4.3 Piping Spools
1.3.1.5 Receipt of Materials
1.3.1.6 QA/QC, NDT, and Dimensional Control
1.3.1.7 Weight Control Reports
1.3.1.8 As-Built Drawings and Certification Dossier
1.3.2 Fabrication - Jacket
1.3.2.1 Frames
1.3.2.1.1 Frame 1
1.3.2.1.2 Frame 2
1.3.2.1.3 Frame A

(continued)

Table X3-2. *(Continued)*

WBS Element
1.3.2.1.4 Frame B
1.3.2.2 Horizontal Levels
1.3.2.2.1 Level 1
1.3.2.2.2 Level 2
1.3.2.2.3 Level 3
1.3.2.2.4 Level 4
1.3.2.3 Fabrication - Jacket - Appurtenances
1.3.2.3.1 Disposal Pile
1.3.2.3.2 Caissons
1.3.2.3.3 Risers
1.3.2.3.4 Boat Landing
1.3.2.3.5 Corrosion Protection
1.3.2.3.6 Stairs, Walkways, and Landings
1.3.2.4 Fabrication - Jacket - Installation Aids
1.3.2.5 Fabrication - Jacket - Loadout and Seafasten
1.3.3 Fabrication - Piling
1.3.3.1 Pile A1
1.3.3.2 Pile A2
1.3.3.3 Pile B1
1.3.3.4 Pile B2
1.3.3.5 Fabrication - Piling - Loadout and Seafasten
1.3.4 Fabrication - Topsides
1.3.4.1 Main Deck

(continued)

Table X3-2. *(Continued)*

WBS Element
1.3.4.1.1 Main Deck - Plate Girders
1.3.4.1.2 Main Deck - Deck Panels
1.3.4.1.3 Main Deck - Tertiary Steel
1.3.4.2 Cellar Deck
1.3.4.2.1 Cellar Deck - Plate Girders
1.3.4.2.2 Cellar Deck - Deck Panels
1.3.4.2.3 Cellar Deck - Tertiary Steel
1.3.4.3 Sub-Cellar Deck
1.3.4.4 Legs
1.3.4.5 Bracing
1.3.4.6 Equipment Installation
1.3.4.7 Interconnect Piping
1.3.4.8 Fabrication - Topsides - Electrical
1.3.4.9 Instrumentation
1.3.4.10 Precommissioning
1.3.4.11 Fabrication - Topsides - Appurtenances
1.3.4.11.1 Flare Boom
1.3.4.11.2 Stairs, Walkways and Landings
1.3.4.11.3 Fabrication - Topsides - Appurtenances - Installation Aids
1.3.4.12 Fabrication - Topside - Loadout and Seafasten
1.4 Transportation
1.4.1 Transportation - General
1.4.1.1 Transportation - General - Safety Manual and Plan

(continued)

Table X3-2. *(Continued)*

WBS Element
1.4.1.2 Seafastening Drawings
1.4.1.3 Marine Warranty Surveyor Review and Approval
1.4.2 Transportation - Jacket
1.4.3 Transportation - Piling
1.4.4 Transportation - Topsides
1.5 Installation, Hookup, and Commissioning
1.5.1 Installation - General
1.5.1.1 Installation - General - Safety Manual and Plan
1.5.1.2 Installation Procedures and Drawings
1.5.1.3 Installation - General - Qualification of Welding Procedures and Welders
1.5.1.3.1 Installation - General - Qualification - Structural
1.5.1.3.2 Installation - General - Qualification - Piping
1.5.1.4 As-Installed Drawings
1.5.1.5 Mobilization
1.5.1.6 Demobilization
1.5.2 Installation - Jacket
1.5.3 Installation - Piling
1.5.4 Installation - Topsides
1.5.4.1 Hookup
1.5.4.2 Commissioning
1.5.4.3 Startup
1.6 Project Management

X3.2 BIOVENTING TEST PROJECT EXAMPLE

This WBS represents a project to conduct a bioventing test for the remediation of hydrocarbon-impacted soils. Table X3-3 provides WBS characteristics of a bioventing test project, followed by a WBS hierarchical example (Figure X3-2) and a WBS outline example (Table X3-4).

Table X3-3. Bioventing Test Project—WBS Characteristics

Industry	Type of Decomposition				Life Cycle	
Environmental Management	Action-oriented	X	Phase-oriented		Predictive	X
	Backlog-oriented		Product-oriented		Iterative	
	Contract-oriented		Program-oriented		Incremental	
	Deliverable-oriented	X			Agile	

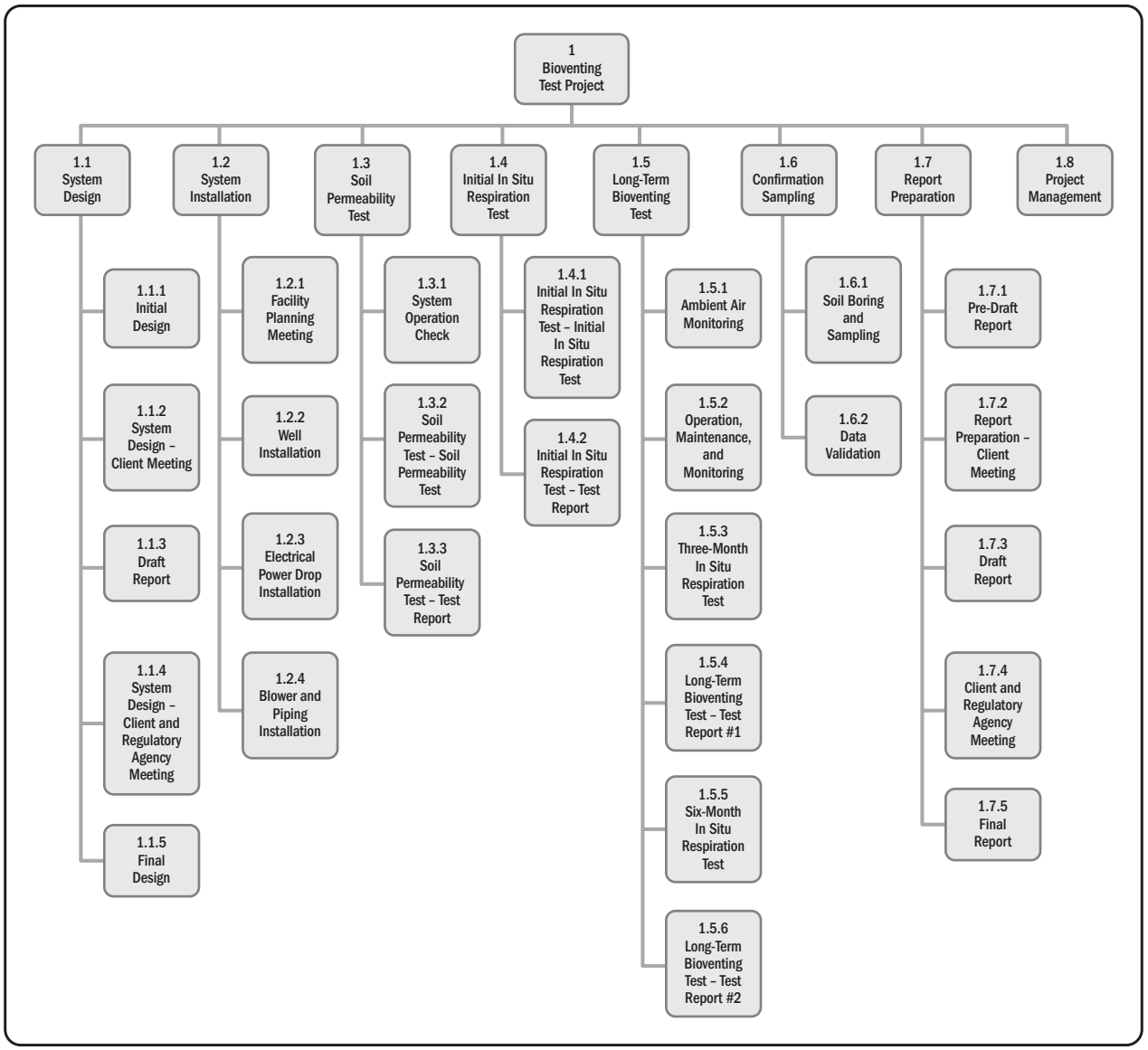


Figure X3-2. Bioventing Test Project—WBS Hierarchical Example

Table X3-4. Bioventing Test Project—WBS Outline Example

WBS Element
1 Bioventing Test Project
1.1 System Design
1.1.1 Initial Design
1.1.2 System Design - Client Meeting
1.1.3 Draft Design
1.1.4 System Design - 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 - Soil Permeability Test
1.3.3 Soil Permeability Test - Test Report
1.4 Initial In Situ Respiration Test
1.4.1 Initial In Situ Respiration Test - Initial In Situ Respiration Test
1.4.2 Initial In Situ Respiration Test - Test Report
1.5 Long-Term Bioventing Test
1.5.1 Ambient Air Monitoring
1.5.2 Operation, Maintenance, and Monitoring

(continued)

Table X3-4. *(Continued)*

WBS Element
1.5.3 Three-Month In Situ Respiration Test
1.5.4 Long-Term Bioventing Test - Test Report #1
1.5.5 Six-Month In Situ Respiration Test
1.5.6 Long-Term Bioventing Test - Test Report #2
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 Report Preparation - Client Meeting
1.7.3 Draft Report
1.7.4 Client and Regulatory Agency Meeting
1.7.5 Final Report
1.8 Project Management

X3.3 NEW COMPOUND DEVELOPMENT PROJECT EXAMPLE

Table X3-5 provides WBS characteristics of a new compound development project, followed by a WBS hierarchical example (Figure X3-3) and a WBS outline example (Table X3-6).

Table X3-5. New Compound Development Project—WBS Characteristics

Industry	Type of Decomposition					Life Cycle	
Pharmaceutical	Action-oriented	X		Phase-oriented	X	Predictive	X
	Backlog-oriented			Product-oriented	X	Iterative	
	Contract-oriented			Program-oriented		Incremental	X
	Deliverable-oriented					Agile	

This WBS example represents the development of a new compound. A development program containing more than one compound consists 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 life cycle. These elements reflect the structure of the organizations making up the enterprise, such as marketing, regulatory affairs, pharmaceutical development, etc. Other Level 2 elements reflect the product development life cycle itself, such as Phase 1 Clinical Program, Phase 2 Clinical Program, reflecting the way the business manages the overall development program. The WBS illustrates the structure of deliverable creation, but not necessarily the sequence. Creating the network diagram and schedule for this project reflects the sequence of the activities that produce the deliverables within both the functionally organized elements and those organized by the product life cycle.

Note that this WBS describes a generic product, not a project to develop a specific compound. As such, it is a *WBS framework* customizable using specific terms describing different development projects. Some elements are modular and repeatable as often as necessary in a given project. Depending on the project, the project manager includes some, but not all, of the possible elements included in the WBS. For example, if the objective of the project encompasses a line extension of an existing product, it is likely that the project manager excludes any aspect of lead identification in the WBS. In other cases, the project manager includes geographic components in the WBS, addressed outside the United States.

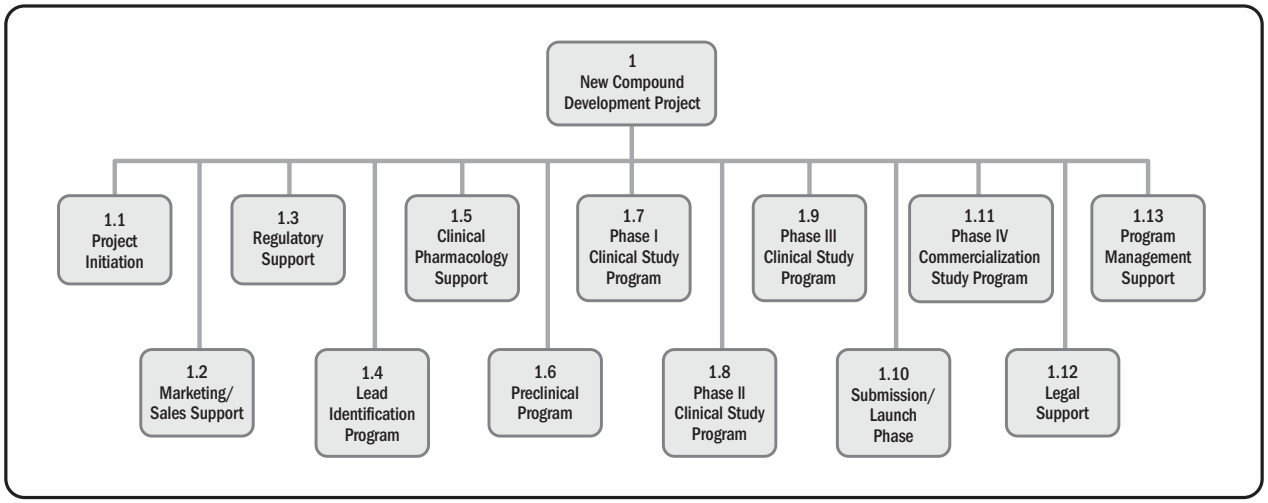


Figure X3-3. New Compound Development Project—WBS Hierarchical Example

Table X3-6. New Compound Development Project—WBS Outline Example

WBS Element
1 New Compound Development Project
1.1 Project Initiation
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 Regulatory Support - IND Submission
1.3.1.1 Pre-IND Meeting
1.3.1.2 IND Preparation
1.3.1.2.1 IND Preparation - Preclinical Package
1.3.1.2.2 IND Preparation - Clinical Package
1.3.1.2.3 IND Preparation - Clinical Pharmacology Package
1.3.1.2.4 IND Preparation - CM and C Package
1.3.1.3 Regulatory Support - IND Submission - IND Submission
1.3.2 Regulatory Support - End of Phase 2 Meeting
1.3.2.1 Pre-Meeting Package
1.3.2.2 Regulatory Support - End of Phase 2 Meeting - End of Phase 2 Meeting
1.3.3 Regulatory Support - BLA/NDA Submission
1.3.3.1 Pre-BLA/NDA Meeting

(continued)

Table X3-6. ***(Continued)***

WBS Element
1.3.3.2 BLA/NDA Preparation
1.3.3.2.1 BLA/NDA Submission - Preclinical Package
1.3.3.2.2 BLA/NDA Submission - Clinical Package
1.3.3.2.3 Clinical Pharmacology Package
1.3.3.2.4 BLA/NDA Submission - CM and C Package
1.3.3.3 Regulatory Support - BLA/NDA Submission - 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
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 Clinical Pharmacology Support - Pharmacokinetic Study(ies)
1.5.2 Clinical Pharmacology Support - Drug Interaction Study(ies)
1.5.3 Clinical Pharmacology Support - Renal Effect Study(ies)

(continued)

Table X3-6. *(Continued)*

WBS Element
1.5.4 Clinical Pharmacology Support - Hepatic Effect Study(ies)
1.5.5 Clinical Pharmacology Support - Bioequivalency Study(ies)
1.5.6 Clinical Pharmacology Support - 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 Preclinical Program - Clinical Pharmacology Support
1.6.2.1 Preclinical Pharmacology Support - Pharmacokinetic Study(ies)
1.6.2.2 Preclinical Pharmacology Support - Drug Interaction Study(ies)
1.6.2.3 Preclinical Pharmacology Support - Renal Effect Study(ies)
1.6.2.4 Preclinical Pharmacology Support - Hepatic Effect Study(ies)
1.6.2.5 Preclinical Pharmacology Support - Bioequivalency Study(ies)
1.6.2.6 Preclinical Pharmacology Support - 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)

(continued)

Table X3-6. ***(Continued)***

WBS Element
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 Report 1 - 10
1.8 Phase II Clinical Study Program
1.8.1 Multiple Dose Efficacy Study(ies)
1.8.2 Phase II Clinical Study Program - Other Clinical Study(ies)
1.9 Phase III Clinical Study Program
1.9.1 Pivotal Registration Study(ies)
1.9.2 Phase III Clinical Study Program - 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
1.11.2 Registry Studies
1.12 Legal Support
1.12.1 Publications
1.12.2 Patents/Intellectual Property

(continued)

Table X3-6. *(Continued)*

WBS Element
1.12.3 Trademarks
1.12.4 Other Legal Support
1.13 Program Management Support
1.13.1 Program-Level Project Management
1.13.2 Preclinical Project Management
1.13.3 Clinical Project Management
1.13.4 CM and C Project Management
1.13.5 Other Project Management Support

X3.4 PROCESS PLANT CONSTRUCTION PROJECT EXAMPLE

Table X3-7 provides WBS characteristics of a process plant construction project, followed by a WBS hierarchical example (Figure X3-4) and a WBS outline example (Table X3-8).

Table X3-7. Process Plant Construction Project—WBS Characteristics

Industry	Type of Decomposition				Life Cycle	
Construction	Action-oriented	X	Phase-oriented		Predictive	X
	Backlog-oriented		Product-oriented		Iterative	
	Contract-oriented		Program-oriented		Incremental	
	Deliverable-oriented	X			Agile	

This WBS example represents the construction of a process plant. This is an example of an engineering project, as the focus is on the design of systems rather than on the startup and commissioning of systems. Optimizing communication between the engineering team and the construction/commissioning team minimizes 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. If the WBS has a system focus, a structure focus, or deliverable focus, the sequence of work is not the purpose of the WBS.

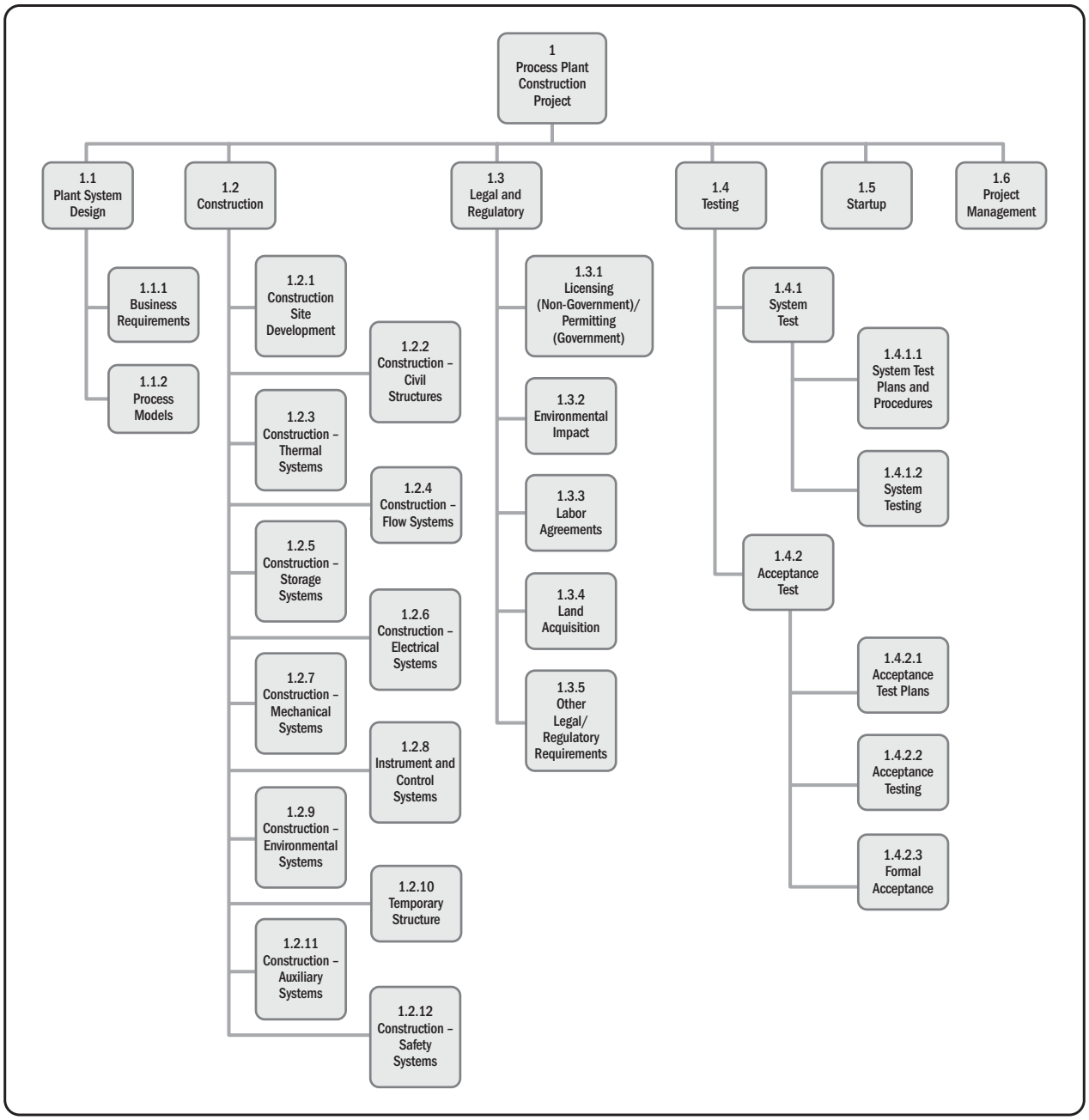


Figure X3-4. Process Plant Construction Project—WBS Hierarchical Example

Table X3-8. Process Plant Construction Project—WBS Outline Example

WBS Element
1 Process Plant Construction Project
1.1 Plant System Design
1.1.1 Business Requirements
1.1.1.1 Business Requirements - System Engineering
1.1.1.2 Business Requirements - Site Development
1.1.1.3 Business Requirements - Civil Structures
1.1.1.4 Business Requirements - Thermal Systems
1.1.1.5 Business Requirements - Flow Systems
1.1.1.6 Business Requirements - Storage Systems
1.1.1.7 Business Requirements - Electrical Systems
1.1.1.8 Business Requirements - Mechanical Systems
1.1.1.9 Business Requirements - Environmental Systems
1.1.1.10 Business Requirements - Instrumentation and Control Systems
1.1.1.11 Business Requirements - Auxiliary Systems
1.1.1.12 Security Systems
1.1.2 Process Models
1.1.2.1 System Engineering
1.1.2.2 Process Models - Site Development
1.1.2.3 Process Models - Civil Structures
1.1.2.4 Process Models - Thermal Systems
1.1.2.5 Process Models - Flow Systems
1.1.2.6 Process Models - Storage Systems

(continued)

Table X3-8. ***(Continued)***

WBS Element
1.1.2.7 Process Models - Electrical Systems
1.1.2.8 Process Models - Mechanical Systems
1.1.2.9 Process Models - Environmental Systems
1.1.2.10 Process Models - Instrumentation and Control Systems
1.1.2.11 Process Models - Auxiliary Systems
1.1.2.12 Process Models - Safety Systems
1.2 Construction
1.2.1 Construction - Site Development
1.2.2 Construction - Civil Structures
1.2.3 Construction - Thermal Systems
1.2.4 Construction - Flow Systems
1.2.5 Construction - Storage Systems
1.2.6 Construction - Electrical Systems
1.2.7 Construction - Mechanical Systems
1.2.8 Instrument and Control Systems
1.2.9 Construction - Environmental Systems
1.2.10 Temporary Structure
1.2.11 Construction - Auxiliary Systems
1.2.12 Construction - Safety Systems
1.3 Legal and Regulatory
1.3.1 Licensing (Non-Government)/Permitting (Government)
1.3.1.1 Licensing (Non-Government)

(continued)

Table X3-8. *(Continued)*

WBS Element
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

(continued)

Table X3-8. ***(Continued)***

WBS Element
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 Start-Up
1.6 Project Management

X3.5 OUTSOURCING PROJECT EXAMPLE

Table X3-9 provides WBS characteristics of an outsourcing project, followed by a WBS hierarchical example (Figure X3-5) and a WBS outline example (Table X3-10).

Table X3-9. Outsourcing Project Example—WBS Characteristics

Industry	Type of Decomposition				Life Cycle	
Service	Action-oriented	X	Phase-oriented		Predictive	X
	Backlog-oriented		Product-oriented		Iterative	
	Contract-oriented		Program-oriented		Incremental	
	Deliverable-oriented	X			Agile	

The unique aspect of this WBS is its inclusion of an RFP (request for proposal) process. This WBS is generic and tailorable for use in a project, and therefore serves as a WBS template.

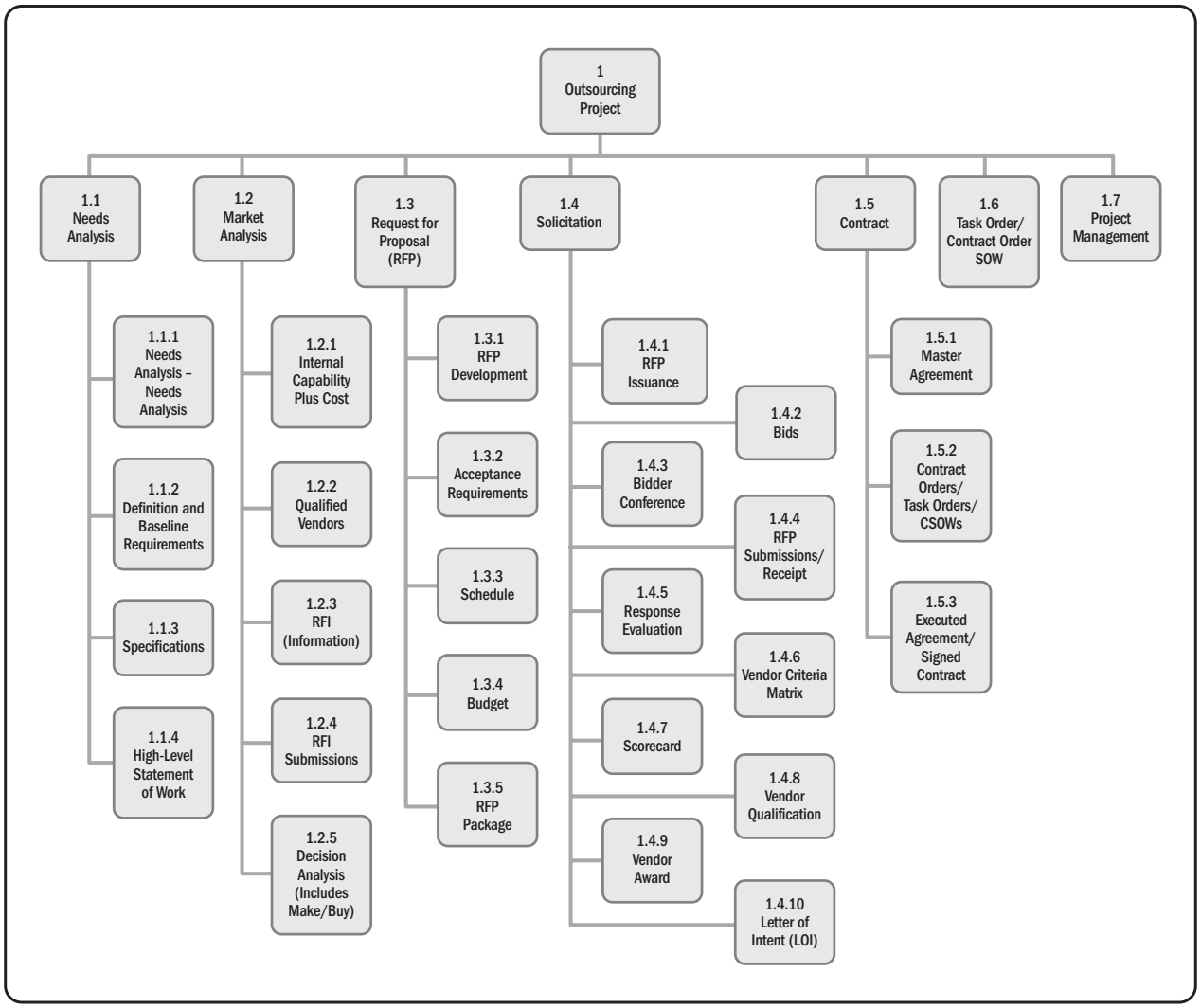


Figure X3-5. Outsourcing Project Example—WBS Hierarchical Example

Table X3-10. Outsourcing Project Example—WBS Outline Example

WBS Element
1 Outsourcing Project
1.1 Needs Analysis
1.1.1 Needs Analysis - 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

(continued)

Table X3-10. ***(Continued)***

WBS Element
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

(continued)

Table X3-10. ***(Continued)***

WBS Element
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

X3.6 WEB DESIGN PROJECT EXAMPLE

Table X3-11 provides WBS characteristics of a web design project, followed by a WBS hierarchical example (Figure X3-6) and a WBS outline example (Table X3-12).

Table X3-11. Web Design Project—WBS Characteristics

Industry	Type of Decomposition				Life Cycle	
Software	Action-oriented	X	Phase-oriented	X	Predictive	X
	Backlog-oriented		Product-oriented	X	Iterative	
	Contract-oriented		Program-oriented		Incremental	
	Deliverable-oriented	X			Agile	

This WBS reflects the design, build, and deploy of a commercial internet website that sells the organization's own products in one country. The high-level phases of the development life cycle reside at Level 2 of the WBS. With all WBS examples, different branches of a WBS decompose to different levels of detail. This WBS is generic and, as such, serves as a WBS template customizable for a specific project.

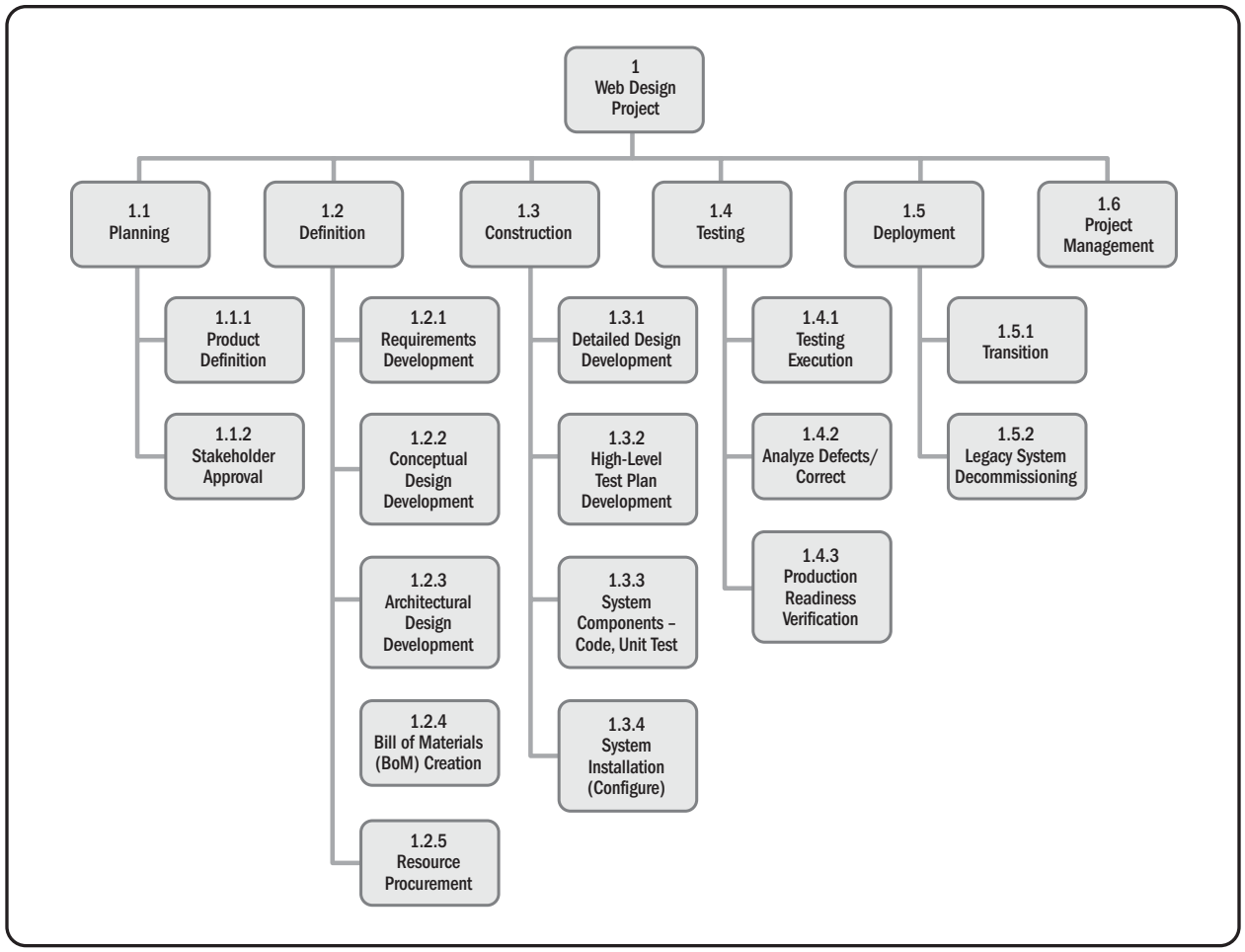


Figure X3-6. Web Design Project—WBS Hierarchical Example

Table X3-12. Web Design Project—WBS Outline Example

WBS Element
1 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

(continued)

Table X3-12. ***(Continued)***

WBS Element
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
1.3.2 High-Level Test Plan Development
1.3.3 System Components - Code, Unit Test
1.3.3.1 Database Components
1.3.3.2 Code/Logic Components
1.3.3.3 Web GUI Interface Components
1.3.4 System Installation (Configure)
1.4 Testing
1.4.1 Testing Execution
1.4.1.1 System Test
1.4.1.2 User Acceptance Test
1.4.1.3 Performance Test
1.4.2 Analyze Defects/Correct
1.4.3 Production Readiness Verification
1.5 Deployment
1.5.1 Transition
1.5.1.1 Support Personnel Training
1.5.1.2 Support Procedures Documentation

(continued)

Table X3-12. *(Continued)*

WBS Element
1.5.1.3 Software
1.5.1.4 Hardware
1.5.2 Legacy System Decommissioning
1.6 Project Management

X3.7 TELECOMMUNICATIONS PROJECT EXAMPLE

Table X3-13 provides WBS characteristics of a telecommunications project, followed by a WBS hierarchical example (Figure X3-7) and a WBS outline example (Table X3-14).

Table X3-13. Telecommunications Project—WBS Characteristics

Industry	Type of Decomposition					Life Cycle	
Telecommunications	Action-oriented	X		Phase-oriented	X	Predictive	X
	Backlog-oriented			Product-oriented		Iterative	
	Contract-oriented			Program-oriented		Incremental	
	Deliverable-oriented	X				Agile	

The following WBS example represents a typical telecommunications project. At level 2, this WBS reflects a basic project life cycle—from creation of the concept through product development, customer acceptance, and ongoing support and maintenance. Each level 2 WBS element includes lower-level deliverables that are specific to that stage and include, among others, reviews and decisions, analyses, tangible deliverables, and services.

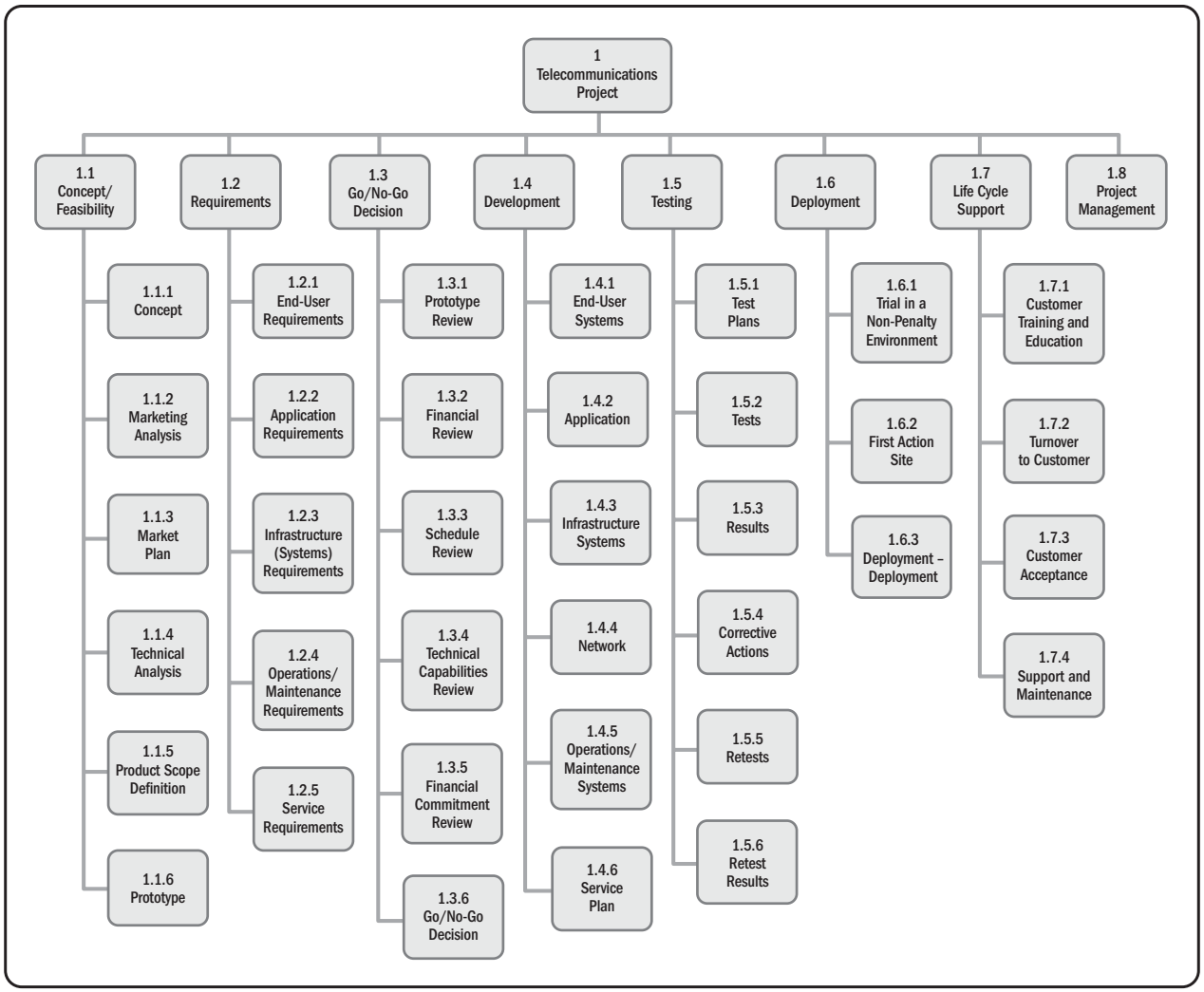


Figure X3-7. Telecommunications Project—WBS Hierarchical Example

Table X3-14. Telecommunications Project—WBS Outline Example

WBS Element
1 Telecommunications 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

(continued)

Table X3-14. ***(Continued)***

WBS Element
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 - Deployment
1.7 Life Cycle Support
1.7.1 Customer Training and Education
1.7.2 Turnover to Customer
1.7.3 Customer Acceptance
1.7.4 Support and Maintenance
1.8 Project Management

X3.8 DESIGN-BID-BUILD PROJECT EXAMPLE

Table X3-15 provides WBS characteristics of a design-bid-build project, followed by a WBS hierarchical example (Figure X3-8) and a WBS outline example (Table X3-16).

Table X3-15. Design-Bid-Build Project—WBS Characteristics

Industry	Type of Decomposition				Life Cycle	
Government	Action-oriented	X	Phase-oriented	X	Predictive	X
	Backlog-oriented		Product-oriented		Iterative	
	Contract-oriented		Program-oriented		Incremental	
	Deliverable-oriented	X			Agile	

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 decomposes to a greater level of detail in specific cases. Because this is a design-bid-build project, each phase represents a significant body of work. For this reason, it makes sense to include certain WBS elements separately within each phase (e.g., project management).

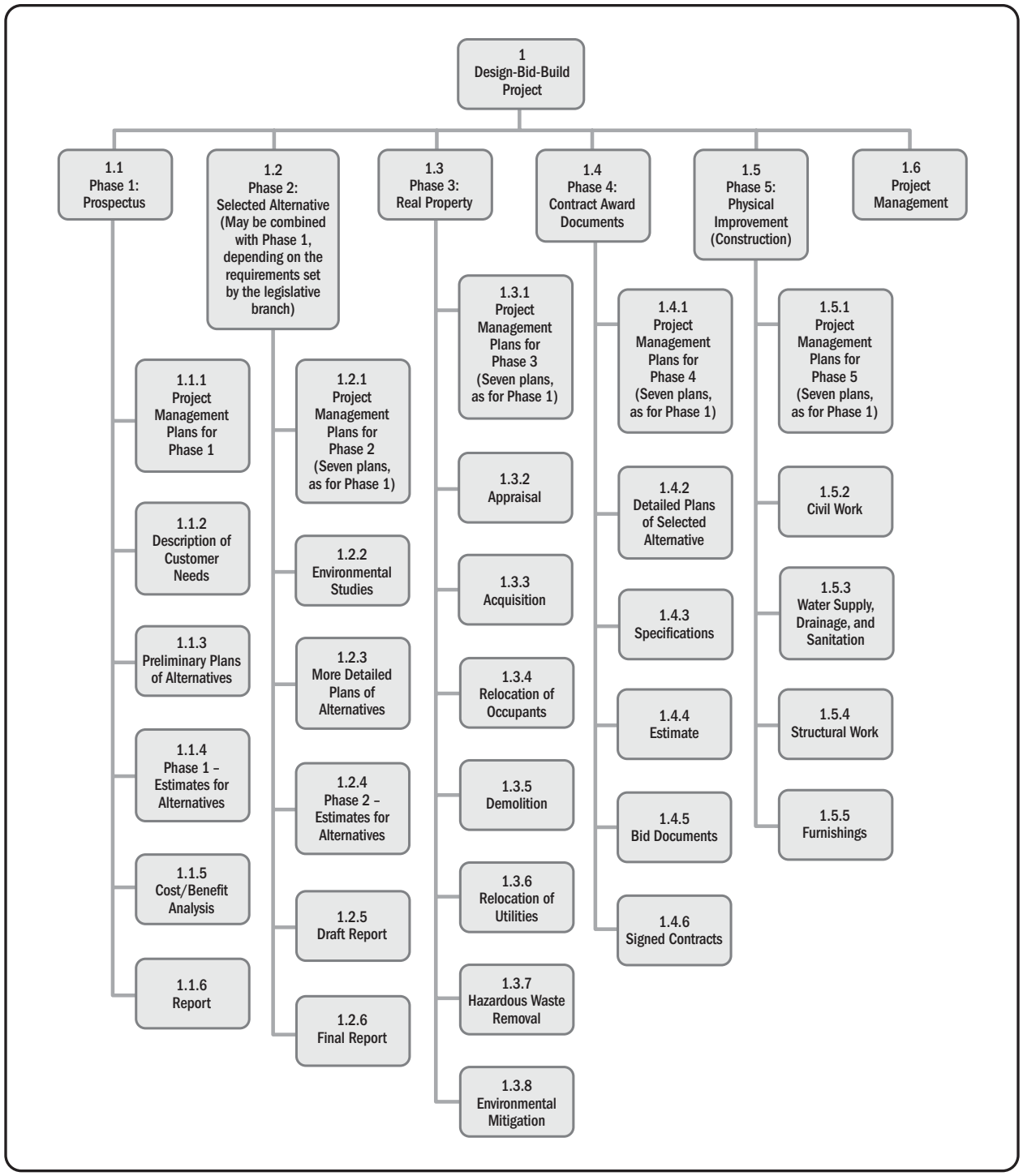


Figure X3-8. Design-Bid-Build Project—WBS Hierarchical Example

Table X3-16. Design-Bid-Build Project—WBS Outline Example

WBS Element
1 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 Phase 1 - 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

(continued)

Table X3-16. ***(Continued)***

WBS Element
1.2.2.5 Social and Economic
1.2.3 More Detailed Plans of Alternatives
1.2.4 Phase 2 - 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

(continued)

Table X3-16. ***(Continued)***

WBS Element
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
1.6 Project Management

X3.9 SOFTWARE IMPLEMENTATION PROJECT EXAMPLE

Table X3-17 provides WBS characteristics of a software implementation project, followed by a WBS hierarchical example (Figure X3-9) and a WBS outline example (Table X3-18).

Table X3-17. Software Implementation Project—WBS Characteristics

Industry	Type of Decomposition				Life Cycle	
General	Action-oriented	X	Phase-oriented	X	Predictive	X
	Backlog-oriented		Product-oriented	X	Iterative	
	Contract-oriented		Program-oriented		Incremental	X
	Deliverable-oriented	X			Agile	

This example illustrates a generic WBS applicable to a range of different software development projects by suitable customization, especially at the lower levels and, as such, is a WBS template. The WBS elements include administration, requirements approvals, configured software, and training.

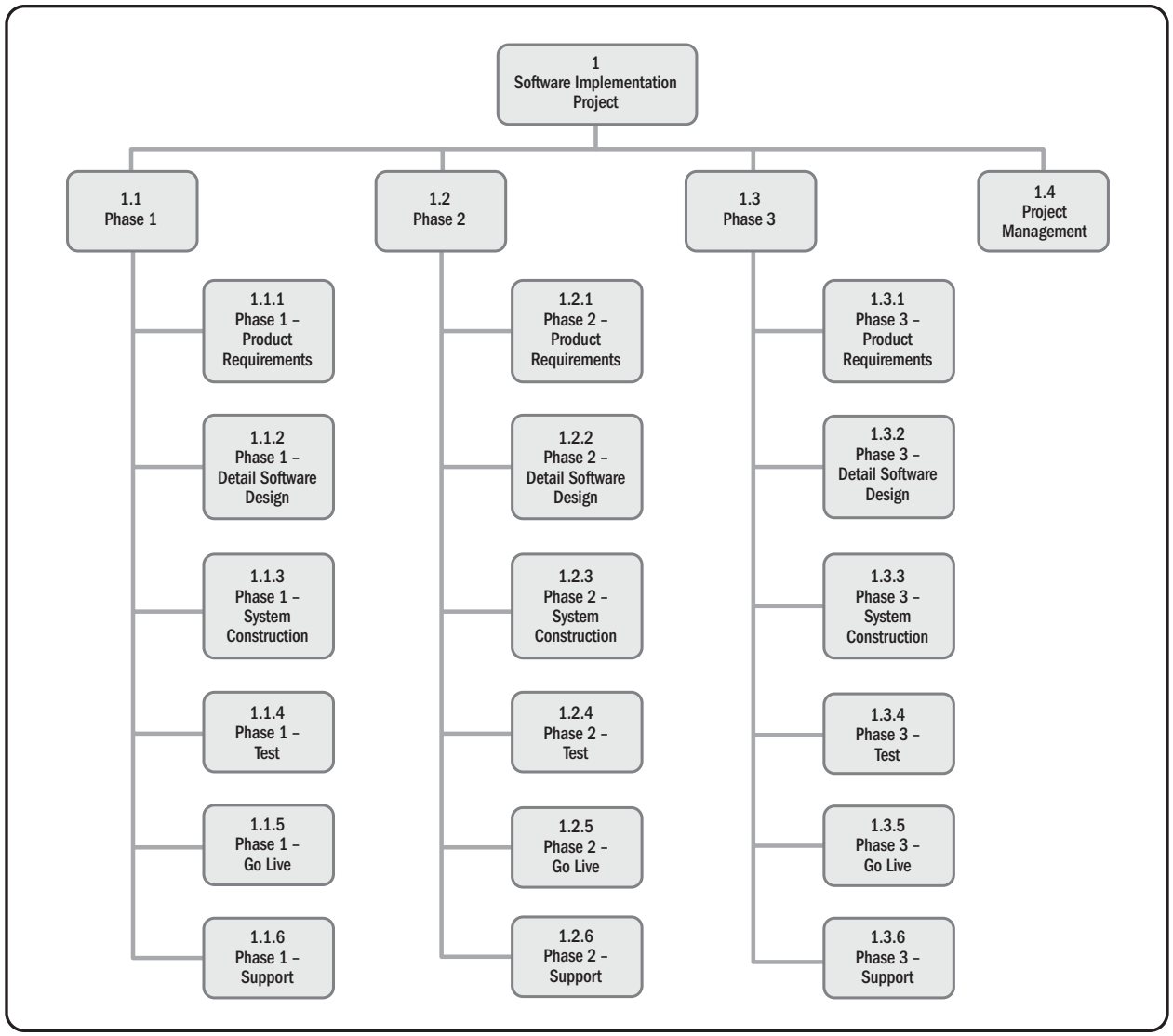


Figure X3-9. Software Implementation Project—WBS Hierarchical Example

Table X3-18. Software Implementation Project—WBS Outline Example

WBS Element
1 Software Implementation Project
1.1 Phase 1
1.1.1 Phase 1 - Product Requirements
1.1.1.1 Phase 1 - Software Requirements
1.1.1.1.1 Phase 1 - Draft Software Requirements
1.1.1.1.2 Phase 1 - Final Software Requirements
1.1.1.1.3 Phase 1 - Software Requirements Approval
1.1.1.2 Phase 1 - User Documentation
1.1.1.2.1 Phase 1 - Draft User Documentation
1.1.1.2.2 Phase 1 - Final User Documentation
1.1.1.2.3 Phase 1 - User Documentation Approval
1.1.1.3 Phase 1 - Training Program Materials
1.1.1.3.1 Phase 1 - Initial Training Requirements
1.1.1.3.2 Phase 1 - Initial Training Materials
1.1.1.3.3 Phase 1 - Trial Course Delivery
1.1.1.4 Phase 1 - Hardware
1.1.1.4.1 Phase 1 - Draft Hardware Requirements
1.1.1.4.2 Phase 1 - Final Hardware Requirements
1.1.1.4.3 Phase 1 - Hardware Requirements Approval
1.1.1.5 Phase 1 - Product Requirements - Implementation and Future Support
1.1.2 Phase 1 - Detail Software Design
1.1.2.1 Phase 1 - Initial Software Design
1.1.2.2 Phase 1 - Final Software Design
1.1.2.3 Phase 1 - Software Design Approval

(continued)

Table X3-18. ***(Continued)***

WBS Element
1.1.3 Phase 1 - System Construction
1.1.3.1 Phase 1 - Configured Software
1.1.3.2 Phase 1 - Customized User Documentation
1.1.3.3 Phase 1 - Customized Training Program Materials
1.1.3.4 Phase 1 - Installed Hardware
1.1.3.5 Phase 1 - System Construction - Implementation and Future Support
1.1.4 Phase 1 - Test
1.1.4.1 Phase 1 - System Test Plan
1.1.4.2 Phase 1 - System Test
1.1.4.3 Phase 1 - System Test Results
1.1.4.4 Phase 1 - Acceptance Test Plan
1.1.4.5 Phase 1 - Acceptance Test Cases
1.1.4.6 Phase 1 - Acceptance Test Results
1.1.4.7 Phase 1 - Approved User Documentation
1.1.5 Phase 1 - Go Live
1.1.6 Phase 1 - Support
1.1.6.1 Phase 1 - Training
1.1.6.2 Phase 1 - End-User Support
1.1.6.3 Phase 1 - Product Support
1.2 Phase 2
1.2.1 Phase 2 - Product Requirements
1.2.1.1 Phase 2 - Software Requirements
1.2.1.1.1 Phase 2 - Draft Software Requirements
1.2.1.1.2 Phase 2 - Final Software Requirements

(continued)

Table X3-18. ***(Continued)***

WBS Element
1.2.1.1.3 Phase 2 - Software Requirements Approval
1.2.1.2 Phase 2 - User Documentation
1.2.1.2.1 Phase 2 - Draft User Documentation
1.2.1.2.2 Phase 2 - Final User Documentation
1.2.1.2.3 Phase 2 - User Documentation Approval
1.2.1.3 Phase 2 - Training Program Materials
1.2.1.3.1 Phase 2 - Initial Training Requirements
1.2.1.3.2 Phase 2 - Initial Training Materials
1.2.1.3.3 Phase 2 - Trial Course Delivery
1.2.1.4 Phase 2 - Hardware
1.2.1.4.1 Phase 2 - Draft Hardware Requirements
1.2.1.4.2 Phase 2 - Final Hardware Requirements
1.2.1.4.3 Phase 2 - Hardware Requirements Approval
1.2.1.5 Phase 2 - Product Requirements - Implementation and Future Support
1.2.2 Phase 2 - Detail Software Design
1.2.2.1 Phase 2 - Initial Software Design
1.2.2.2 Phase 2 - Final Software Design
1.2.2.3 Phase 2 - Software Design Approval
1.2.3 Phase 2 - System Construction
1.2.3.1 Phase 2 - Configured Software
1.2.3.2 Phase 2 - Customized User Documentation
1.2.3.3 Phase 2 - Customized Training Program Materials
1.2.3.4 Phase 2 - Installed Hardware

(continued)

Table X3-18. ***(Continued)***

WBS Element
1.2.3.5 Phase 2 - System Construction - Implementation and Future Support
1.2.4 Phase 2 - Test
1.2.4.1 Phase 2 - System Test Plan
1.2.4.2 Phase 2 - System Test Cases
1.2.4.3 Phase 2 - System Test Results
1.2.4.4 Phase 2 - Acceptance Test Plan
1.2.4.5 Phase 2 - Acceptance Test Cases
1.2.4.6 Phase 2 - Acceptance Test Results
1.2.4.7 Phase 2 - Approved User Documentation
1.2.5 Phase 2 - Go Live
1.2.6 Phase 2 - Support
1.2.6.1 Phase 2 - Training
1.2.6.2 Phase 2 - End-User Support
1.2.6.3 Phase 2 - Product Support
1.3 Phase 3
1.3.1 Phase 3 - Product Requirements
1.3.1.1 Phase 3 - Software Requirements
1.3.1.1.1 Phase 3 - Draft Software Requirements
1.3.1.1.2 Phase 3 - Final Software Requirements
1.3.1.1.3 Phase 3 - Software Requirements Approval
1.3.1.2 Phase 3 - User Documentation
1.3.1.2.1 Phase 3 - Draft User Documentation
1.3.1.2.2 Phase 3 - Final User Documentation

(continued)

Table X3-18. ***(Continued)***

WBS Element
1.3.1.2.3 Phase 3 - User Documentation Approval
1.3.1.3 Phase 3 - Training Program Materials
1.3.1.3.1 Phase 3 - Initial Training Requirements
1.3.1.3.2 Phase 3 - Initial Training Materials
1.3.1.3.3 Phase 3 - Trial Course Delivery
1.3.1.4 Phase 3 - Hardware
1.3.1.4.1 Phase 3 - Draft Hardware Requirements
1.3.1.4.2 Phase 3 - Final Hardware Requirements
1.3.1.4.3 Phase 3 - Hardware Requirements Approval
1.3.1.5 Phase 3 - Product Requirements - Implementation and Future Support
1.3.2 Phase 3 - Detail Software Design
1.3.2.1 Phase 3 - Initial Software Design
1.3.2.2 Phase 3 - Final Software Design
1.3.2.3 Phase 3 - Software Design Approval
1.3.3 Phase 3 - System Construction
1.3.3.1 Phase 3 - Configured Software
1.3.3.2 Phase 3 - Customized User Documentation
1.3.3.3 Phase 3 - Customized Training Program Materials
1.3.3.4 Phase 3 - Installed Hardware
1.3.3.5 Phase 3 - System Construction - Implementation and Future Support
1.3.4 Phase 3 - Test
1.3.4.1 Phase 3 - System Test Plan
1.3.4.2 Phase 3 - System Test Cases

(continued)

Table X3-18. *(Continued)*

WBS Element
1.3.4.3 Phase 3 - System Test Results
1.3.4.4 Phase 3 - Acceptance Test Plan
1.3.4.5 Phase 3 - Acceptance Test Cases
1.3.4.6 Phase 3 - Acceptance Test Results
1.3.4.7 Phase 3 - Approved User Documentation
1.3.5 Phase 3 - Go Live
1.3.6 Phase 3 - Support
1.3.6.1 Phase 3 - Training
1.3.6.2 Phase 3 - End-User Support
1.3.6.3 Phase 3 - Product Support
1.4 Project Management

X3.10 INTERNATIONAL CAR SCHOOL COMPETITION PROJECT EXAMPLE

Table X3-19 provides WBS characteristics of an international car school competition project, followed by a WBS hierarchical example (Figure X3-10) and a WBS outline example (Table X3-20).

Table X3-19. International Car School Competition Project—WBS Characteristics

Industry	Type of Decomposition				Life Cycle	
Academic	Action-oriented		Phase-oriented		Predictive	X
	Backlog-oriented		Product-oriented	X	Iterative	
	Contract-oriented		Program-oriented		Incremental	X
	Deliverable-oriented	X			Agile	

This example WBS represents the deliverables produced for a team to participate in a Formula 1 (F1) in Schools competition. F1 in Schools is an international science, technology, engineering, and mathematics (STEM) competition for school children (ages 11–18). Groups of three to six students design and manufacture a miniature car out of the official F1 Model Block using CAD/CAM design tools. CO_2 cartridges power the cars, and the cars attach to a track by a nylon wire. Computer timing of the cars begins from the moment of launch to when they pass the finish line. This WBS shows a generic view of the deliverables from a team for participation in the competition (car design, presentation, website, uniform design, pit display, promotion, etc.).

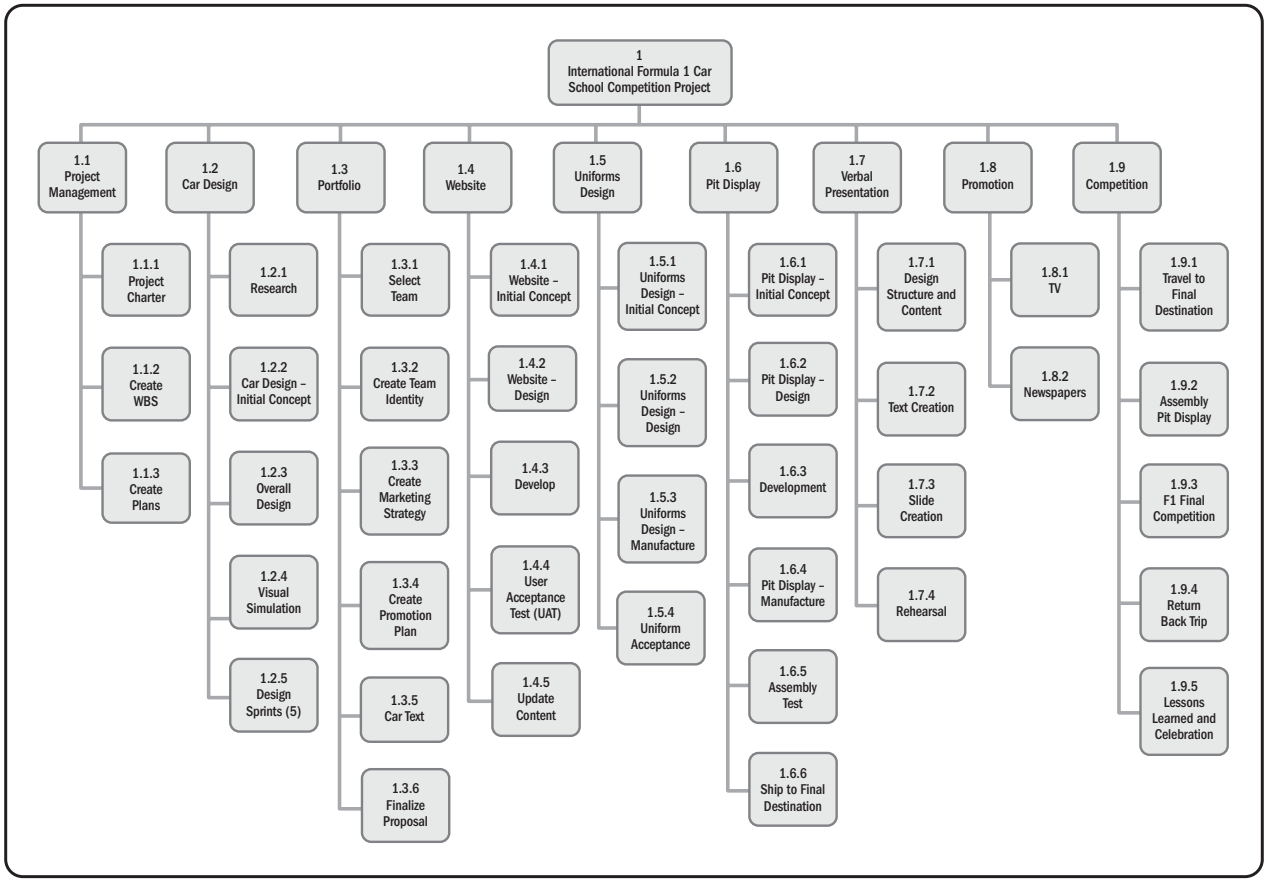


Figure X3-10. International Car School Competition Project—WBS Hierarchical Example

Table X3-20. International Car School Competition Project—WBS Outline Example

WBS Element
1 International Formula 1 Car School Competition Project
1.1 Project Management
1.1.1 Project Charter
1.1.2 Create WBS
1.1.3 Create Plans
1.2 Car Design
1.2.1 Research
1.2.2 Car Design - Initial Concept
1.2.3 Overall Design
1.2.4 Visual Simulation
1.2.5 Design Sprints (5)
1.3 Portfolio
1.3.1 Select Team
1.3.2 Create Team Identity
1.3.3 Create Marketing Strategy
1.3.4 Create Promotion Plan
1.3.5 Car Text
1.3.6 Finalize Proposal
1.4 Website
1.4.1 Website - Initial Concept
1.4.2 Website - Design
1.4.3 Develop

(continued)

Table X3-20. *(Continued)*

WBS Element
1.4.4 User Acceptance Test (UAT)
1.4.5 Update Content
1.5 Uniforms Design
1.5.1 Uniforms Design - Initial Concept
1.5.2 Uniforms Design - Design
1.5.3 Uniforms Design - Manufacture
1.5.4 Uniforms Acceptance
1.6 Pit Display
1.6.1 Pit Display - Initial Concept
1.6.2 Pit Display - Design
1.6.3 Development
1.6.4 Pit Display - Manufacture
1.6.5 Assembly Test
1.6.6 Ship to Final Destination
1.7 Verbal Presentation
1.7.1 Design Structure and Content
1.7.2 Text Creation
1.7.3 Slide Creation
1.7.4 Rehearsal
1.8 Promotion
1.8.1 TV
1.8.2 Newspapers

(continued)

Table X3-20. *(Continued)*

WBS Element
1.9 Competition
1.9.1 Travel to Final Destination
1.9.2 Assembly Pit Display
1.9.3 F1 Final Competition
1.9.4 Return Back Trip
1.9.5 Lessons Learned and Celebration

X3.11 SUBWAY LINE PROGRAM 1 PROJECT EXAMPLE

Table X3-21 provides WBS characteristics of a subway line program, followed by a WBS hierarchical example (Figure X3-11) and a WBS outline example (Table X3-22).

Table X3-21. Subway Line Program 1—WBS Characteristics

Industry	Type of Decomposition					Life Cycle	
Transportation	Action-oriented	X		Phase-oriented	X	Predictive	X
	Backlog-oriented			Product-oriented		Iterative	
	Contract-oriented			Program-oriented	X	Incremental	
	Deliverable-oriented					Agile	

Construction of a new subway/metro line is the program's objective. The program includes civil engineering deliverables (tunnels, underground train stations, and a maintenance depot) and rail-systems deliverables (rolling stock, track systems, power systems, signaling, control and communication systems, etc.). These deliverables require design, procurement, construction, manufacturing, installation, integration, and testing, while the entire endeavor requires management and control. This example is a WBS created from the owner's perspective, where the procurement strategy is to have the two main groups of deliverables (civil structures and rail systems) contracted to two main contractors. As a result, the program comprises two separate projects and various program-level work packages.

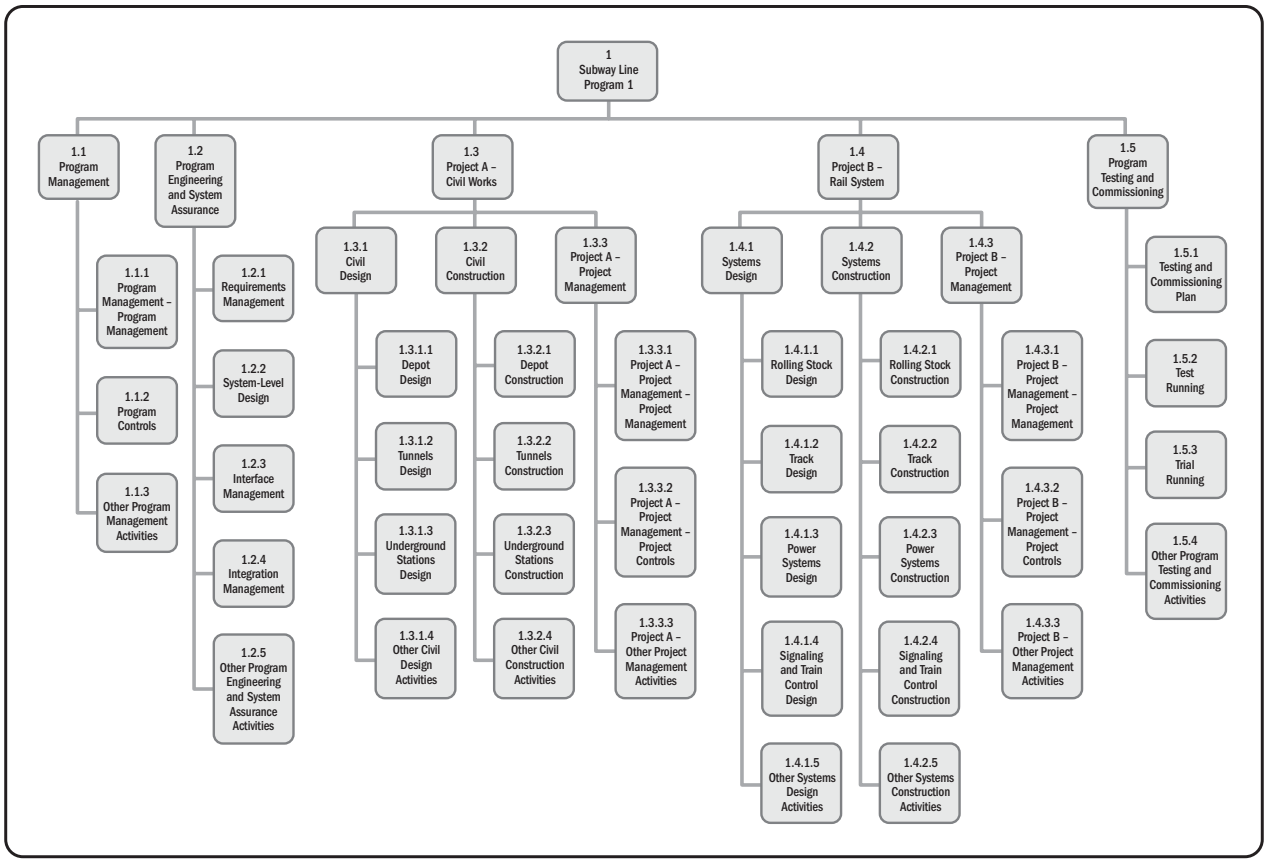


Figure X3-11. Subway Line Program 1—WBS Hierarchical Example

Table X3-22. Subway Line Program 1—WBS Outline Example

WBS Element
1 Subway Line Program 1
1.1 Program Management
1.1.1 Program Management - Program Management
1.1.2 Program Controls
1.1.3 Other Program Management Activities
1.2 Program Engineering and System Assurance
1.2.1 Requirements Management
1.2.2 System-Level Design
1.2.3 Interface Management
1.2.4 Integration Management
1.2.5 Other Program Engineering and System Assurance Activities
1.3 Project A - Civil Works
1.3.1 Civil Design
1.3.1.1 Depot Design
1.3.1.2 Tunnels Design
1.3.1.3 Underground Stations Design
1.3.1.4 Other Civil Design Activities
1.3.2 Civil Construction
1.3.2.1 Depot Construction
1.3.2.2 Tunnels Construction
1.3.2.3 Underground Stations Construction
1.3.2.4 Other Civil Construction Activities
1.3.3 Project A - Project Management
1.3.3.1 Project A - Project Management - Project Management

(continued)

Table X3-22. ***(Continued)***

WBS Element
1.3.3.2 Project A - Project Management - Project Controls
1.3.3.3 Project A - Other Project Management Activities
1.4 Project B - Rail System
1.4.1 Systems Design
1.4.1.1 Rolling Stock Design
1.4.1.2 Track Design
1.4.1.3 Power Systems Design
1.4.1.4 Signaling and Train Control Design
1.4.1.5 Other Systems Design Activities
1.4.2 Systems Construction
1.4.2.1 Rolling Stock Construction
1.4.2.2 Track Construction
1.4.2.3 Power Systems Construction
1.4.2.4 Signaling and Train Control Construction
1.4.2.5 Other Systems Construction Activities
1.4.3 Project B - Project Management
1.4.3.1 Project B - Project Management - Project Management
1.4.3.2 Project B - Project Management - Project Controls
1.4.3.3 Project B - Other Project Management Activities
1.5 Program Testing and Commissioning
1.5.1 Testing and Commissioning Plan
1.5.2 Test Running
1.5.3 Trial Running
1.5.4 Other Program Testing and Commissioning Activities

X3.12 SUBWAY LINE PROGRAM 2 PROJECT EXAMPLE

Table X3-23 provides WBS characteristics of a subway line program, followed by a WBS hierarchical example (Figure X3-12) and a WBS outline example (Table X3-24).

Table X3-23. Subway Line Program 2—WBS Characteristics

Industry	Type of Decomposition				Life Cycle	
Transportation	Action-oriented	X	Phase-oriented	X	Predictive	X
	Backlog-oriented		Product-oriented	X	Iterative	
	Contract-oriented		Program-oriented	X	Incremental	
	Deliverable-oriented	X			Agile	

Construction of a new subway/metro line is the program's objective. The program includes civil engineering deliverables (tunnels, underground train stations, and a maintenance depot) and rail-system deliverables (rolling stock, track systems, power systems, signaling, control and communication systems, etc.). These deliverables require design, procurement, construction, manufacturing, installation, integration, and testing, while the entire endeavor requires management and control. This example is a WBS created from the owner's perspective, where the second level of decomposition includes the projects intended to deliver the final deliverables of the program, regardless of the various engineering disciplines involved. This way each project includes the design, construction, systems installation, and integration and testing of one, all-inclusive major deliverable—tunnel, underground station, and depot. As a result, the program comprises four separate projects and various program-level work packages.

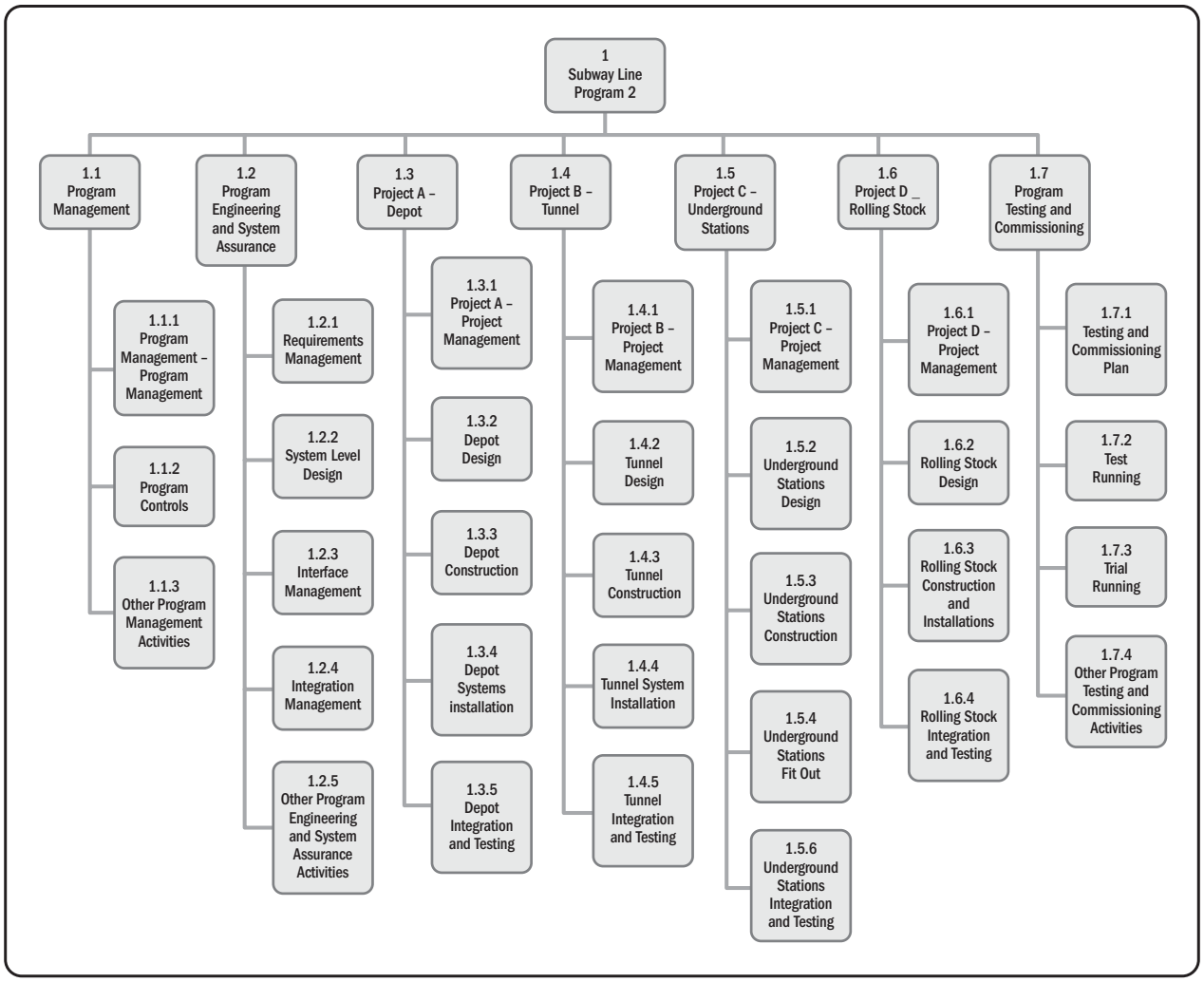


Figure X3-12. Subway Line Program 2—WBS Hierarchical Example

Table X3-24. Subway Line Program 2—WBS Outline Example

WBS Element
1 Subway Line Program 2
1.1 Program Management
1.1.1 Program Management - Program Management
1.1.2 Program Controls
1.1.3 Other Program Management Activities
1.2 Program Engineering and System Assurance
1.2.1 Requirements Management
1.2.2 System-Level Design
1.2.3 Interface Management
1.2.4 Integration Management
1.2.5 Other Program Engineering and System Assurance Activities
1.3 Project A - Depot
1.3.1 Project A - Project Management
1.3.2 Depot Design
1.3.3 Depot Construction
1.3.4 Depot Systems Installation
1.3.5 Depot Integration and Testing
1.4 Project B - Tunnel
1.4.1 Project B - Project Management
1.4.2 Tunnel Design
1.4.3 Tunnel Construction
1.4.4 Tunnel Systems Installation

(continued)

Table X3-24. ***(Continued)***

WBS Element
1.4.5 Tunnel Integration and Testing
1.5 Project C - Underground Stations
1.5.1 Project C - Project Management
1.5.2 Underground Stations Design
1.5.3 Underground Stations Construction
1.5.4 Underground Stations Fit Out
1.5.5 Underground Stations Integration and Testing
1.6 Project D - Rolling Stock
1.6.1 Project D - Project Management
1.6.2 Rolling Stock Design
1.6.3 Rolling Stock Construction and Installations
1.6.4 Rolling Stock Integration and Testing
1.7 Program Testing and Commissioning
1.7.1 Testing and Commissioning Plan
1.7.2 Test Running
1.7.3 Trial Running
1.7.4 Other Program Testing and Commissioning Activities

X3.13 SUBWAY LINE PROGRAM 3 PROJECT EXAMPLE

Table X3-25 provides WBS characteristics of a subway line program, followed by a WBS hierarchical example (Figure X3-13) and a WBS outline example (Table X3-26).

Table X3-25. Subway Line Program 3—WBS Characteristics

Industry	Type of Decomposition				Life Cycle	
Transportation	Action-oriented	X	Phase-oriented	X	Predictive	X
	Backlog-oriented		Product-oriented		Iterative	
	Contract-oriented		Program-oriented	X	Incremental	
	Deliverable-oriented	X			Agile	

Construction of a new subway/metro line is the program's objective. The program includes civil engineering deliverables (tunnels, underground train stations, and a maintenance depot) and rail-systems deliverables (rolling stock, track systems, power systems, signaling, control and communication systems, etc.). These deliverables require design, procurement, construction, manufacturing, installation, integration, and testing, while the entire endeavor requires management and control. This example is a WBS created from the owner's perspective, where the second level of decomposition is the program's main phases. The program life cycle approach prescribes that each major phase—design, procurement, construction, integration, and testing—is contained within a separate project. As a result, the program comprises four separate projects and various program-level work packages.

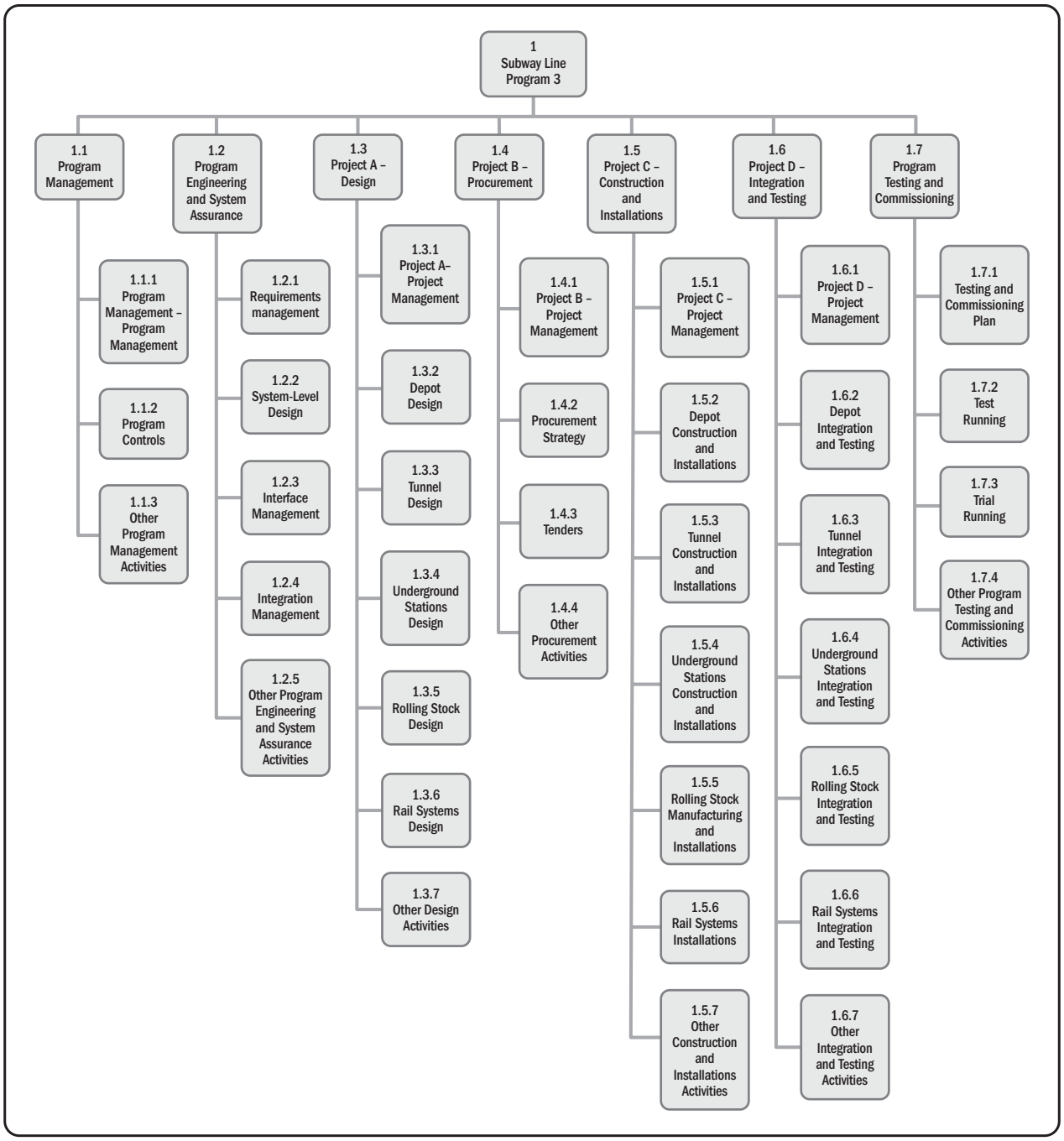


Figure X3-13. Subway Line Program 3—WBS Hierarchical Example

Table X3-26. Subway Line Program 3—WBS Outline Example

WBS Element
1 Subway Line Program 3
1.1 Program Management
1.1.1 Program Management - Program Management
1.1.2 Program Controls
1.1.3 Other Program Management Activities
1.2 Program Engineering and System Assurance
1.2.1 Requirements Management
1.2.2 System-Level Design
1.2.3 Interface Management
1.2.4 Integration Management
1.2.5 Other Program Engineering and System Assurance Activities
1.3 Project A - Design
1.3.1 Project A - Project Management
1.3.2 Depot Design
1.3.3 Tunnel Design
1.3.4 Underground Stations Design
1.3.5 Rolling Stock Design
1.3.6 Rail Systems Design
1.3.7 Other Design Activities
1.4 Project B - Procurement
1.4.1 Project B - Project Management
1.4.2 Procurement Strategy

(continued)

Table X3-26. *(Continued)*

WBS Element
1.4.3 Tenders
1.4.4 Other Procurement Activities
1.5 Project C - Construction and Installations
1.5.1 Project C - Project Management
1.5.2 Depot Construction and Installations
1.5.3 Tunnel Construction and Installations
1.5.4 Underground Stations Construction and Installations
1.5.5 Rolling Stock Manufacturing and Installations
1.5.6 Rail Systems Installations
1.5.7 Other Construction and Installations Activities
1.6 Project D - Integration and Testing
1.6.1 Project D - Project Management
1.6.2 Depot Integration and Testing
1.6.3 Tunnel Integration and Testing
1.6.4 Underground Stations Integration and Testing
1.6.5 Rolling Stock Integration and Testing
1.6.6 Rail Systems Integration and Testing
1.6.7 Other Integration and Testing Activities
1.7 Program Testing and Commissioning
1.7.1 Testing and Commissioning Plan
1.7.2 Test Running
1.7.3 Trial Running
1.7.4 Other Program Testing and Commissioning Activities

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 distinct, scheduled portion of work performed during the course of a project.

Agile. A term used to describe a mindset of values and principles as set forth in the Agile Manifesto.

Agile Life Cycle. An approach that is both iterative and incremental to refine work items and deliver frequently.

Agile Manifesto. The original and official definition of agile values and principles.

Agile Mindset. A way of thinking and behaving underpinned by the four values and twelve principles of the Agile Manifesto.

Agile Principles. The twelve principles of agile project delivery as embodied in the Agile Manifesto.

Backlog. See *Product Backlog*.

Backlog Refinement. The progressive elaboration of project requirements and/or the ongoing activity in which the team collaboratively reviews, updates, and writes requirements to satisfy the need of the customer request.

Child Level. The lower of two levels in the context of a hierarchy, the level immediately below a parent level.

Control Account. A management control point where scope, budget, actual cost, and schedule are integrated and compared to earned value for performance measurement. See also *work package*.

Customer. The person or organization that will use the project's product, service, or result.

Decomposition. A technique used for dividing and subdividing the project scope and project deliverables into smaller, more manageable parts.

Deliverable. Any unique and verifiable product, result, or capability to perform a service that is produced to complete a process, phase, or project.

Hierarchical. Of, relating to, or arranged in a hierarchy.

Hybrid Approach. A combination of two or more agile and non-agile elements, having a non-agile end result.

Increment. A functional, tested, and accepted deliverable that is a subset of the overall project outcome.

Incremental Life Cycle. An approach that provides finished deliverables that the customer may be able to use immediately.

Iteration. A timeboxed cycle of development on a product or deliverable in which all of the work that is needed to deliver value is performed.

Iterative Life Cycle. An approach that allows feedback for unfinished work to improve and modify that work.

Level of Decomposition. The total work broken down into levels where the work packages are assignable and is often guided by the degree of control needed to effectively manage the project.

Level of Effort. An activity that does not produce definitive end products and is measured by the passage of time. [Note: Level of effort is one of the three earned value management (EVM) types of activities used to measure work performance.]

Life Cycle. The process through which a product is imagined, created, and put into use.

Organizational Breakdown Structure. A hierarchical representation of the project organization, which illustrates the relationship between project activities and the organizational units that will perform those activities. See also *resource breakdown structure*, *risk breakdown structure*, and *work breakdown structure (WBS)*.

Parent Level. The upper level of two levels in a hierarchy, the level immediately above the child level.

Phase. See *project phase*.

Portfolio. Projects, programs, subsidiary portfolios, and operations managed as a group to achieve strategic objectives. See also *program* and *project*.

Portfolio Management. The centralized management of one or more portfolios to achieve strategic objectives. See also *program management* and *project management*.

Predictive Approach. An approach to work management that utilizes a work plan and management of that work plan throughout the life cycle of a project.

Predictive Life Cycle. A more traditional approach, with the bulk of planning occurring up-front, then executing in a single pass; a sequential process.

Product Backlog. An ordered list of user-centric requirements that a team maintains for a product.

Product Owner. A person responsible for maximizing the value of the product and who is ultimately responsible and accountable for the end product that is built.

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

Program. Related projects, subsidiary programs, and program activities managed in a coordinated manner to obtain benefits not available from managing them individually.

Program Management. The application of knowledge, skills, and principles to a program to achieve the program objectives and to obtain benefits and control not available by managing program components individually. See also *portfolio management* and *project management*.

Program Management Office. A management structure that standardizes the program-related governance processes and facilitates the sharing of resources, methodologies, tools, and techniques. See also *project management office*.

Progressive Elaboration. The iterative process of increasing the level of detail in a project management plan as greater amounts of information and more accurate estimates become available.

Project. A temporary endeavor undertaken to create a unique product, service, or result. See also *portfolio* and *program*.

Project Management Office. A management structure that standardizes the project-related governance processes and facilitates the sharing of resources, methodologies, tools, and techniques. See also *program management office*.

Project Phase. A collection of logically related project activities that culminates in the completion of one or more deliverables.

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

Resource Breakdown Structure. A hierarchical representation of resources by category and type. See also *organizational breakdown structure*, *risk breakdown structure*, and *work breakdown structure (WBS)*.

Responsibility Assignment Matrix. A grid that shows the project resources assigned to each work package.

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

Rolling Wave Planning. An iterative planning technique in which the work to be accomplished in the near term is planned in detail, while the work in the future is planned at a higher level.

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.

Scope Statement. The description of the project scope, major deliverables, assumptions and constraints.

Sprint. Describes a timeboxed iteration in Scrum.

Stakeholder. An individual, group, or organization that may affect, be affected by, or perceive itself to be affected by a decision, activity, or outcome of a project, program, or portfolio.

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.

Timebox. A fixed period of time, for example, 1 week, 1 fortnight, 3 weeks, or 1 month. See also *Iteration*.

Types of Decomposition. One or more selections to guide the hierarchy design: action-oriented, backlog-oriented, contract-oriented, deliverable-oriented, phase-oriented, product-oriented, or program-oriented.

User Story. A brief description of deliverable value for a specific user. It is a promise for a conversation to clarify details.

WBS Dictionary. A document that provides detailed deliverable, activity, and scheduling information about each component in the work breakdown structure. See also *work breakdown structure (WBS)*.

Work Breakdown Structure (WBS). A hierarchical decomposition of the total scope of work to be carried out by the project team to accomplish the project objectives and create the required deliverables. See also *organizational breakdown structure*, *resource breakdown structure*, *risk breakdown structure*, and *WBS dictionary*.

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

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. The work defined at the lowest level of the work breakdown structure for which cost and duration are estimated and managed. See also *control account*.

INDEX

C

D

E

F

G

H

I

Q

R

S

T

U

V

W

Practice Standard for Work Breakdown Structures – Third Edition

The work breakdown structure (WBS) is an essential component of the planning process of all project types, whether external or internal facing, regardless of industry or discipline. The WBS organizes the total scope of a project and reflects the work specified for the approved project scope. The WBS serves as an essential tool for the project team to overcome large project uncertainties.

The WBS is a key input to the project's schedule, budget, risk, and performance tracking and serves as a cross-discipline foundation upon which to report project status and progress in a unified and standard manner. The WBS also functions as a mechanism to balance management's need for control through the appropriate level-of-detail representation.

As a comprehensive update to the *Practice Standard for Work Breakdown Structures* – Second Edition, the third edition applies the WBS to the predictive, iterative, incremental, and agile project life cycles; it also explores several different types of decomposition in practice today.

The *Practice Standard for Work Breakdown Structures* – Third Edition aligns with other recent PMI standards, including *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)* – Sixth Edition. This practice standard provides practitioners with a useful tool to create a valuable, high-quality WBS for portfolios, programs, and projects.

Project Management Institute
GLOBALSTANDARD

Project Management Institute
Global Headquarters
14 Campus Blvd
Newtown Square, PA 19073 USA
Tel: +1 610 356 4600
PMI.org

ISBN: 978-1-62825-619-2 U.S. $63.95
56395
9 781628 256192