

How to Develop Work Breakdown Structures



Michael D. Taylor

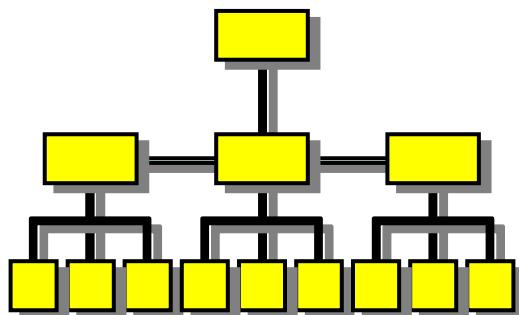
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WORK BREAKDOWN STRUCTURES

"A Work Breakdown Structure is a deliverable-oriented hierarchical decomposition of the work to be executed by the project team to accomplish the project objectives and create the required deliverables."¹

A Work Breakdown Structure (WBS) is a fundamental project management technique for defining and organizing the total scope of a project, using a hierarchical tree structure. The first two levels of the WBS (the root node and Level 2) define a set of *planned outcomes* that collectively and exclusively represent 100% of the project scope. At each subsequent level, the children of a parent node collectively and exclusively represent 100% of the scope of their parent node.



A well-designed WBS describes planned outcomes instead of planned actions. Outcomes are the desired ends of the project, such as a product, result, or service, and can be predicted accurately. Actions, on the other hand, may be difficult to predict accurately. A well-designed WBS makes it easy to assign any project activity to one and only one terminal element of the WBS.

TYPES OF WORK BREAKDOWN STRUCTURES

Even though the term “Work Breakdown Structure” has been used as a label for all project scope hierarchical diagrams, there are, in practice, many types other than “deliverable” oriented structures.

¹ A Guide to the Project Management Body of Knowledge, (Newton Square, PA: Project Management Institute, 2004).

Verb-oriented WBS: a task-oriented WBS defines the deliverable of project work in terms of the actions that must be done to produce the deliverable. The first word in a given WBS element usually is a verb, such as, design, develop, optimize, transfer, test, etc.

Noun-oriented WBS: a deliverable-oriented WBS defines project work in terms of the components (physical or functional) that make up the deliverable. In this case, the first word in a given WBS element is a noun, such as, Module A, Subsystem A, Automobile Engine, Antenna, etc. Since the nouns are usually parts of a product, this WBS type is sometimes called a “Product Breakdown Structure (PBS). Deliverable-oriented WBS structures are the preferred type according to PMI’s definition.

Time-phased WBS: a “time-phased” WBS is one that is used on very long projects. It breaks the project into major phases instead of tasks. In this type, a “rolling wave” approach is adopted and only the near-term phase is planned in detail.

Other WBS types may include organization-types, geographical-types, cost breakdown types, and profit-center types.

WBS DESIGN PRINCIPLES

The 100% Rule

One of the most important WBS design principles is called the 100% Rule. The *Practice Standard for Work Breakdown Structures (Second Edition)*, published by the Project Management Institute (PMI) defines the 100% Rule as follows:

The 100% Rule...states that the WBS includes 100% of the work defined by the project scope and captures ALL deliverables – internal, external, interim – in terms of the work to be completed, including project management. The 100% rule is one of the most important principles guiding the development, decomposition and evaluation of the WBS. The rule applies at all levels within the hierarchy: the sum of the work at the “child” level must equal 100% of the work represented by the “parent” and the WBS should not include any work that falls outside the actual scope of the project, that is, it cannot include more than 100% of the work... It is important to remember that the 100% rule also applies to the activity level. The work represented by the activities in each work package must add up to 100% of the work necessary to complete the work package.

Planned Outcomes, Not Planned Actions

If the WBS designer attempts to capture any action-oriented details in the WBS, he/she will likely include either too many actions or too few actions. Too many actions will exceed 100% of the parent's scope and too few will fall short of 100% of the parent's scope. The best way to adhere to the 100% Rule is to define WBS elements in terms of outcomes or results. This also ensures that the WBS is not overly prescriptive of methods, allowing for greater ingenuity and creative thinking on the part of the project participants. For new product development projects, the most common technique to assure an *outcome-oriented* WBS is to use a product breakdown structure (PBS).

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Feature-driven software projects may use a similar technique which is to employ a feature breakdown structure. When a project provides professional services, a common technique is to capture all planned deliverables to create a *deliverable-oriented* WBS. Work breakdown structures that subdivide work by project phases (e.g. Preliminary Design Phase, Critical Design Phase) must ensure that phases are clearly separated by a deliverable (e.g. an approved Preliminary Design Review document, or an approved Critical Design Review document).

Level 2 is the Most Important

Of all the levels on a WBS, Level-2 is often the most important because it determines how actual costs and schedule data are grouped for future project cost and schedule estimating. A project manager may find it useful to know how much it took to design (major work element) a product after it had been completed so that the data can be used for future analogous estimating. In other cases, the project manager may want to know how much a major part of the product actually cost after the project was completed. For this a PBS would be used. Level-2 is therefore used to capture “actuals” from a project for future estimating purposes.

The Four Elements in Each WBS Element

Each WBS element, when completed should contain the following **four items**:

1. The scope of work, including any “**deliverables**.”
2. The beginning and end dates for the scope of work.
3. The budget for the scope of work.
4. The name of the person responsible for the scope of work.

By using a WBS in this manner the project manager can approach a complex project and decompose it into manageable, assignable portions. There is minimal confusion among project members when this technique is used.

Mutually-exclusive Elements

In addition to the 100% Rule, it is important that there is no overlap in scope definition between two elements of a WBS. This ambiguity could result in duplicated work or miscommunications about responsibility and authority. Likewise, such overlap is likely to cause confusion regarding project cost accounting. If the WBS element names are ambiguous, a WBS dictionary can help clarify the distinctions between WBS elements

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How Far Down?

The WBS is decomposed down to the work package level. A work package is the lowest level in the WBS, and is the point at which the cost and schedule for the work can be reliably estimated.²

A question to be answered in the design of any WBS is when to stop dividing work into smaller elements. If a WBS terminal elements are defined too broadly, it may not be possible to track project performance effectively. If a WBS terminal elements are too granular, it may be inefficient to keep track of so many terminal elements, especially if the planned work is in the distant future. A satisfactory tradeoff may be found in the concept of *progressive elaboration* which allows WBS details to be progressively refined before work begins on an element of work.

An effective limit of WBS granularity may be reached when it is no longer possible to define *planned outcomes*, and the only details remaining are

One form of progressive elaboration in large projects is called *rolling wave planning* which establishes a regular time schedule for progressive elaboration. In reality, an effective limit of WBS granularity may be reached when it is no longer possible to define *planned outcomes*, and the only details remaining are actions. Unless these actions can be defined to adhere to the 100% Rule, the WBS should not be further subdivided.

² PMBOK

The 40-Hour Rule of Decomposition

Another rule-of-thumb for determining how far down a WBS should be decomposed is called the “40 Hour Rule.” Generally, when a project has been decomposed down to an element that has about 40 hours of allocated direct labor, there is no need to decompose further. The 40 Hour Rule is based on a 40-hour work week. Because of this, most WBS diagrams are not symmetrical. Some legs may go down to Level-4 while others may go down to Level-5.

The 4% Rule of Decomposition

Gary Heerkens suggests a 4% Rule for decomposing a WBS. With this rule a WBS is adequately decomposed when the lowest element is about 4% of the total project.³ For a 26-week schedule, the lowest element should be about one week. For a \$2.6M project, the lowest level should be about \$104K.

WBS Identification Numbering

It is common for WBS elements to be numbered sequentially to reveal the hierarchical structure. For example *1.3.2 Rear Wheel* identifies this item as a Level 3 WBS element, since there are three numbers separated decimal point. A coding scheme also helps WBS elements to be recognized in any written context.

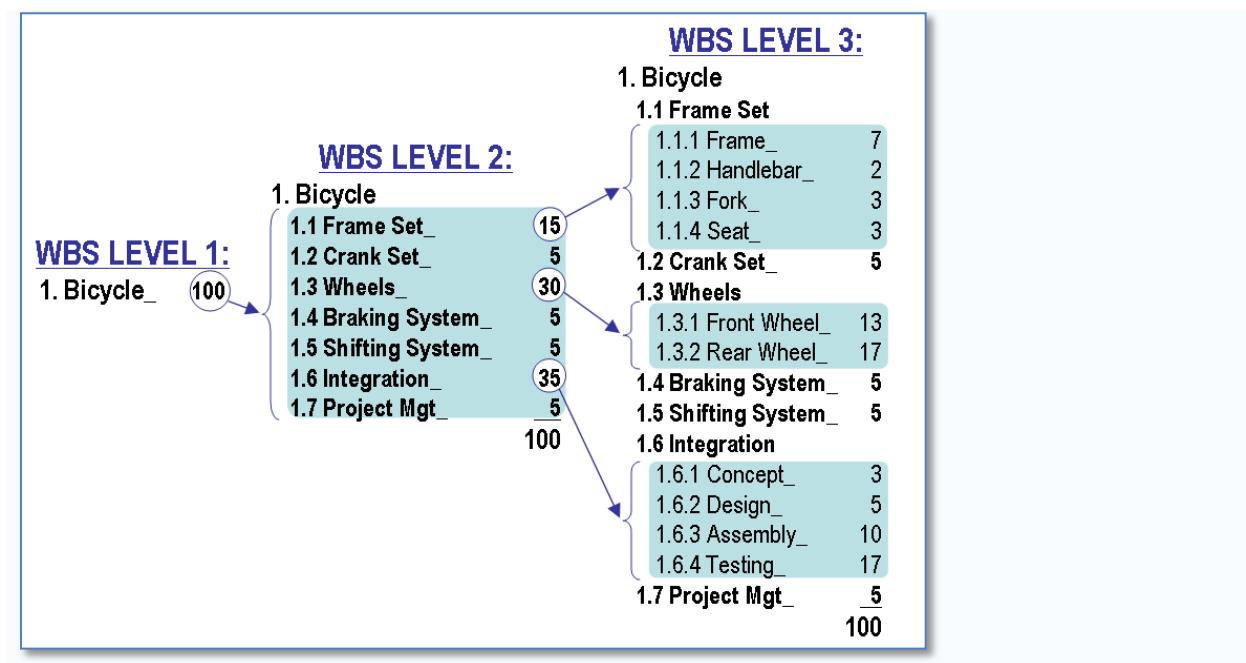


Figure 1 WBS Construction Example

The above WBS is from PMI's *Practice Standard for Work Breakdown Structures (2nd Edition)*. This image illustrates an objective method of employing the 100% Rule during WBS construction.

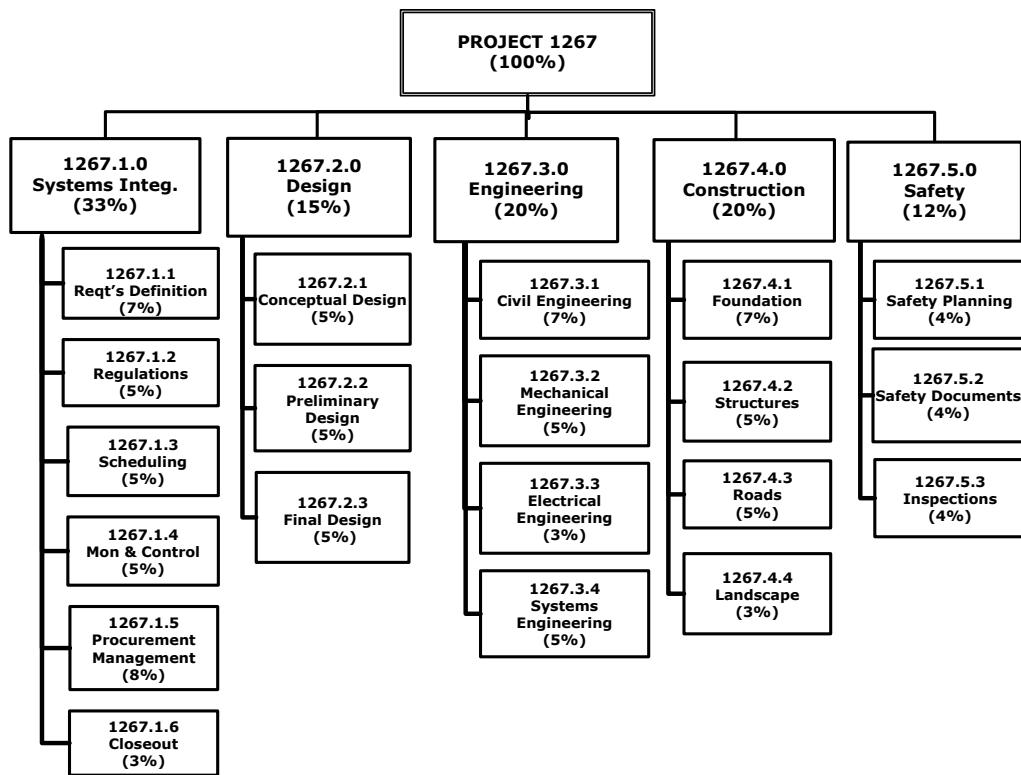
³ Gary R. Heerkens, *Project Management* (New York, NY: McGraw-Hill Publishers, 2002) p. 103, 122.

Figure 1 shows a WBS construction technique that demonstrates the 100% Rule quantitatively. At the beginning of the design process, the project manager has assigned 100 points to the total scope of this project, which is designing and building a custom bicycle. At WBS Level 2, the 100 total points are subdivided into seven comprehensive elements. The number of points allocated to each is a judgment based on the relative effort involved; it is NOT an estimate of duration. The three largest elements of WBS Level 2 are further subdivided at Level 3, and so forth. The largest terminal elements at Level 3 represent only 17% of the total scope of work. These larger elements may be further subdivided using the *progressive elaboration* technique described above.

In this example, the WBS coding scheme includes a trailing "underscore" character ("_") to identify terminal elements. This is a useful coding scheme because planned project schedule activities (e.g. "Install inner tube and tire") will be assigned to terminal elements instead of parent elements.

It is recommended that WBS design be initiated with interactive software (e.g. a spreadsheet) that allows automatic rolling up of point values. Another recommended practice is to discuss the point estimations with project team members. This collaborative technique builds greater insight into scope definitions, underlying assumptions, and consensus regarding the level of granularity required to manage the project.

Another example of a Project WBS using the 100% Method is shown below.



COMMON PITFALLS AND MISCONCEPTIONS

A WBS is not an exhaustive list of work. It is instead a comprehensive classification of project scope.

A WBS is not a project plan or a project schedule and it is not a chronological listing. It is considered poor practice to construct a project schedule (e.g. using project management software) before designing a proper WBS. This would be similar to scheduling the activities of home construction before completing the house design. Without concentrating on planned outcomes, it is very difficult to follow the 100% Rule at all levels of the WBS hierarchy. It is not possible to recover from an improperly defined WBS without starting over, so it is worthwhile to finish the WBS design before starting a project plan or project schedule.

A WBS is not an organizational hierarchy. Some practitioners make the mistake of creating a WBS that shadows the organizational chart. While it is common for responsibility to be *assigned* to organizational elements, a WBS that shadows the organizational structure is not descriptive of the project scope and is not outcome-oriented.

Short-term memory capacity should not dictate the size and span of a WBS tree structure. Some reference material suggests that each WBS level be limited to 5-9 elements because that is a theoretical limit to short-term memory. It is far more important to construct a logical grouping of planned outcomes than to worry about the limits of short-term human memory.

WBS updates, other than progressive elaboration of details, require formal change control. This is another reason why a WBS should be outcome-oriented and not be prescriptive of methods. Methods can and do change frequently, but changes in planned outcomes require a higher degree of formality. If outcomes and actions are blended, change control may be too rigid for actions and too informal for outcomes.

WBS Checklist

- The top element of the WBS is the overall deliverable of the project, and all stakeholders agree with it.
- The first two levels of the WBS (the root node and Level 2) define a set of planned outcomes that collectively and exclusively represent 100% of the project scope.
- The WBS elements are defined in terms of outcomes or results. (Outcomes are the desired ends of the project, and can be predicted accurately).
- Each WBS element has an identification number assigned which identifies its relative position within the structure.

- The WBS encompasses everything that will ultimately comprise the project deliverable, and all deliverables in the project are included.
- Each WBS element contains the following four items:
 - The scope of work, including any “deliverables.”
 - The beginning and end dates for the scope of work.
 - The budget for the scope of work.
 - The name of the person responsible for the scope of work.
- There is no overlap in scope definition between two elements of a WBS.
- The WBS is not a project plan or a project schedule, and it is not a chronological listing.
- In the judgment of all parties involved, the WBS has been decomposed and it is no longer possible to define planned outcomes--the only details remaining are actions.
- The WBS is not an exhaustive list of work. It is instead a comprehensive classification of project scope.
- The WBS is not an organizational hierarchy.
- In the judgment of all parties involved, the WBS is neither over-simplified or overly complex. It provides an adequate graphical or outline form for viewing the overall scope of the project.

Where to Get More Information

- Carl L. Pritchard. *Nuts and Bolts Series 1: How to Build a Work Breakdown Structure*. ISBN 1-890367-12-5
- Dennis P. Miller, *Visual Project Planning & Scheduling, Second Edition* (2002). ISBN 0-9640630-2-6 (Note: This e-book is essential a facilitator's guide for planning a project based on the WBS.)
- Gary R. Heerkens. *Project Management*. (New York, NY: McGraw-Hill Publishers, 2002). ISBN 0-07-137952-5.
- Gregory T. Haugan. *Effective Work Breakdown Structures (The Project Management Essential Library Series)*. ISBN 1-56726-135-3.
- Project Management Institute. *Project Management Institute Practice Standard for Work Breakdown Structures, Second Edition* (2006). ISBN 1-933890-13-4 (Note: The Second Edition is an extensive re-write of the Practice Standard).
- Robert Wysocki. *Effective Project Management: Traditional, Adaptive, Extreme*. Indianapolis, IN: Wiley Publishing, 2003.