

Module 5: Implementation**Technical Annex****Work Breakdown Structure****A. Introduction**

A work breakdown structure (WBS) is a fundamental project management technique for defining and organising the total scope of a project, using a hierarchical tree structure¹. A well-designed WBS describes planned outcomes instead of planned actions. Outcomes are the desired ends of the project, and can be predicted accurately; actions comprise the project plan and may be difficult to predict accurately. A well-designed WBS makes it easy to assign any project activity to one and only one terminal element² of the WBS.

This technical annex briefly introduces the technique and its design principles, provides an example for its application, and outlines common pitfalls and misconceptions.

B. 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)*³ 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-

¹ A tree structure is a way of representing the hierarchical nature of a structure in a graphical form. It is named a "tree structure" because the graph looks a bit like a tree, even though the tree is generally shown upside down compared with a real tree; that is to say with the root at the top and the leaves at the bottom.

² In project management, a terminal element is the lowest element (activity or deliverable) in a work breakdown structure (WBS); it is not further subdivided. Terminal elements are the items that are estimated in terms of resource requirements, budget and duration, linked by dependencies and scheduled.

³ See also: <http://www.pmi.org/info/default.asp>

oriented WBS is to use a product breakdown structure⁴. 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 also used in defining Entry and Exit Criteria (e.g. an approved Preliminary Design Review document, or an approved Critical Design Review document).

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. The WBS Dictionary describes each component of the WBS with milestones, deliverables, activities, scope, and sometimes dates, resources, costs, quality, etc.

Level of Detail (Granularity) and Progressive Elaboration

A question to be answered in the design of any WBS is when to stop dividing work into smaller elements. If WBS terminal elements are defined too broadly, it may not be possible to track project performance effectively. If 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 trade off 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. 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.

WBS Coding Scheme

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 recognised in any written context.

C. WBS Construction Example

The figure below 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,

⁴ In project management, a product breakdown structure (PBS) is an exhaustive, hierarchical tree structure of components that make up an item, arranged in whole-part relationship. A PBS can help clarify what is to be delivered by the project and can help build a work breakdown structure.

the WBS coding scheme includes a trailing "underscore" character ("_") to identify terminal elements. This is a useful coding scheme because planned activities (e.g. "Install inner tube and tire") will be assigned to terminal elements instead of parent elements. Incidentally, this quantitative method is related to the Earned Value Management technique⁵.

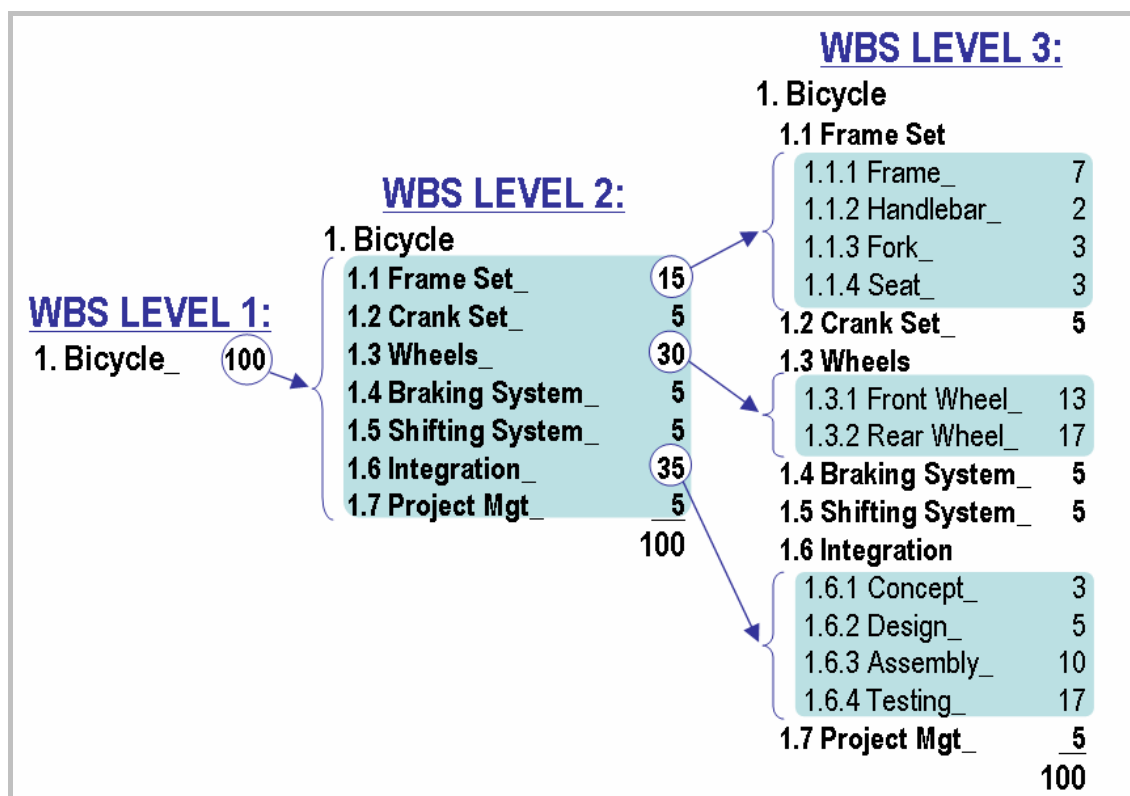


Figure 1: WBS Construction Technique

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.

D. Common Pitfalls and Misconceptions

WBS is characterised by the following 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

⁵ Earned value management (EVM) is a project management technique that measures forward progress objectively. EVM has the unique ability to combine measurements of technical performance (i.e., accomplishment of planned work), schedule performance (i.e., behind / ahead of schedule), and cost performance (i.e., under/over budget) within a single integrated methodology. EVM provides an early warning of performance problems while there is time for corrective action. In addition, EVM improves the definition of project scope, prevents scope creep, communicates objective progress to stakeholders, and keeps the project team focused on achieving progress.

management software⁶) 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 organisational hierarchy. Some practitioners make the mistake of creating a WBS that shadows the organisational chart. While it is common for responsibility to be *assigned* to organisational elements, a WBS that shadows the organisational structure is not descriptive of the project scope and is not outcome-oriented. See also: responsibility assignment matrix⁷.
- ❑ Short-term memory capacity should not dictate the size and span of a WBS tree structure. Some reference material suggest that each WBS level be limited to 5 - 9 elements because that is a theoretical limit to short-term memory. Such advice is part of the urban legend regarding "The Magical Number Seven, Plus or Minus Two"⁸, since WBS elements are certainly not random unconnected data. Definitive references regarding WBS construction do not contain such advice. 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.

References and Sources for Further Reading

- [1] Wikipedia 2007: Work Breakdown Structure.
http://en.wikipedia.org/wiki/Work_breakdown_structure

⁶ Project management software is a term covering many types of software, including scheduling, resource allocation, collaboration software, communication and documentation systems, which are used to deal with the complexity of large projects.

⁷ Responsibility assignment matrix (RAM) is typically used to link activities to resources to ensure that the scope's components are each assigned to an individual or team.

⁸ "The Magical Number Seven, Plus or Minus Two: Some Limits on Our Capacity for Processing Information" is a 1956 paper by the cognitive psychologist George A. Miller. In it Miller showed a number of remarkable coincidences between the channel capacity of a number of human cognitive and perceptual tasks. In each case, the effective channel capacity is equivalent to between 5 and 9 equally-weighted error-less choices.