"Breaking Down" The Work Breakdown Structure

The WBS is the Beginning of Everything Else in the Acquisition Process

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A WBS is a product-oriented family tree, composed of hardware, software, services, data, facilities, testing, and everything else resulting from a system engineering process. Whenever an organization has a large project to manage—whether organizing a picnic for several hundred people or developing a major weapon system—breaking down the effort into manageable parts is the first step.

DoD and large commercial contractors use a specific format, called a Work Breakdown Structure (WBS), to organize the breakdown of work into small areas and parts. Organized as a hierarchical structure, the WBS depicts a relationship between the largest and the smallest elements.

WBS Types

There are two types of WBS: *Program* WBS and *Contract* WBS. In the Program WBS, the government develops Levels 1 to 3. In the Contract WBS, the contractor develops all levels below Level 3. Developed prior to program initiation, the Program WBS encompasses the entire overall effort (big picture) of the program. To illustrate, Figure 1 represents a very simple WBS—a diagram of a new house (to be constructed).

Level 4 and below would represent the beginning of the Contract WBS. The Contract WBS is developed by the contractor and covers all of the products and services that the contractor is responsible to produce and perform. Contractors will take the government's Pro-

The B-2 Bomber, with its unique flying wing configuration, was designed as a highly versatile multi-role bomber, capable of delivering both nuclear and conventional munitions. Over 200 Configuration Items were identified on the Work Breakdown Structure for the B-2. The advanced state of stealth technology (materials and manufacturing process) used on the aircraft required extra attention by the program management team. Over 900 new manufacturing processes had to be invented to develop the B-2.

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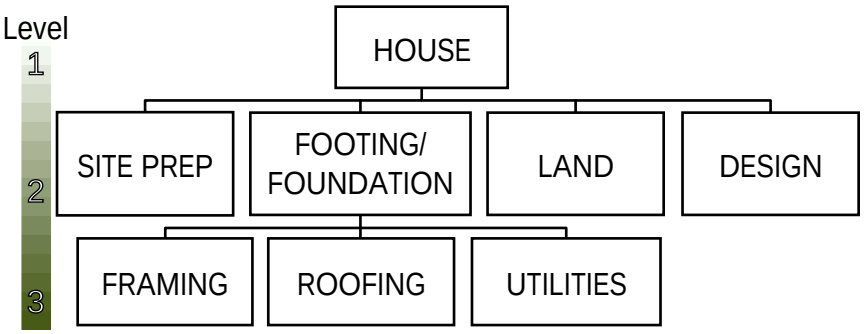
Photo courtesy Boeing Media

gram WBS and extend the effort down (in the form of the Contract WBS) to whatever level they believe is necessary to make a realistic bid on the contract and manage the work effort on the program. They will break each element down into further levels of detail until they reach the level of work packages, which are portions of the project that will determine cost accounting data in each area within the organization. Work packages typically range from 80 hours to 60 days of level of effort. Details of the process are described later in this article.

Within the acquisition process, the WBS is used on several occasions throughout a system's life cycle. Regardless of the life cycle model, the WBS applies to all acquisition models.

FIGURE 1. Program WBS



Early in the acquisition process, the WBS is a "strawman" of a proposed program WBS. As the program develops and other documents provide further guidance, the WBS takes shape into a real object. A notional design for an early prototype eventually evolves into a refined engineering effort. The WBS creates this notional structure to help the manufacturer work toward a design and eventually prepare for production.

In certain instances, depots will bid on a contract and also will be required to submit a Contract WBS. Depots would be expected to generate the same level of information as any other contractor to realistically bid and manage the work effort.

The Contract WBS usually starts off with a Level 3 element from the Program WBS to ensure continuity. For example, in our Program WBS for the house (Figure 1), one of the Level 3 elements was the framing. The Contract WBS would divide the framing into components (such as the wall framing, ceiling framing, floor framing, and interior framing). Each of these areas would be further subdivided into smaller and smaller parts. The program and contract WBS must be consistent with one another; and any revisions to one must be reflected in the other.

Obviously, Figure 1 does not show everything used in the construction of a house—the drawing would be too massive for this page. So, realize that all entities of the house (e.g., blueprints, labor and materiel cost, paint, nails, subcontractors' work) are actually shown in a WBS, but not for this particular illustration.

Now, consider a Program WBS for an aircraft system (Figure 2). Like our WBS in Figure 1, the aircraft system has three levels in a Program WBS. Directly below the Program WBS appears a Contract WBS.

At the top (Level 1) is the overall project—the aircraft system. Level 1 is usually directly identified as a major program; a PPBS [Planning, Programming, and Budgeting System] program element; or as a project or subprogram within an aggregated program.

The second row (Level 2) is a general breakout of the parts and activities associated with the aircraft system. Level 2 elements are major elements of the defense materiel item; for example, the vehicle itself (the prime mission product, which includes all hardware and software elements), aggregations of system-level services (e.g., systems test and evaluation, system engineering, program management), training, and data.

The third level (Level 3) further breaks down the components into more detailed levels. Level 3 elements are elements subordinate to Level 2 major elements such as airframe, propulsion, and fire control type of service (e.g., developmental test and evaluation, contractor technical support), or types of data (e.g., technical publications). Level 3 elements are generally common across similar programs. Lower levels follow the same process.

In rare circumstances, the Program WBS can extend below Level 3. However, these circumstances would be in cases where the government believes that a critical management effort is necessary to control the program. Otherwise, dic-

tating a contractor to go below three levels could result in litigation against the government if the development goes poorly.

Defining the Program

The WBS is used primarily during the development and production of defense systems. Large commercial companies also use the WBS when developing complex systems. For example, Boeing used the WBS to link their Integrated Product Teams, called Design Build Teams (DBTs) with established design goals. Boeing's 238 DBTs directly corresponded to major elements in the WBS. Each DBT had a specific design goal assigned by management.

The WBS is intended to completely define *everything* in the program. A WBS displays and defines the products(s) to be developed or produced and relates the elements of work to be accomplished to each other and to the end product. Therefore, the WBS plays a significant role in planning and assigning management and technical responsibilities; and monitoring and controlling the progress and status of engineering efforts, resource allocations, cost estimates, expenditures, and cost and technical performance.

Providing a logical framework for specifying the technical objectives of the program, the WBS first defines the program in terms of hierarchically related, product-oriented elements and the work processes required for their completion. Each element for the WBS provides logical summary points for assessing technical accomplishments, and for measuring the cost and schedule performance accomplished in attaining the specified technical objectives.

For each WBS element, the detailed technical objectives are defined as well as the specific work tasks assigned to each contractor organization element; and the resources, materials, and processes required to attain the objectives.

As resources are employed and work progresses on the task, current technical, schedule, and cost data are reported. The task data may then be summarized to provide successive levels of management with the appropriate report on planned, actual, and current projected status of the elements for which they are responsible. Management will thus be better able to maintain visibility of status and to apply their efforts to assure desired performance.

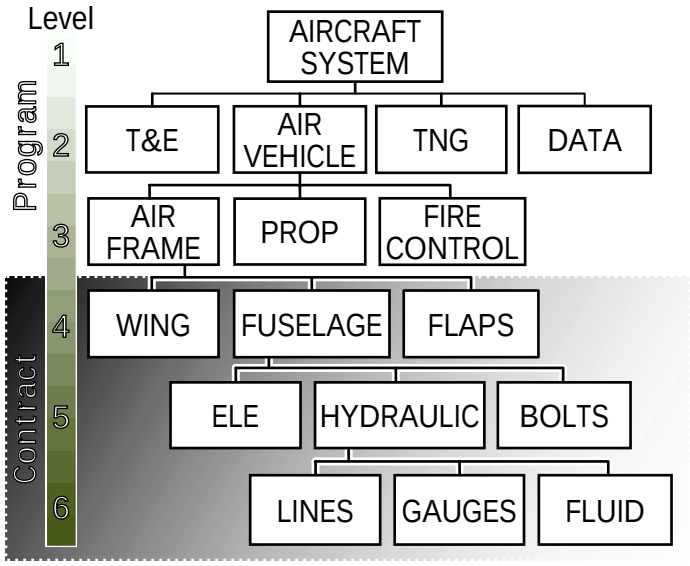
The WBS is: 1) identified on the Contract Data Requirements List (CDRL); 2) included with the Statement of Work (SOW); and 3) submitted as part of the draft Request For Proposal (RFP).

The format for developing a WBS is provided in Military Handbook 881 (MIL-HDBK-881), formerly Military Standard 881B (MIL-STD 881B), which contains a format for the seven types of systems. In developing the Contract WBS, MIL-HDBK-881 shall be cited "for guidance only" in solicitations and contracts.

- Missile System
- Ordnance System
- Ship System
- Space System
- Surface Vehicle System
- Aircraft System
- Electronic/Automated Software System

Figure 3 is an overall depiction of the relationship of the WBS to the contractor work effort.

FIGURE 2. Program and Contract WBS



Because it is an evolving document that represents a snapshot in time, the WBS does not end here. The WBS is the *beginning* of everything else in the acquisition process. For example, the WBS plays an important role in configuration management. Configuration Items (CIs)—also called Computer Software Configuration Items (CSCIs), or Software Items (SIs)—are initially identified by the PM and marked on the WBS. The CIs are an aggregation of hardware or software items that are risky to manufacture, new technology, potential safety problems, or are politically sensitive.

For example, the WBS for the B-2 Bomber identified over 200 CIs. The advanced state of stealth technology (materials and manufacturing process) used on the B-2 required extra attention by the program management team. Over 900 new manufacturing processes had to be invented to develop the B-2.

Private industry often refers to the WBS as Scope Definition. Scope Definition is defined as the customer's deliverables that are reflected in the WBS. The deliverables are ultimately verified by the stakeholders through reviews and audits—the same as DoD. Outside DoD, the WBS is often referred to as the Project WBS (PWBS), Contractual WBS (CWBS), Organizational WBS (OWBS), or Resources WBS (RWBS). Each of these WBS entities performs distinct functions.

Not Exclusively a Scheduling Tool

Although the WBS can be used for developing a schedule, it is not *exclusively* a scheduling tool. Within the WBS, a cost account matrix is also developed that relates functional organizations to the WBS elements. A logical numbering system is used on the WBS to keep track of all the WBS elements. This numbering system is typically referred to as the Code of Accounts. The code of accounts normally displays the relationship between the cost account and the work package. The cost account code is one level above the work package and is used for cost reporting purposes. An example of this relationship follows:

	Cost Account Code
Cost Account (Summary Activity or Parent)	1.4.3
Work Package (Child)	1.4.3.1

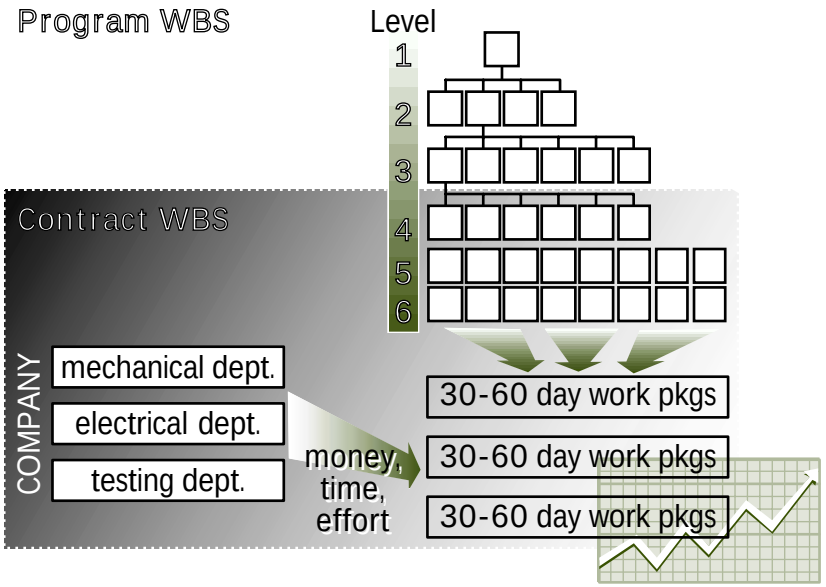
Note the numeric relationship between parent and child. The work package simply adds a digit to the original cost account number. Network diagrams are ultimately derived from these work packages. Again, work packages normally range from 80 hours' level of effort (not in duration) to 60 calendar days. The WBS provides the structure for the efforts of contracting, cost accounting, manufacturing, engineering, testing, and logistics. Also, the WBS is a form of network that ultimately addresses risk vs. time.

Various government and commercial tools exist that use the WBS structure to convey risk and schedule data. The Program Manager's WorkStation (PMWS) is an excellent automated tool to track and manage risk. Another good example of the risk management effort is the resulting Program Evaluation and Review Technique (PERT) and Cost Performance Measure (CPM) information generated from the WBS to develop a schedule and depict critical paths. Automated tools such as Microsoft Project are also very useful to convey a multitude of scheduling configurations.

The WBS will continue to be a useful tool in commercial industry and the DoD acquisition process. Program managers will continue to use the WBS to help with cost, schedule, performance, manufacturing, logistics, testing, and risk management. More importantly, the customer will continue to get a cost-effective and better product as a result of the WBS.

Editor's Note: The authors welcome questions or comments on this article. Contact Clark at *clarkj@lee.army.mil*; contact Littrell at *Philip.Littrell@dau.mil.*

FIGURE 3. WBS Transition to Work Packages



DAU Welcomes Back Former Commandant, Claude M. Bolton Jr.

Claude M. Bolton Jr., former Commandant of the Defense Systems Management College (DSMC), returned to the College Feb. 13—his first official visit to the Defense Acquisition University (DAU) since appointment by the President to his new position as the Assistant Secretary of the Army for Acquisition, Logistics and Technology (ASA/ALT).

Bolton was invited to the University as a Distinguished Guest Lecturer for students attending DAU's Advanced Program Management Course (APMC 02-1). During his remarks, he talked about programs, people, and production; and discussed key Army programs in development, DoD limited funding levels, and ASA/ALT organizational changes. His focus was on how to improve management and support the troops with limited funding.

Bolton served as DSMC's 12th Commandant from March 1993 to March 1996.

Editor's Note: Also see press release on p. 42, "Claude M. Bolton Jr. Sworn-in as New Assistant Secretary of the Army for Acquisition, Logistics and Technology."

Assistant Secretary of the Army for Acquisition, Logistics and Technology Claude M. Bolton Jr., lectures students of the Defense Acquisition University's Advanced Program Management Course (APMC 02-1) on Feb. 13, 2002, at Scott Hall, Fort Belvoir, Va. Photo by Army Sgt. Kevin Moses