



CRITICAL THINKING.
SOLUTIONS DELIVERED.

Developing Work Breakdown Structures

Presented By:
Neil F. Albert
MCR, LLC
nalbert@mcri.com
703-506-4600

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Outline

- Background
- Purpose and Definition
- Development Process
- WBS Dictionary
- Program/Project Integration Requirements
- Organizational/Functional Relationship
- Uses of a WBS
- Summary
- References

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Background

- Why Is A WBS Important In Today's Environment?
 - Acquisition Environment Changing
 - Provides a consistent and visible framework for programs and contracts
 - Improves communication throughout the acquisition process
 - Assists in planning and the assignment of management and technical responsibilities
 - Provides the foundation for project integration and success
 - Provides Standardization - consistency and commonality for Government and Industry implementation

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Background

- Use of Work Breakdown Structures (WBS) is critical to the success of proper program management
- WBS defines work and system
 - List of Requirements/Specifications
 - List of Resources
 - List of Tasks
 - Statement of Work
 - Structured Subdivision of Project Elements to be communicated within and outside the program

Does Not Drive a Program's Requirements

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Work Breakdown Structure Definition

- A product (deliverable) oriented family tree of hardware, software, services, and data which results from engineering efforts during development and production of a system
- Displays and defines the product(s) and relates the elements of work to each other and the end product, and completely defines the program
- Uses the “100% rule: Next level of decomposition of a WBS element (child level) must represent 100% of the work applicable to the next higher level (parent)

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Work Breakdown Structure Definition

- Two types of Work Breakdown Structures:
 - 1) Program Work Breakdown Structure encompasses entire program and consists of at least three levels of the program
 - Used to define the entire program
 - Encompasses all elements and used to develop and extend to lower level WBS element structures
 - Ensures that work elements are defined and related to only one specific work effort so activities are not omitted or duplicated

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Work Breakdown Structure Definition

- Two types of Work Breakdown Structures (Cont'd)
 - 2) Contract Work Breakdown Structure is the WBS for reporting purposes and its discretionary extension by the contractor
 - Includes all the elements for the products which are responsibility of the contractor
 - Contract work statement should provide the reporting requirements



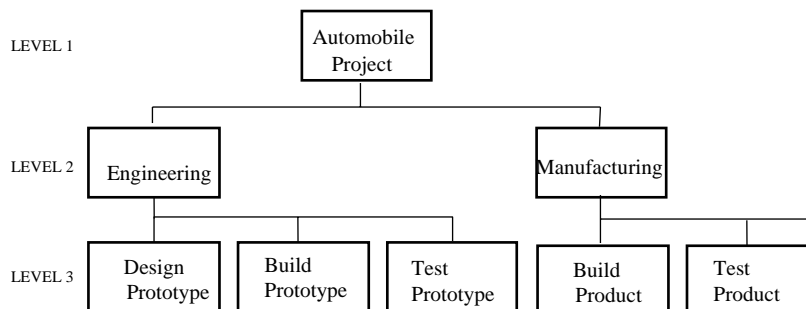
WBS Levels

- Level 1
 - Entire System, Program, Study
 - Program Element, Project or Subprogram
- Level 2
 - Major Elements of the System, Program, Study
 - Top Level Aggregations of Services or Data
- Level 3
 - Subordinate Items to Level 2 Elements
 - Generally Common Across Similar Programs, Systems, or Studies

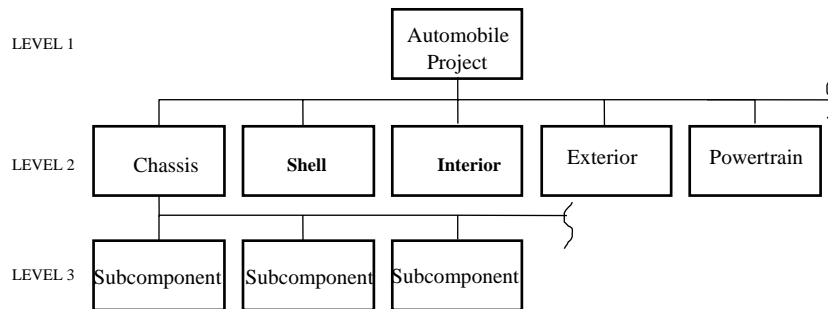
Common WBS Elements

- Examples of common areas across all items include:
 - Engineering
 - Program Management
 - Test and Evaluation
 - Training
 - Data
 - Support Equipment
 - Implementation

Functional/Organization Work Breakdown Structure (Example)



Product (Deliverable) Work Breakdown Structure (Example)



Developing a WBS

- Assist the Program Manager in developing a clear vision
 - the end-product of the project
 - the overall project by which it will be created.
- Should stimulate thought when developing a WBS to handle and manage the program
 - think below the first level (what do the trees in the proverbial forest look like?)
 - think deliverables (what is to be provided/what is required?)
 - think with the end in mind (how will this element contribute to the finished output?)



Generic System Work Breakdown Structure

<u>LEVEL 1</u>	<u>LEVEL 2</u>	<u>LEVEL 3</u>
Delivered System	Prime Mission Product (PMP)	Subsystem 1 ..n (Specify Names) PMP Applications Software PMP System Software PMP Integration, Assembly, Test and Checkout
	Engineering	
	Program Management	
	Test and Evaluation	Development Test and Evaluation Operational Test and Evaluation Mock-ups Test and Evaluation Support Test Facilities
	Training	Equipment Services Facilities
	Data	Technical Publications Engineering Data Management Data Support Data Data Depository

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Generic System Work Breakdown Structure

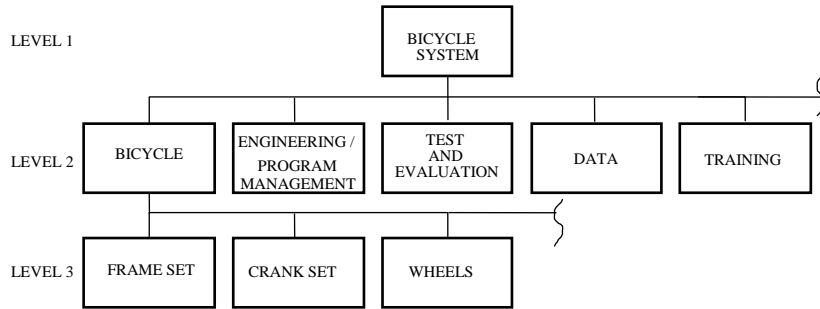
<u>LEVEL 1</u>	<u>LEVEL 2</u>	<u>LEVEL 3</u>
	Support Equipment	Test and Measurement Equipment Support and Handling Equipment
	Site Implementation	System Assembly, Installation and Checkout on Site Contractor Technical Support Site Construction Site Conversion

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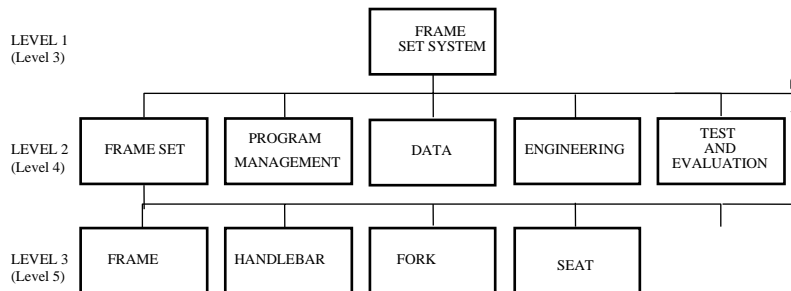
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Program WBS (Example)



Contract WBS





Software and Software Intensive Systems

- Increasingly critical in today's acquisition environment
- Divided into two categories for WBS development
 - Software that operates on specific equipment
 - Software that may be procured separately from the operating equipment or is stand-alone that is developed for specific equipment and then must be identified as a subset of that equipment



Visibility into Software Development Processes

- Due to product-oriented hierarchy
 - Progressive subdivision results in common management or functional tasks (i.e., development processes, etc.)
 - Example: Software widespread throughout the WBS and represent high risk in the contract. Program manager requires specific visibility into software performance. Do not overly complicate the Contract WBS and the contractor's management system
 - Specify appropriate reporting requirements in the Statement of Work (SOW)
- Provide detail/visibility of key software development processes (i.e., requirements analysis, design, code and test, etc.) through contractor's management system and WBS
 - Not extending the WBS to excessively low levels or developing a separate WBS for software
 - Aggregate information for reporting



Software Operating on Specific Equipment

- Identified as a subset of the equipment WBS element, which either includes the software in the element specification or exercises the most critical performance constraint
- High technical risk and high cost - the following structure and definitions may be used



Generic System WBS - Software

<u>LEVEL N</u>	<u>LEVEL N+1</u>	<u>LEVEL N+2</u>
Build 1...n	CSCI 1	CSC 1...n CSC to CSC Integration and Checkout
	CSCI 2	CSC 1...n CSC to CSC Integration and Checkout
	CSCI 3	CSC 1...n CSC to CSC Integration and Checkout
	CSCI to CSCI Integration and Checkout	

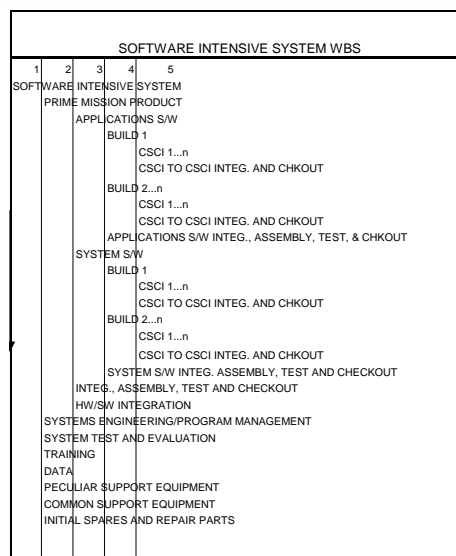


Separately Contracted or Stand-Alone Software

- Separately contracted or stand-alone software
 - Includes the data, services, and facilities required to develop and produce that software product
 - Where software is considered stand alone, the customer should use the same product-oriented WBS format



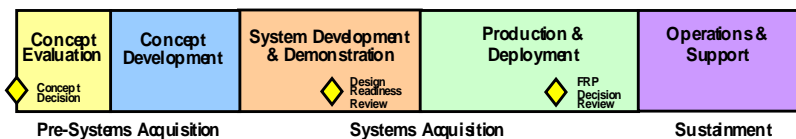
Software Intensive System WBS





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DoD Program Evolution



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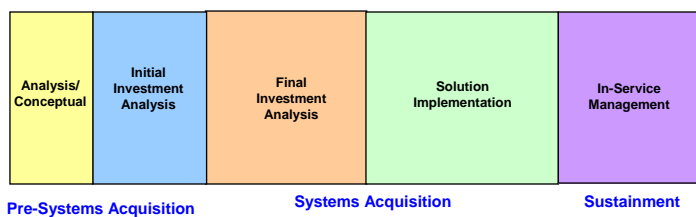
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FAA Program Evolution



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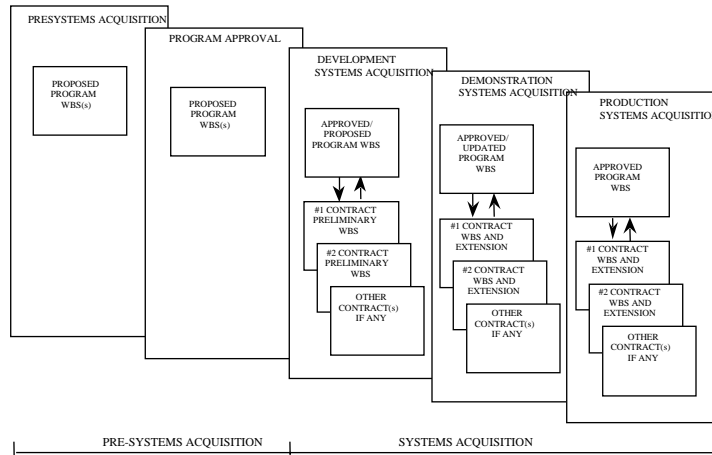
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Work Breakdown Structure Evolution



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Program Manager Role and Responsibility

- Leads A Multi-Disciplined Team That Attempts To Balance And Integrate:
 - Technical Performance (Quality)
 - Schedule (Time)
 - Cost (Resources)
 - Risk (Acceptable Level)
 - Communicate the team's Vision/Mission.
 - Promotes Multi-Discipline Communication - All the Time
- WBS provides logical framework to manage

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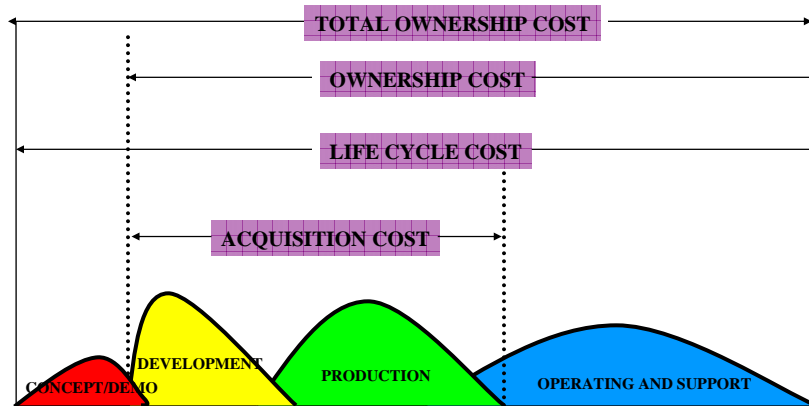
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Program Life Cycle



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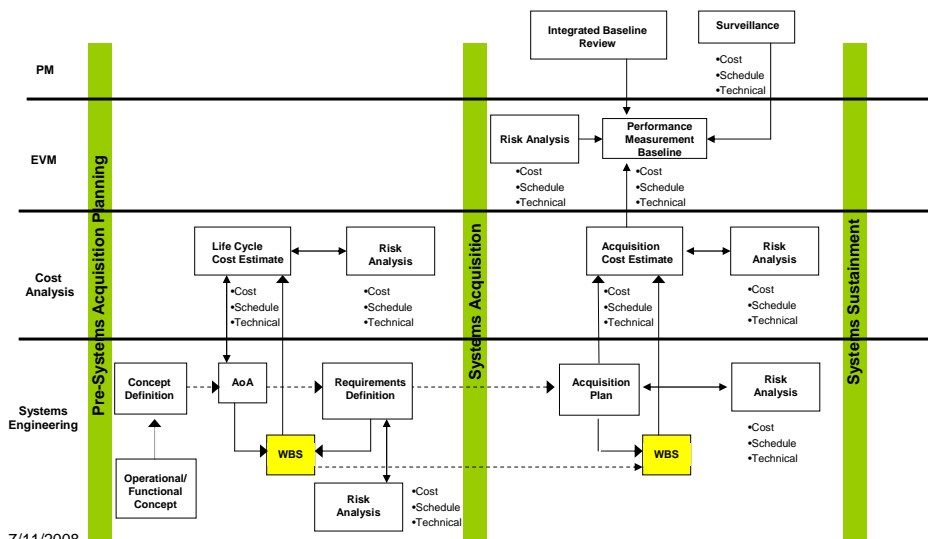
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Program Life Cycle

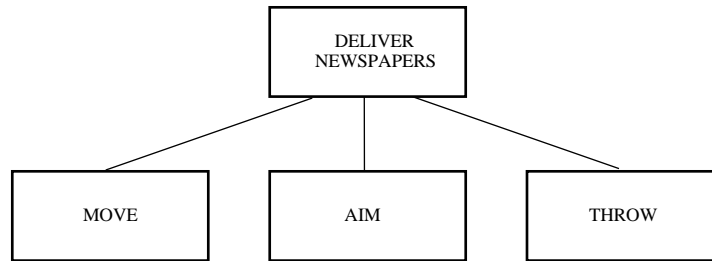


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Expected Results



Pre-Systems Acquisition Phase



Pre-Systems Acquisition

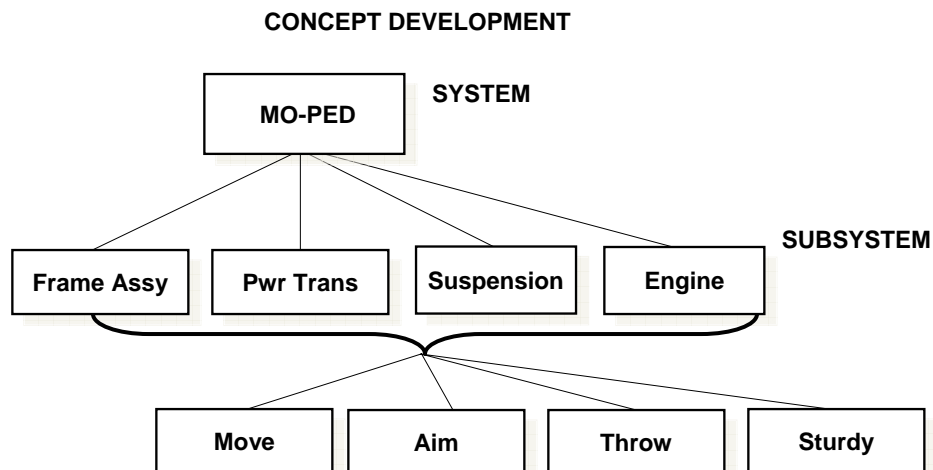
WBS impact –

- Concept Decision point driven by requirements for “expected results”
- Analysis of Alternatives
- Need generic or historical WBS to support AoA
- Requirements Definition is output of analysis

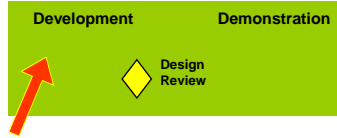
Pre-Systems Acquisition

- **WBS Definition**
 - Preliminary WBS Developed
 - Overall cost, schedule and performance goals for the total systems acquisition effort
 - Specific cost, schedule and performance goals and exit criteria for the development and demonstration phase
 - Risk Management planning and scheduling defined
- **Requirements Definition based on AoA results**
 - Rationale for acquisition strategy
 - Appropriate limits on prototypes produced and deployed
 - Performance goals and Exit Criteria to be met prior to proceeding into Development and Demonstration phase and producing additional prototypes

Analysis of Alternatives Results



Systems Acquisition Development



Development

Enter: PM has technical solution but has not designed, developed, or integrated into complete system

Activities:

- System design, development and integration of demonstrated subsystems and components
- Reduction of integration risk

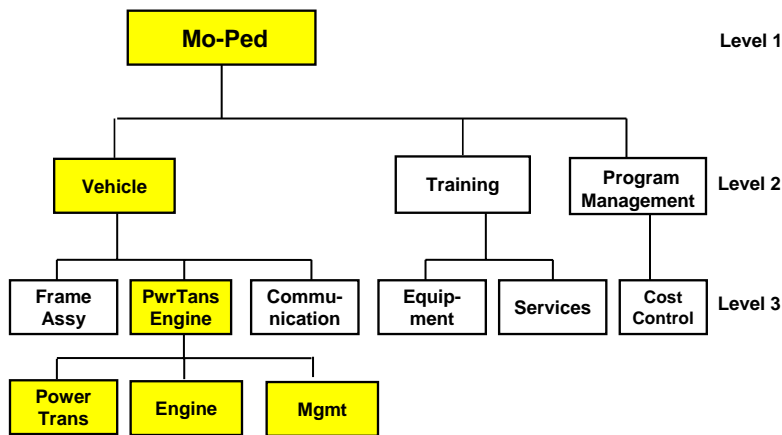
Exit: Demonstration of prototypes in relevant environment

WBS Development

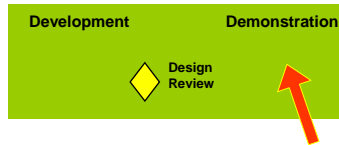
- Top Level WBS with extension into lower level development.
- Completed prototypes ready for demonstration in intended environment
- Cost, schedule and performance measured (EVM) reporting
- Risk management planning and scheduling integrated

Detailed WBS Development

DEVELOPMENT AND DEMONSTRATION



Systems Acquisition Demonstration



WBS Development

- Complete WBS linked to major products and systems
- Fully integrated with Program Management/Cost functions
- Cost/Schedule Performance (EVM) reporting
- Risk Planning and Scheduling ongoing

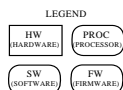
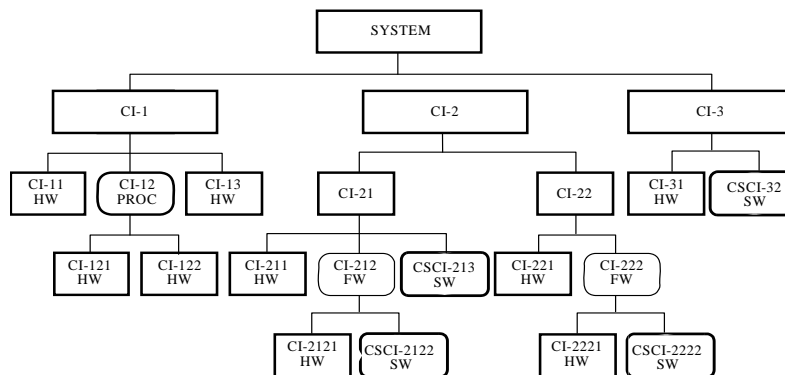
Demonstration

Enter: Prototypes demonstrated in intended environment

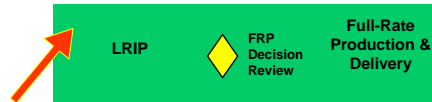
Activities:

- Complete system demonstration
- Exit: Demonstration using engineering development models; meets requirements

System Configuration



Systems Acquisition Low Rate Initial Production



LRIP

Enter: System matured for production

Activities:

- Low-rate initial production
- Establish full manufacturing capability

Exit: Operationally effective, suitable and ready for full rate production

WBS Development

- Maintenance of WBS
- Change planning for engineering changes (Major Scope changes)
- Cost/Schedule Performance tracking in place
- EVM reporting in place

Systems Acquisition Production and Delivery



WBS Development

- Maintenance of WBS
- Change planning for major modifications and minor engineering changes
- Cost/Schedule Performance tracking in place
- EVM reporting in place

Full-Rate Production & Delivery

Enter:

- Demonstrated control of manufacturing process
- Full-up systems level completed

Activities:

- Full rate production
- Deliver system
- Start support

Exit: Full operational capability; delivery complete



Work Breakdown Structure Dictionary

- **WBS Dictionary will serve multiple functions within the program.**
 - Defines element in terms of technical, schedule, and performance criteria
 - Includes detailed description of element and how it relates to next higher element,
 - Supports product structure regardless of phase or funding
 - Subcontractor effort detailed where it supports the system
 - Identifies what is not in the elements to ensure clear relationship
 - Supports technical, schedule, and/or cost risk assessment and mitigation



Relationship To Management Plan and Schedule

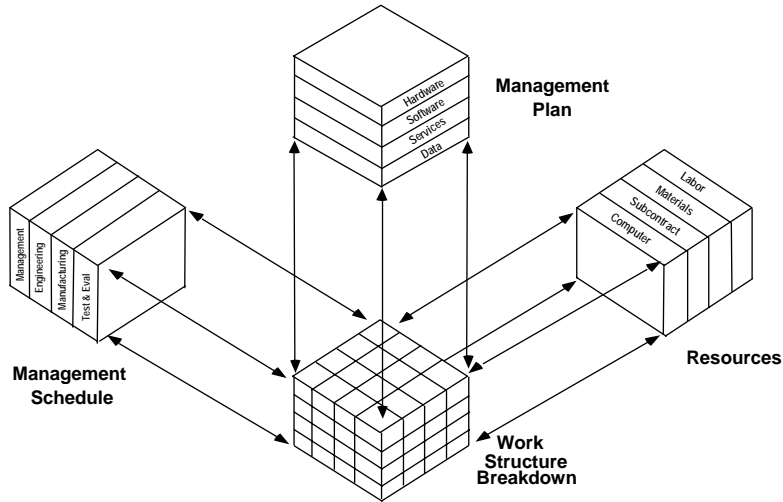
Three (3) Elements of Control

- **Project Control is the first unit of control**
 - Integrated Management Plan (IMP) ties work scope with technical plans and goals of the program
- **Time or Schedule is the second unit of control**
 - Integrated Management Schedule (IMS) ties work scope to schedule or milestones goals
 - Understanding the duration to go from step one to step two of the work scope the better the plan and the better the control
- **Identifying Resources is the third unit of control**
 - Identifying materials, people and tools to the work scope definition will determine how well the project is utilizing resources and how performance is measured



3 Dimensions Of Project Control

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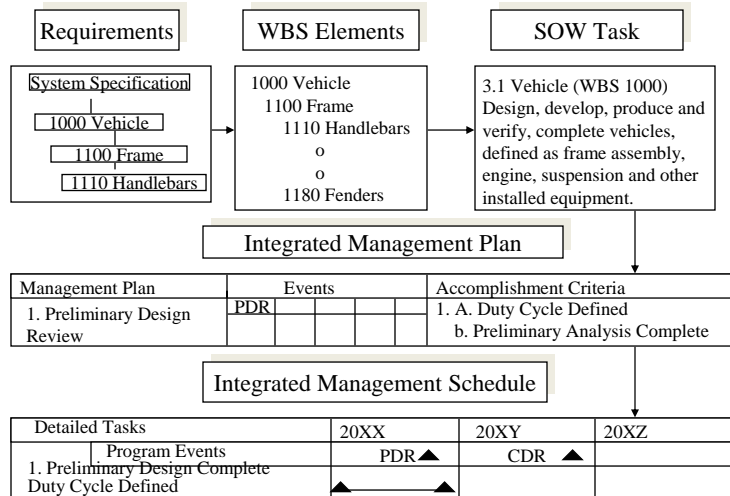
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Integrated Management

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Organizational Breakdown Structure

- “Org Chart”
- Lays out the hierarchical organization of the resources that are available for project work
- WBS organizes the work that needs to be accomplished
- Intersection of OBS and WBS is where work is managed or “control account plans”
- Resources are not attached to the WBS but are part of the activities
- Responsibility Matrix can be represented and assigned



Relationship With Contractor Management System

- Contractor should assign management responsibility for technical, schedule, and cost performance to the control account manager
 - Cost Management System should provide the necessary visibility of the WBS as it interfaces with the organization
 - At juncture of the WBS element and organization unit, control accounts are usually established
 - Performance is planned, measured, recorded and controlled

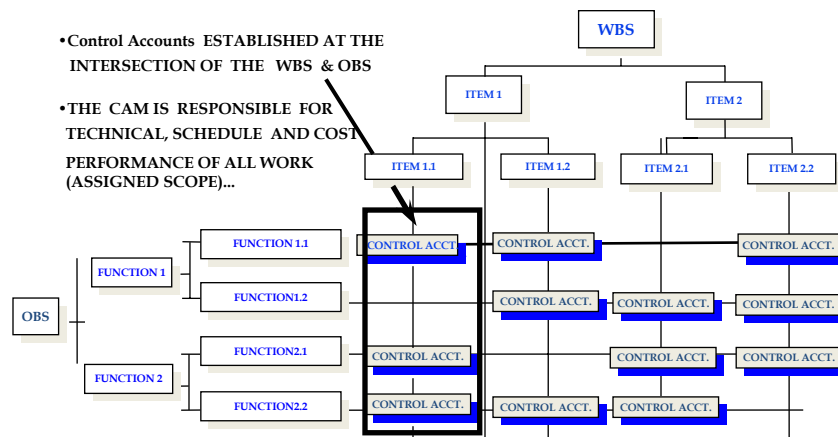
Baseline Management

- Control Account Manager (CAM)
 - Reports to the Program Manager & Delivery order leader
 - Provides technical management & leadership to work team for assigned work scope (SOW & WBS elements)
 - Defines & monitors detailed schedule development for assigned work
 - Defines & monitors resource requirements (BCWS), assignments (work authorization) & cost (ACWP) for authorized/assigned work
 - Defines & monitors schedule progress (performance measurement, BCWP) for assigned work

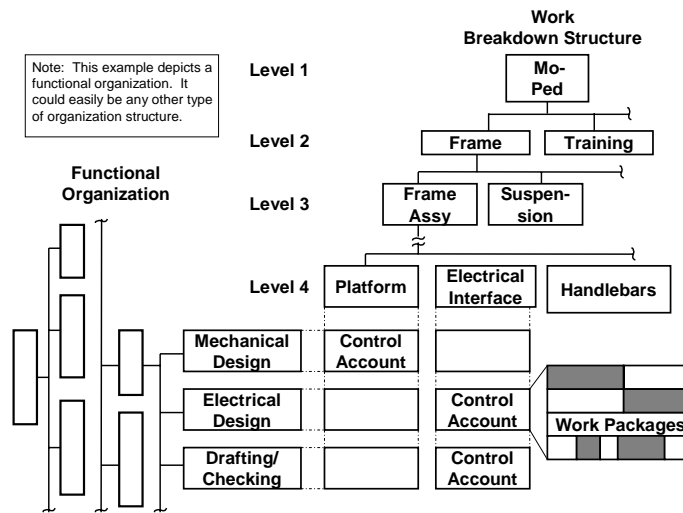
Control Account Intersection

• Control Accounts ESTABLISHED AT THE INTERSECTION OF THE WBS & OBS

• THE CAM IS RESPONSIBLE FOR TECHNICAL, SCHEDULE AND COST PERFORMANCE OF ALL WORK (ASSIGNED SCOPE)...



Translation from Org/Function to Product



Issues in WBS Development

- **Product WBS based on the various views that constitute the functional and/or physical design**
 - Define logical relationship between elements of the program and its natural extension
 - Maintain the integrity of the level of placement
 - Defining to a specific level (typically level 3) of indenture does not constrain ability to define or manage the program or resources
 - Lower level if considered high cost, high risk, high technology (product orientation extension maintained)
- **Historical data important**
 - Aids as resource to the future development or similar items
 - The need for data should not distort/hinder program definition and/or contractor's extension or management of the program

- **Technical Management**
 - Provides framework for defining the technical objectives of the program
 - Together with contract SOW and product specification, aids in establishing a specification tree, defining configuration items, and planning support tasks
 - Contract Statement of Work (SOW)
 - Describes what products and services are to be delivered
 - An effective SOW will facilitate effective contractor evaluation after contract award
 - A standardized WBS is a template for constructing the SOW and the contract line items (CLINS) - streamline the process
 - Use the WBS to provide the framework and facilitate a logical arrangement of the SOW elements

- **Specification Tree**
 - Hierarchy of performance requirements for each component element of the system for which design responsibility is assigned
 - Specifications may not be written for each product
 - May not match the WBS

- Configuration Management
 - Process of managing the technical configuration of items being developed
 - Need to designate which contract deliverables are subject to configuration management controls
 - Configuration Item (CI)
 - Computer Software Configuration Item (CSCI)
 - Framework for designating the configuration items in the WBS

- Acquisition/Financial Management
 - WBS assists management in planning cost and schedule objectives
 - Products are identified in terms of cost and schedule activities
 - Serves as the basis for planning, budgeting and executing resource requirements

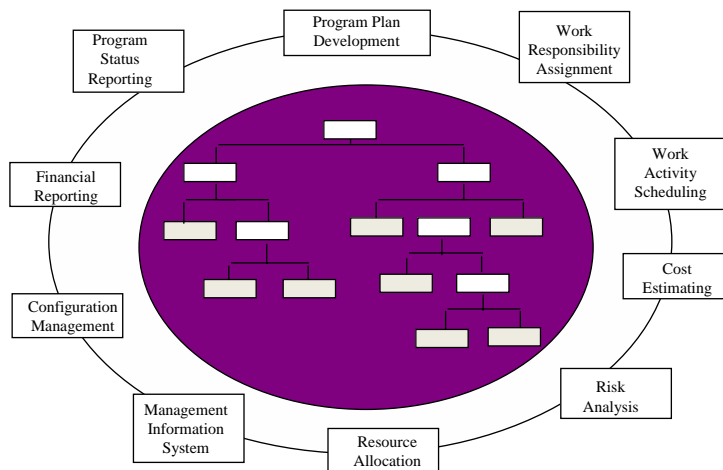
- Cost Estimating
 - Facilitates customer's ability to plan, coordinate, and control various program activities
 - Estimate all phases
 - Reassessment of cost
 - Risk assessment
 - Provides common framework for tracking estimated and actual costs
 - Sensitivity analysis

- Earned Value Management (EVM)
 - Provides tracking of:
 - Technical scope and performance parameters
 - Integrated project master & detail schedules
 - Resource allocation (costs)
 - Risk assessment & mitigation
 - Provides all levels of project management (customer and supplier) with increased visibility into the project's performance and identifies specific accountability for that performance

Uses of a Work Breakdown Structure

- Data Bases
 - Used for pricing and negotiating contracts and contract changes, and for follow-on procurement
 - Provides cost data base of similar WBS elements from different programs
 - Used to develop learning curves, regression and other techniques to estimate the cost requirements
 - Provide comparison to the original estimates
 - Assists in bidding future contracts and budgeting new work

WBS Integration



The WBS Remains the Definitive Framework for Communication of Technical, Cost and Schedule Elements



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- Practice Standard for Work Breakdown Structures
<http://www.pmi.org>