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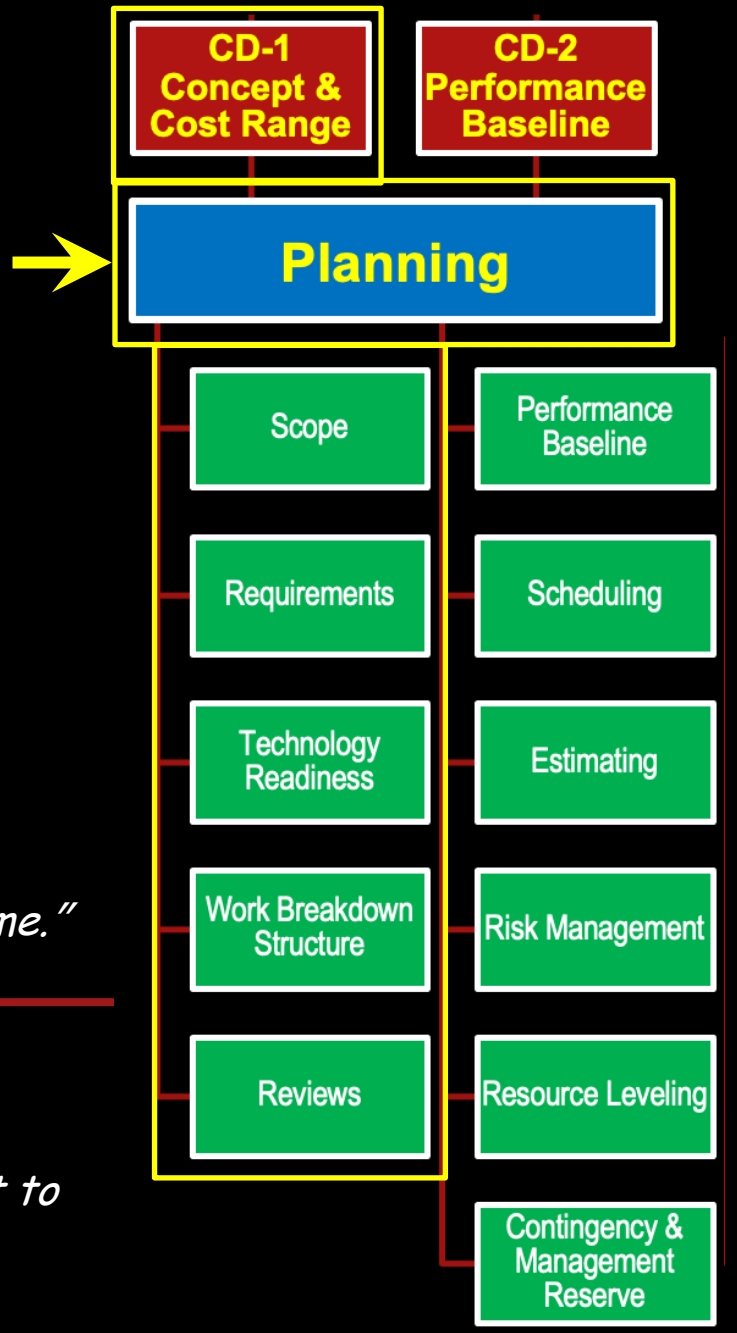
Project Planning

"To achieve great things, two things are needed; a plan, and not quite enough time."
— Leonard Bernstein

"A good plan today is better than a perfect plan tomorrow"

"Happy people plan actions, they don't plan results" — Dennis Wholey

"I know the plans I have for you, declares the lord, plans to prosper you and not to harm you, plans to give you hope and a future." — Jeremiah 29:11



Planning Processes*

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- The Project Team progressively elaborates high-level information into detailed plans throughout the project development cycle.
- Those processes required to
  - establish the scope of the project,
  - refine the objectives, and
  - define the course of action required to attain the objectives that the project was undertaken to achieve.
- At some phases of the project development cycle planning processes will dominate the project activities

- The phase gate requirements often dictate the planning focus

*PMBOK® 6th Edition

All Project Management Expertise Areas Are Needed in Planning

	Integration	Scope	Time	Cost	Quality	Human Resources	Communications	Risk	Procurement	Stakeholder
Initiating	✓									✓
Planning	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Executing	✓				✓	✓	✓		✓	✓
Monitoring & Controlling	✓	✓	✓	✓	✓		✓	✓	✓	✓
Closing	✓								✓	

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Project Planning Processes

- Develop project management plan
- Scope definition
- Scope planning
- Create the work breakdown structure
- Define activities
- Sequence activities
- Resource estimates for activities
- Duration estimates for activities
- Schedule development
- Cost estimating
- Cost budgeting
- Quality planning
- Human resource planning
- Communications planning
- Risk management planning
  - Risk identification
  - Qualitative & quantitative risk analysis
  - Risk response planning
- Procurement contract planning

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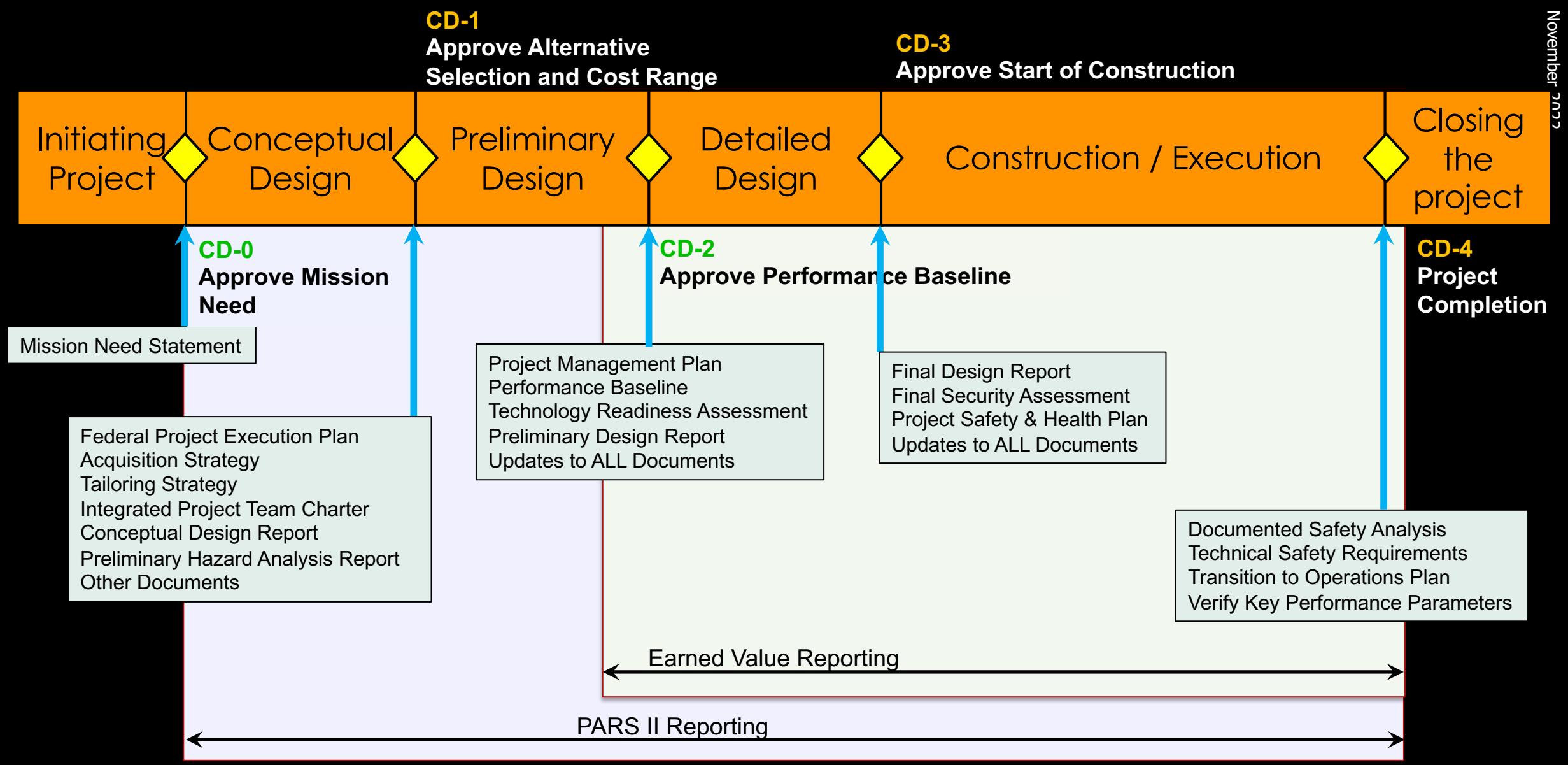
DOE 413.3B Timeline – Planning Emphasis



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The first step in planning is the project management plan

- The project management plan is outlines/details how the project will be run
  - Executed
  - Monitored
  - Controlled
  - Closed
- Depending upon complexity and business risks of the project it can be very detailed or a summary
- 3 major components
  - Subsidiary plans
  - Baselines
  - Additional components

Project Management Plan*		
Subsidiary Plans & Components	1.	Project Development Cycle Description
	2.	Requirements Management Plan
	3.	Scope Management Plan
	4.	Schedule Management Plan
	5.	Cost Management Plan
	6.	Quality Management Plan
	7.	Resource Management Plan
	8.	Risk Management Plan
	9.	Procurement Management Plan
	10.	Change Management Plan
	11.	Configuration Management Plan
	12.	Communications Management Plan
	13.	Stakeholder Engagement Plan
	14.	Management Reviews & Reporting
Baselines	15.	Performance Measurement Baseline
	16.	Scope Baseline
	17.	Schedule Baseline
	18.	Cost Baseline

*Based on PMBOK® 6th Edition Table 4.1

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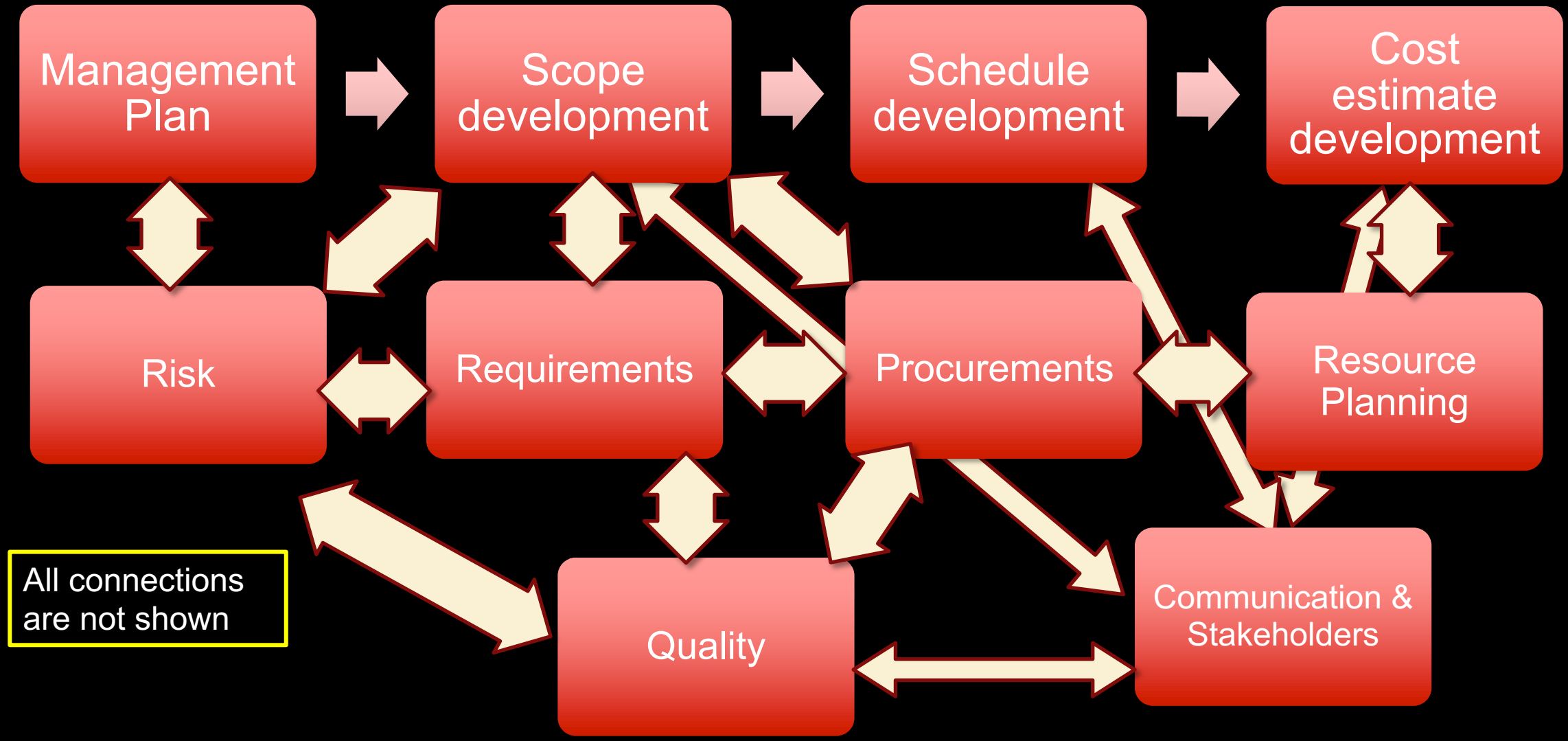
The project planning processes are a flow with interconnections with iterations and feedback loops



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Project Planning Process

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- The project planning process includes:
  - Deciding the overall program or strategy to be followed
  - Setting objectives
  - Developing the scope
  - Developing the schedule
  - Estimating resource requirements (includes $)
  - Forecasting the future project environment
  - Developing the project organization
  - Preparing required operating policies and procedures
  - Developing standards for performance

Why People Fail to Plan

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- If people fail to plan, or fail to plan successfully, it is because:
  - They do not appreciate what planning will help them accomplish
  - They do not realize the potential consequences of not planning
  - They do not know how
  - **FEAR**
- It is not possible to successfully complete even a relatively simple project without planning
- Project planning uses a set of techniques that every manager should understand and apply
  - You want to be the first to know if trouble is on the horizon
  - You do **not** want other stakeholders to find out first

Project Planning – First Steps (2)

- Project Planning is the establishment, within a forecasted environment, of a course of action designed to accomplish a given set of objectives within established constraints
  - A "forecasted environment" means that certain conditions are assumed (e.g. the DIAMOND will be built at Rutherford not Daresbury)
  - The set of objectives ultimately described in the Conceptual Design Report
  - Established constraints include the total, budget and staffing levels

The plan will certainly change; planning is continuous

"In preparing for battle I have always found that plans are useless, but planning is indispensable." — Dwight David Eisenhower

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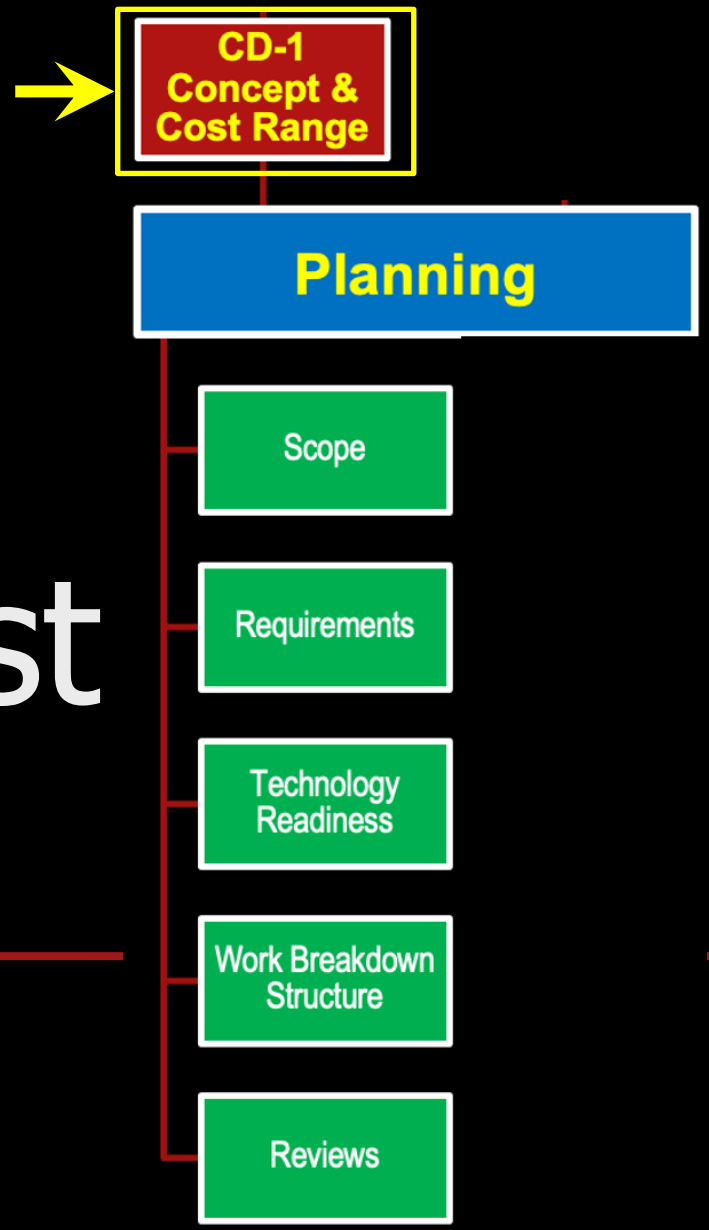
CD-1 Approve Alternative and Cost Range



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DOE 413.3B CD-1 – Approve Alternative Selection and Cost Range

Developing the project and scope

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- From CD-0 to CD-1 the focus is on
  - Demonstrating the selected approach is the optimum choice
  - Analyzing and developing the scope of the project
  - Preparing and framing the project for the in-depth planning & execution to follow

Phase 1: Conception & Project Definition

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- **Start Conceptual Design with Operating funds**

- **Phase 1a – Conception**
  - Specifying the requirements which the project must meet
  - Determining whether the project can be successfully completed
  - Assessing the relative desirability of performing the project
  - Formulating alternative approaches to performing the project
  - Development of the preliminary Key Performance Parameters (KPPs)

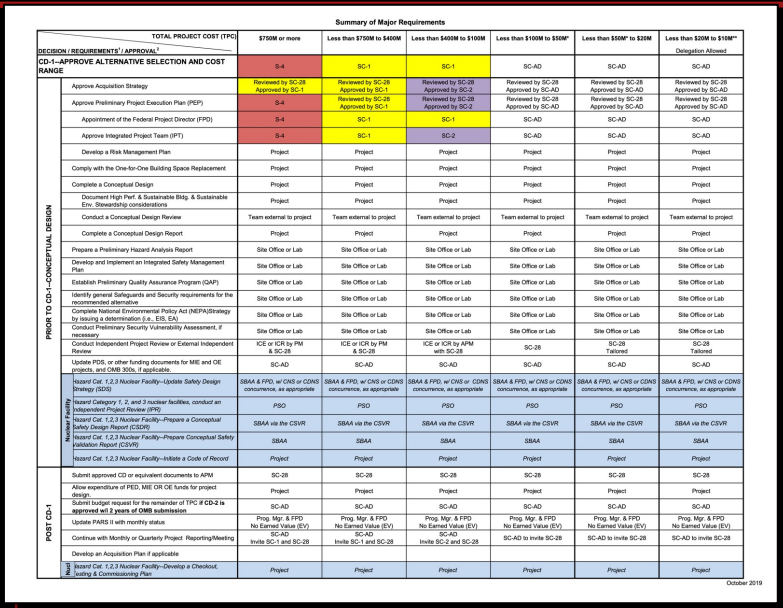
- **Phase 1b Project Definition**
  - Determining overall requirements
  - Preparing the Scope (Statement) of Work
  - Developing the schedule
  - Determining the resource budgets
  - Obtaining commitment and support for the project

DOE/SC CD-1 Requirements from Decision Matrix

Progressive elaboration – the project is accelerating and gaining momentum

- Acquisition Strategy
  - Analysis of Alternatives
- Preliminary Project Execution Plan
- Federal Project Director (FPD) appointment
- Integrated Project Team (IPT)
- Risk Management Plan
- 1 for 1 Building Space Replacement
- Conceptual Design
  - Conceptual Design Review
  - Conceptual Design Report
  - Sustainable Building

- Preliminary Hazards Analysis Report (PHAR)
- Integrated Safety Management (ISM) Plan
- Quality Assurance Program (QAP)
- Safeguards and Security
- NEPA Strategy and determination
- Prelim Security Vulnerability
- CD-1 Independent Project Review (IPR)
- Independent Cost Estimate (ICE) / Review (ICR) if >$100 M



Summary of Major Requirements

	TOTAL PROJECT COST (TPC) / DECISION / REQUIREMENTS[1] / APPROVAL[2]	$750M or more	Less than $750M to $400M	Less than $400M to $100M	Less than $100M to $50M*	Less than $50M* to $20M	Less than $20M to $10M**
							Delegation Allowed
	CD-1–APPROVE ALTERNATIVE SELECTION AND COST RANGE	S-4	SC-1	SC-1	SC-AD	SC-AD	SC-AD
PRIOR TO CD-1—CONCEPTUAL DESIGN	Approve Acquisition Strategy	Reviewed by SC-2/Approved by SC-1	Reviewed by SC-2/Approved by SC-1	Reviewed by SC-2/Approved by SC-2	Reviewed by SC-2/Approved by SC-AD	Reviewed by SC-2/Approved by SC-AD	Reviewed by SC-2/Approved by SC-AD
	Approve Preliminary Project Execution Plan (PEP)	S-4	Reviewed by SC-2/Approved by SC-1	Reviewed by SC-2/Approved by SC-2	Reviewed by SC-2/Approved by SC-AD	Reviewed by SC-2/Approved by SC-AD	Reviewed by SC-2/Approved by SC-AD
	Appointment of the Federal Project Director (FPD)	S-4	SC-1	SC-1	SC-AD	SC-AD	SC-AD
	Approve Integrated Project Team (IPT)	S-4	SC-1	SC-2	SC-AD	SC-AD	SC-AD
	Develop a Risk Management Plan	Project	Project	Project	Project	Project	Project
	Comply with the One-for-One Building Space Replacement	Project	Project	Project	Project	Project	Project
	Complete a Conceptual Design	Project	Project	Project	Project	Project	Project
	Document High Perf. & Sustainable Bldg. & Sustainable Env. Stewardship considerations	Project	Project	Project	Project	Project	Project
	Conduct a Conceptual Design Review	Team external to project	Team external to project	Team external to project	Team external to project	Team external to project	Team external to project
	Complete a Conceptual Design Report	Project	Project	Project	Project	Project	Project
	Prepare a Preliminary Hazard Analysis Report	Site Office or Lab	Site Office or Lab	Site Office or Lab	Site Office or Lab	Site Office or Lab	Site Office or Lab
	Develop and Implement an Integrated Safety Management Plan	Site Office or Lab	Site Office or Lab	Site Office or Lab	Site Office or Lab	Site Office or Lab	Site Office or Lab
	Establish Preliminary Quality Assurance Program (QAP)	Site Office or Lab	Site Office or Lab	Site Office or Lab	Site Office or Lab	Site Office or Lab	Site Office or Lab
	Identify general Safeguards and Security requirements for the recommended alternative	Site Office or Lab	Site Office or Lab	Site Office or Lab	Site Office or Lab	Site Office or Lab	Site Office or Lab
	Complete National Environmental Policy Act (NEPA)Strategy by issuing a determination (i.e., EIS, EA)	Site Office or Lab	Site Office or Lab	Site Office or Lab	Site Office or Lab	Site Office or Lab	Site Office or Lab
	Conduct Preliminary Security Vulnerability Assessment, if necessary	Site Office or Lab	Site Office or Lab	Site Office or Lab	Site Office or Lab	Site Office or Lab	Site Office or Lab
	Conduct Independent Project Review or External Independent Review	ICE or ICR by PM & SC-2B	ICE or ICR by PM & SC-2B	ICE or ICR by APM with SC-2B	SC-2B	SC-2B Tailored	SC-2B Tailored
	Update PDS, or other funding documents for MIE and OE projects, and OMB 300s, if applicable.	SC-AD	SC-AD	SC-AD	SC-AD	SC-AD	SC-AD
	Nuclear Facility: *Hazard Cat. 1,2,3 Nuclear Facility--Update Safety Design Strategy (SDS)*	SBAA & FPD, w/ CNS or CDNS concurrence, as appropriate	SBAA & FPD, w/ CNS or CDNS concurrence, as appropriate	SBAA & FPD, w/ CNS or CDNS concurrence, as appropriate	SBAA & FPD, w/ CNS or CDNS concurrence, as appropriate	SBAA & FPD, w/ CNS or CDNS concurrence, as appropriate	SBAA & FPD, w/ CNS or CDNS concurrence, as appropriate
	Nuclear Facility: *Hazard Category 1, 2, and 3 nuclear facilities, conduct an Independent Project Review (IPR)*	PSO	PSO	PSO	PSO	PSO	PSO
	Nuclear Facility: *Hazard Cat. 1,2,3 Nuclear Facility--Prepare a Conceptual Safety Design Report (CSDR)*	SBAA via the CSVR	SBAA via the CSVR	SBAA via the CSVR	SBAA via the CSVR	SBAA via the CSVR	SBAA via the CSVR
	Nuclear Facility: *Hazard Cat. 1,2,3 Nuclear Facility--Prepare Conceptual Safety Validation Report (CSVR)*	SBAA	SBAA	SBAA	SBAA	SBAA	SBAA
	Nuclear Facility: *Hazard Cat. 1,2,3 Nuclear Facility--Initiate a Code of Record*	Project	Project	Project	Project	Project	Project
POST CD-1	Submit approved CD or equivalent documents to APM	SC-2B	SC-2B	SC-2B	SC-2B	SC-2B	SC-2B
	Allow expenditure of PED, MIE OR OE funds for project design.	Project	Project	Project	Project	Project	Project
	Submit budget request for the remainder of TPC **if CD-2 is approved w/i 2 years of OMB submission**	SC-AD	SC-AD	SC-AD	SC-AD	SC-AD	SC-AD
	Update PARS II with monthly status	Prog. Mgr. & FPD No Earned Value (EV)	Prog. Mgr. & FPD No Earned Value (EV)	Prog. Mgr. & FPD No Earned Value (EV)	Prog. Mgr. & FPD No Earned Value (EV)	Prog. Mgr. & FPD No Earned Value (EV)	Prog. Mgr. & FPD No Earned Value (EV)
	Continue with Monthly or Quarterly Project Reporting/Meeting	SC-AD Invite SC-1 and SC-2B	SC-AD Invite SC-1 and SC-2B	SC-AD Invite SC-2 and SC-2B	SC-AD to invite SC-2B	SC-AD to invite SC-2B	SC-AD to invite SC-2B
	Develop an Acquisition Plan if applicable						
	Nuclear Facility: *Hazard Cat. 1,2,3 Nuclear Facility--Develop a Checkout, Testing & Commissioning Plan*	Project	Project	Project	Project	Project	Project

October 2019

Page 3 of DOE/SC Decision Matrix

Acquisition Strategy

- Like the MNS, the Acquisition Strategy (AS) is a DOE document, but …
  - … just like the MNS, the laboratory project team provides input
- Guide to achieving project objectives within resource constraints
- Framework for the next phases of planning, organizing, staffing, controlling, and leading a project
- Reviewed by DOE/SC-OPA (SC-28)
- Approved by
  - TPC ≥$400M: Office of Science Director (SC-1)
  - TPC <$400M & ≥$100M: Office of Science Deputy Director (SC-2)
  - TPC <$100M: Office of Science Assoc. Director (SC-AD / Program Director)

Acquisition Strategy Contents

- Justification of Mission Need
- Project Description & Performance Parameters
- Alternatives Analysis
  - Comparative lifecycle costs
- Recommended Alternative
- TPC Range
- Funding Profile
- Key Milestones / Events
- Tailoring Strategy
- Business/Acquisition Approach
- Management Structure/Approach
- Risk Analysis

Acquisition Strategy – Project Description

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Amplification of the Potential Approach in the MNS

- Description of how project fills the mission need/gap
- Major technical and performance parameters
- Items or services that will be produced*
- Estimated quantities of products or services*
- Proposed location of the new asset
- Required square footage for facilities
- Excess buildings or facilities to be eliminated
- External constraints on project
  - Specific laws,
  - Regulations
  - Agreements
  - Other factors that significantly impact project
- Identification of a hazard category 1, 2 or 3 nuclear facility or other hazardous facility*
- Compliance with the DOE Leadership in Energy and Environmental Design (LEED) Green Building Rating System certification*
- Planned end use for a decontamination and decommissioning (D&D) project*

Analysis of Alternatives (AoA)

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- Must analyze at least 3 alternatives
  - *Status Quo* always included
  - For buildings renovating existing facilities
- Tabular and/or narrative with sufficient detail to justify the recommended approach
- GAO-15-37 *DOE and NNSA Analysis of Alternatives* Appendix III identifies 24 best practices

Best Practices for the Analysis of Alternatives (AOA) Process*

I. General principles
1. The customer defines the mission need and functional requirements without a predetermined solution.
2. The customer defines functional requirements based on the mission need.
3. The customer provides the team conducting the analysis of alternatives (AOA) with enough time to complete the AOA process to ensure a robust and complete analysis.
4. The team includes members with diverse areas of expertise including, at a minimum, subject matter expertise, project management, cost estimating, and risk management.
5. The team creates a plan, including proposed methodologies, for identifying, analyzing, and selecting alternatives, before beginning the AOA process.
6. The team documents all steps taken to identify, analyze and select alternatives in a single document.
7. The team documents and justifies all assumptions and constraints used in the analysis.
8. The team conducts the analysis without a predetermined solution.
II. Identifying alternatives
9. The team identifies and considers a diverse range of alternatives to meet the mission need.
10. The team describes alternatives in sufficient detail to allow for robust analysis.
11. The team includes one alternative representing the status quo to provide a basis of comparison among alternatives.
12. The team screens the list of alternatives before proceeding, eliminates those that are not viable, and documents the reasons for eliminating any alternatives.

*Source: GAO. | GAO-15-37

Best Practices for the Analysis of Alternatives (AOA) Process*

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III. Analyzing alternatives
13. The team develops a life-cycle cost estimate for each alternative, including all costs from inception of the project through design, development, deployment, operation, maintenance, and retirement.[a]
14. The team presents the life-cycle cost estimate for each alternative as a range or with a confidence interval, and not solely as a point estimate.
15. The team expresses the life-cycle cost estimate in present value terms and explains why it chose the specific discount rate used.[b]
16. The team uses a standard process to quantify the benefits/effectiveness of each alternative and documents this process.
17. The team quantifies the benefits/effectiveness resulting from each alternative over that alternative's full life cycle, if possible.
18. The team explains how each measure of benefit/effectiveness supports the mission need.
19. The team identifies and documents the significant risks and mitigation strategies for each alternative.
20. The team tests and documents the sensitivity of both the cost and benefit/effectiveness estimates for each alternative to risks and changes in key assumptions.
IV. Selecting a preferred alternative
21. The team or the decision maker defines selection criteria based on the mission need.
22. The team or the decision maker weights the selection criteria to reflect the relative importance of each criterion.
23. The team or the decision maker compares alternatives using net present value,[c] if possible.
24. An entity independent of the AOA process reviews the extent to which all best practices have been followed (for certain projects, additional independent reviews may be necessary at earlier stages of the process such as for reviewing the study plan or for reviewing the identification of viable alternatives).

*Source: GAO. | GAO-15-37

Breakout Activity

Consider alternatives for the project you developed a Mission Need

- Identify at least three alternatives as required by DOE/SC
- Discuss heuristically positives / negatives of each alternative

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Breakout Activity

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Analysis of Alternatives

- Consider alternatives for the project you developed a Mission Need
  - Identify at least three alternatives as required by DOE/SC
  - Discuss heuristically positives / negatives of each alternative

Preliminary Project Execution Plan (PPEP)

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- The Project Execution Plan (PEP) is the *primary agreement* between DOE-HQ, the FPD, and the laboratory project team
- Living document – revised when needed
- High-level and concise
  - Do not include in the PEP points / procedures that are wholly within the control of the laboratory project team – use a separate Project Management Plan (PMP)

DOE/SC FPDs and roles

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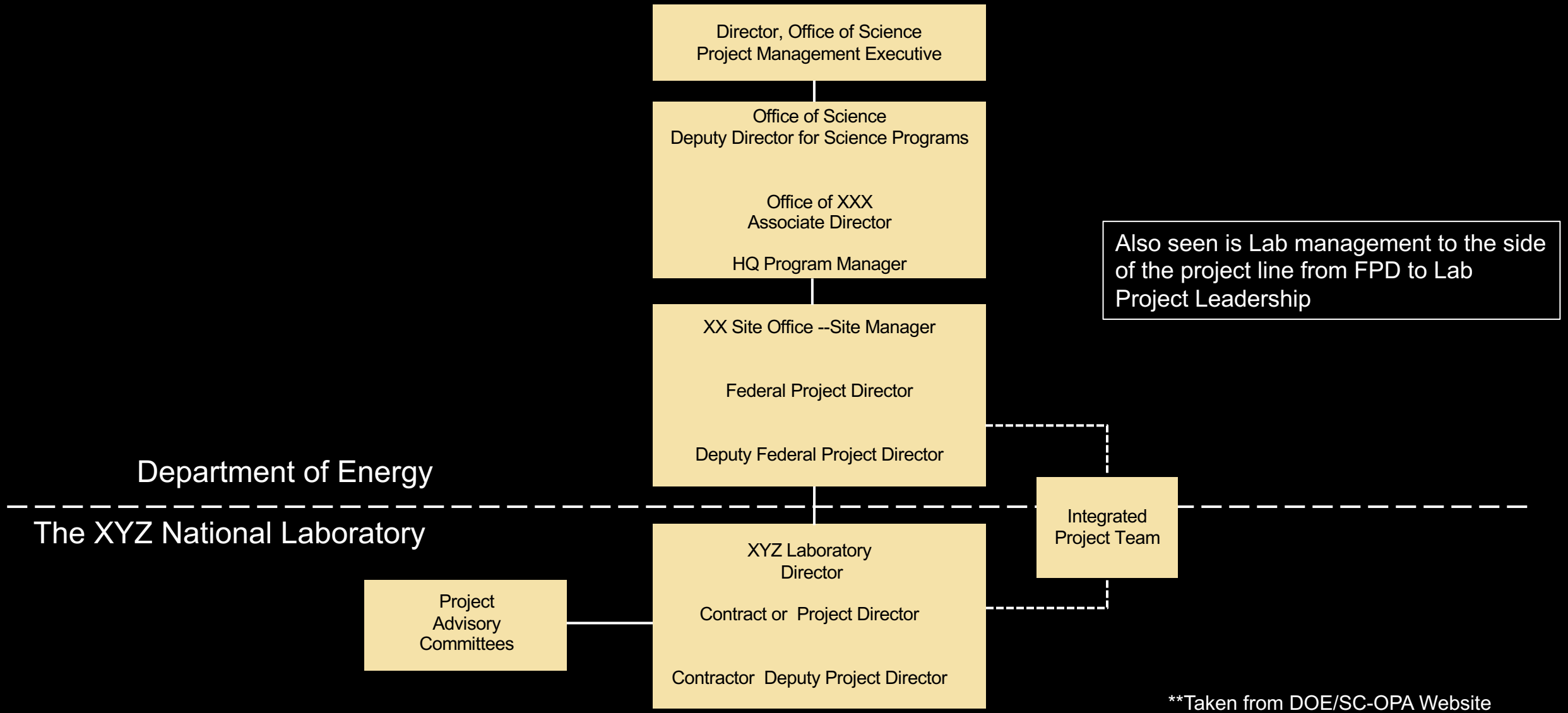
- The overall SC objective is to select competent and capable FPDs to successfully manage SC projects
- FPDs role is to be the "Owner's Representative" for the assigned project
- FPDs serve as the single point of contact between DOE and the contractor, typically as a Contracting Officer's Representative
- FPDs lead the Integrated Project Team and are responsible and accountable within DOE for ensuring the success of the assigned project

Typical* SC Project Organization**

*Sort of



Also seen is Lab management to the side of the project line from FPD to Lab Project Leadership

**Taken from DOE/SC-OPA Website

Federal Project Director

The FPD is one of the most valuable stakeholders associated with your project

- Single POC between Federal and laboratory staff for all matters relating to a project and its performance
- Contracting Officer's Representative, as delegated by the Contracting Officer
- Leads the IPT and provide broad project guidance
- Ensures early warning systems (triggered by thresholds) and communication channels are in place
- Holds and administers contingency within established thresholds

Integrated Project Team (IPT)

- The DOE IPT is a cross-functional group organized to assist FPD in the successful delivery of a project
- It consists for DOE personnel, but can include laboratory and external contractors as deemed necessary by the FPD
- The IPT is a tool for the FPD to ensure that as the DOE *customer representative* the project is actively progressing and addressing risk
- Depending upon circumstances, DOE/SC-HQ program staff may be members of the IPT

Tailoring

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- Paraphrased from the Order
  - …consolidation of CD's, equivalent documents, graded document development, concurrent processes, portfolio of projects (one CD and AS for group of projects)

- Tailoring that has been observed
  - High Performance Computing – Operations Funded / Milestone based
  - Combine CD's (design/build)
  - Equivalent documents (PMP aspects covered in PEP)
  - Portfolio (chunking – multiple projects with a single CD-1)
  - Sub-projects under a large single CD-1
  - Long-lead procurements / site preparation (single or multiple)

Cost Ranges are important to consider carefully

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- The cost ranges must be established based on clear conservative assessments of the range of risks and uncertainties at CD-0 and at CD-1
- The ranges must be realistic
  - The lower end cannot merely be "complete the project without need for contingency"
  - Upper end must reflect the appropriate ensemble sum of risks and uncertainties
- The CD-0 range can be increased at CD-1, but with consternation
- The CD-1 range should not be exceeded by the performance baseline
  - If for some reason the CD-1 range is exceeded by more than 50% the entire project must have its mission need re-evaluated

Preliminary Hazards Analysis Report and ISM Plan

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Use the strength of the Laboratory framework for the heavy lifting

- A specialized application of both systems engineering and risk management
- No specific guidance on the PHAR / HAR exists
  - Conventional wisdom, oral tradition, and opinions do
- Minimize the project-specific points to only those that are not covered by the Laboratory's pre-existing
  - ISM
  - Construction Health and Safety
- Develop a Laboratory standard approach for PHAR and HAR to avoid projects being subjected to *reviewer whim*

- At CD-1 the PHAR should *identify and classify* hazards
  - Type:
    - *Operational*
    - *Construction/Execution*
  - Nature:
    - Complex – project specific
    - Standard Industrial – Laboratory framework
- At CD-3 Splits into
  - Project Construction Safety & Health Plan
  - Hazards Analysis Report (Operational Hazards)

Project Quality Assurance Program (QAP)

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Safeguards & Security

Rely first and foremost on the Laboratory's frameworks

- As with the ES&H, the Laboratory should provide a framework which covers the vast majority of all project related quality assurance points
- The project in its QAP should reference what it is following from the Laboratory QA framework and detail **only** those specific items that are project specific, or from a management standpoint pose a particularly critical risk that merits more specific detailing (unlikely at CD-1*)
- Similarly with the Safeguards and Security

*But not without counter examples

Conceptual Design

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DOE O 413.3B

- The Conceptual Design process requires a mission need as an input. It is the exploration of concepts, specifications and designs for meeting the mission needs, and the development of alternatives that are technically viable, affordable and sustainable. The conceptual design provides sufficient detail to produce a more refined cost estimate range and to evaluate the merits of the project.
- The Conceptual Design Report (CDR) details the complete conceptual design and provides the basis for subsequent design efforts, scope determination, and development of estimates of both schedule and cost

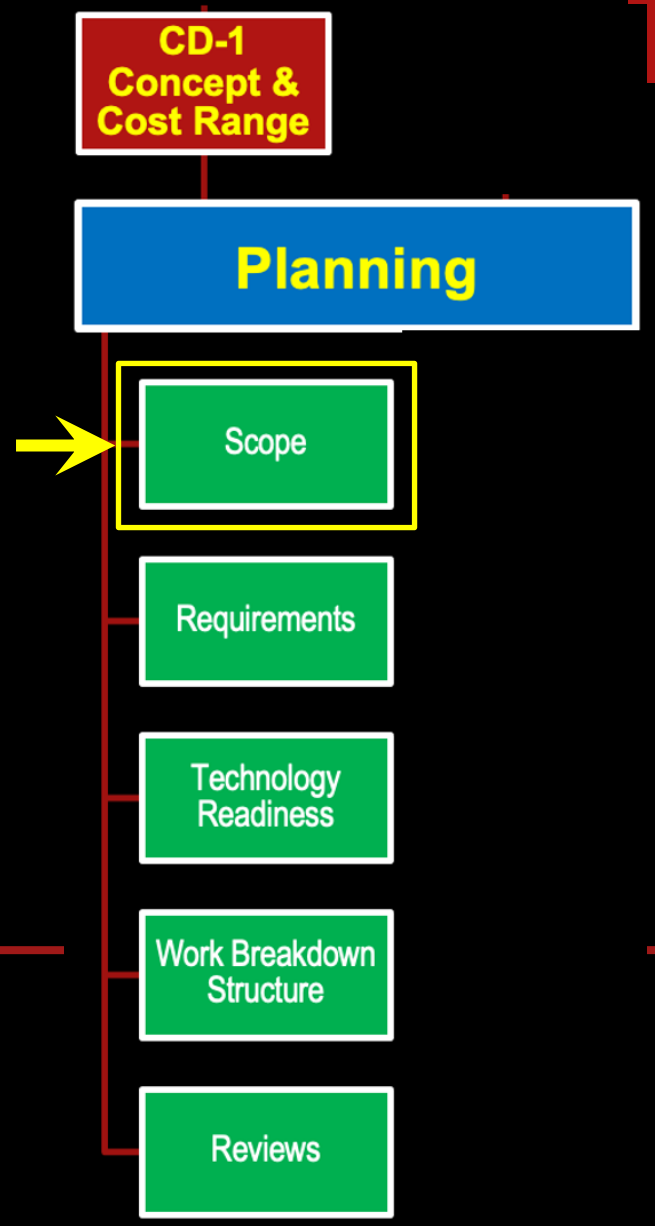
Key Performance Parameters (KPPs)

- The CDR should also clearly and concisely describe the KPPs that will form the basis of the Performance Baseline at CD-2
- Foundational element of the original Performance Baseline
- A KPP is defined by CD-2
  - A characteristic,
  - Function,
  - Requirement or
  - Design basis
- If changed would have a major impact on
  - System or facility performance,
  - Schedule,
  - Cost
  - Risk.
- The KPPs should be the **minimum** needed to characterize the major drivers of project performance.

Description of Scope	Threshold KPP	Objective KPP
Xe Detector	Assembled in inner cryostat, 90% of Xe PMTs sensing PEs from LED calibration source in the surface assembly area	Assembled and underground, cold and with 96% of Xe PMTs sensing PEs from LED calibration source
Kr Removal System	Assembled and having demonstrated capability to reduce Kr concentration to <0.30 ppt in a 100 Kg Xe sample	Assembled and all Xe needed for LZ processed with Kr concentration reduced to <0.015 ppt
Veto System	All major components delivered to surface storage area, PMTs fully tested and ready for assembly	Assembled and filled underground with 95% of PMTs sensing PEs from LED calibration source
FE, DAQ, Online & Offline System	Simulated PMT data processed through offline system and producing data quality plots	PMT signal data from LED flashers processed through entire system and producing data quality plots

- Threshold and Objective KPP values
- **Minimum** KPPs and facility mission must stay intact for the duration of the project

Scope Planning



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Scope Management

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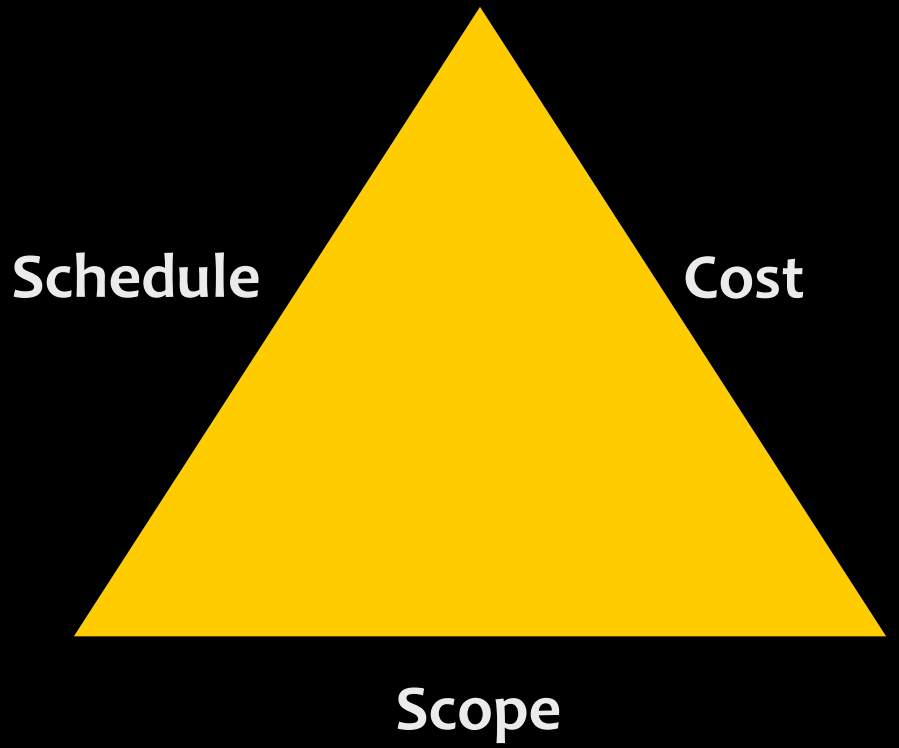
- Plan Scope Management
- Collect Requirements
- Define Scope
- Create Work Breakdown Structure

- Additional items to consider
  - Measurement
  - Analysis
  - Control/Correction
  - Quality Assurance / Control



Planning Scope Management

- 2 Deliverables:
  - Requirements Management Plan
    - Identify
    - Develop
    - Trace
    - Control
  - Scope Management Plan
    - Identify
    - Develop
    - Control

- It is important to distinguish
  - What is needed for the end deliverable?
    - Product scope
  - What is needed to achieve the end deliverable?
    - Project scope

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Scope Definition (1)

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- How?
  - Subdivide major deliverables into smaller, more manageable components to provide better control.
- Déjà vu?
  - Yes, you've seen this before. Scope is a component of the Project Charter.

Scope creates a framework to manage all of the work required, and only the work required to manage the project successfully.

Scope Definition (2)

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- Why?
  - To ensure agreement between the project team, sponsor, and customer on what the final deliverables of the project will be.
- What?
  - The project scope defines who the customers are, the final deliverables, and the criteria with which customers will judge the deliverables.

Scope Definition (3)

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Steps:

1. Review the Project Charter for the Scope elements such as customer's needs and requirements. Project Charter must be complete. (This includes purpose, project name, customer, needs and requirements, final deliverables, org. goals.)

2. Write a detailed description of the final deliverables. This is the team's job. It is important to provide the sponsor/customer a complete picture of what will be produced.

3. Define the customer's criteria for acceptance of the final deliverables. *Where possible, make the criteria measurable.*

Scope Definition (4)

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Steps (cont.)

4. Define the the interim deliverables that will be produced for each final deliverable.

   An interim deliverable directly leads to or supports the production of a final deliverable.

5. Develop a Statement of Work (SOW) or Scope Definition Document
   - Product scope description
   - Deliverables
   - Acceptance criteria
   - Project exclusions

Scope Definition (5)

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Steps (cont.)

6. Identify the processes that are part of the project scope.
   - A process is a set of steps or activities that allows a person or team to produce the same outcome, with minor variations, every time the process is applied.
   - The project scope is a description of what interim and final deliverables will be produced.
   - Review the project's interim and final deliverables to identify the processes that will produce those deliverables.

Scope Definition (6)

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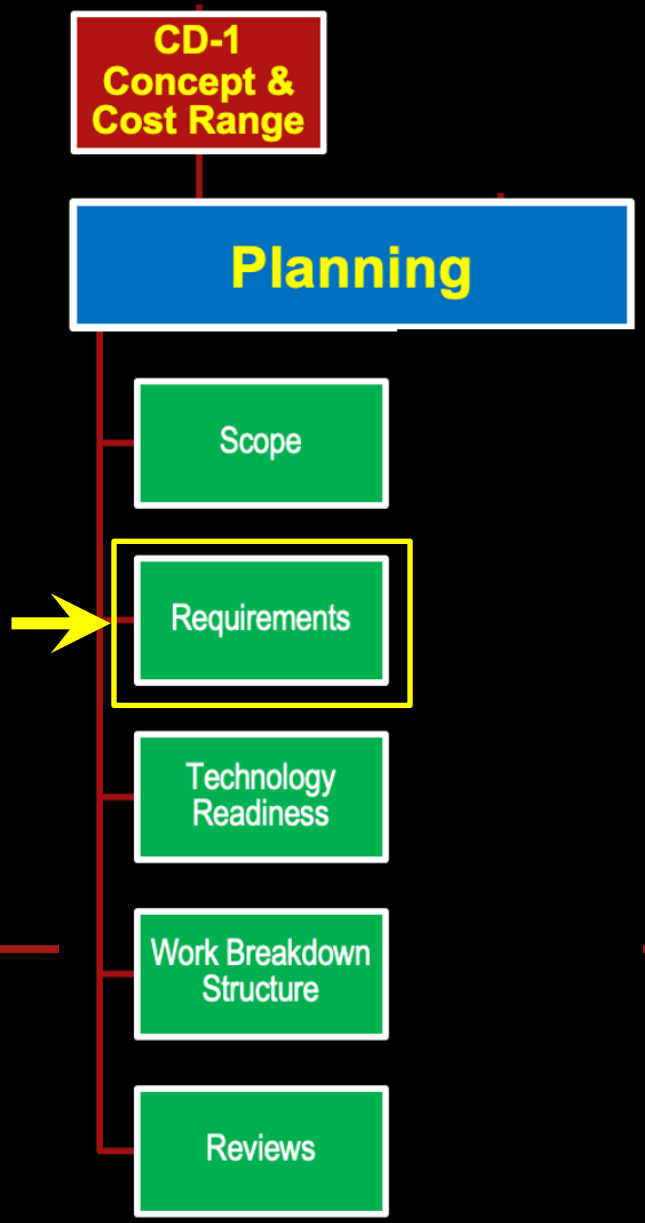
The Project Scope will need revision as project progresses.

It must be controlled.

- In order to properly control scope, the project must have a work breakdown structure with interim milestones identified to sufficient detail to support project planning and control (subsequent topic).

Requirements Management



"I have what I need. This is enough." — Lailah Gifty Akita

"What I like and what I need's two different things." — J.D. Jordan

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As a project is initiated and planned the development of requirements must effectively managed

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- At project initiation there must be careful thought to requirements – that which is necessary for the success of the project
- During project planning the requirements and constraints of the project must be extensively developed in connection with the design
- **Essential Aspect**: Understanding the difference between fundamental, derived, and external (constraints) requirements

More on Requirements

- Fundamental Requirements or Key Performance Parameters (KPP):
  - Technical requirements that if not achieved would be considered a fundamental failure of the project
- Derived Requirements
  - Requirements on the project deliverables that evolve or are developed from other more fundamental requirements
    - Example: Resolving capacity (fundamental) → vibrational stability (derived)
- External Requirements (constraints)
  - Requirements that are imposed external to the project that are not directly related to the KPPs but must be met and/or limit how the project may be executed, or the deliverables met
    - Example: Environmental / Safety compliance standards

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Example from LBNF/DUNE Project, June 2015 (1)

Requirements

DUNE and LBNF requirements are:

- **Determined by the primary science goals of the collaboration**
  - LBNF: Baseline, Conventional Facilities & Beam
  - Far Detector: for oscillation physics, proton decay, and SNB neutrinos
  - Near Detector: to constrain LBL systematics
- **Informed by the ancillary science program**
  - Near Detector: to provide a rich self-contained neutrino physics program (largely follows from primary requirements)

Example from LBNF/DUNE Project, June 2015 (2)

Requirements: Methodology

Detailed flow-down of requirements from the:

- DUNE Scientific Objectives ➡ Scientific Requirements ➡ Science/Engineering requirements ➡ Engineering specification

Example:

Glo--obj--2	Precision measurements of oscilla@ons in the $\nu_\mu \rightarrow \nu_e$ and $\bar{\nu}_\mu \rightarrow \bar{\nu}_e$ appearance channel	Precision measurements in both Near and Far detectors which are necessary to determine the parameters that govern $\nu_\mu \rightarrow \nu_e$ appearance, and similarly, $\bar{\nu}_\mu \rightarrow \bar{\nu}_e$ appearance	These will allow accurate measurements of the third mixing angle θ_{13}, and simultaneous measurement of the CP viola@ng phase δ, and the mass--hierarchy (sign of Δm^2_{32}).

➡

Glo--Sci--3	requirement	Iden@fica@on of Electron Neutrino and An@--neutrino Events	Far detector shall be capable of iden@fying electron neutrino and an@--neutrino charged current beam events in sufficient numbers within the fiducial volume of the detector. The neutrino flavor of the event will be iden@fied by clearly iden@fying the primary final state charged electron.

➡

LArFD--L2--se--66	requirement	EM showers	High energy EM showers [>100MeV] shall be iden@fied by their topology.
LArFD--L2--se--67	requirement	e--gamma Separa@on	Electron and photon induced showers shall be separated using ioniza@on density at the start of the shower.

➡ Key Detector Performance Requirements

Flow-available in document 10873

Example from LBNF/DUNE Project, June 2015 (3)

Far Detector Performance Reqs.

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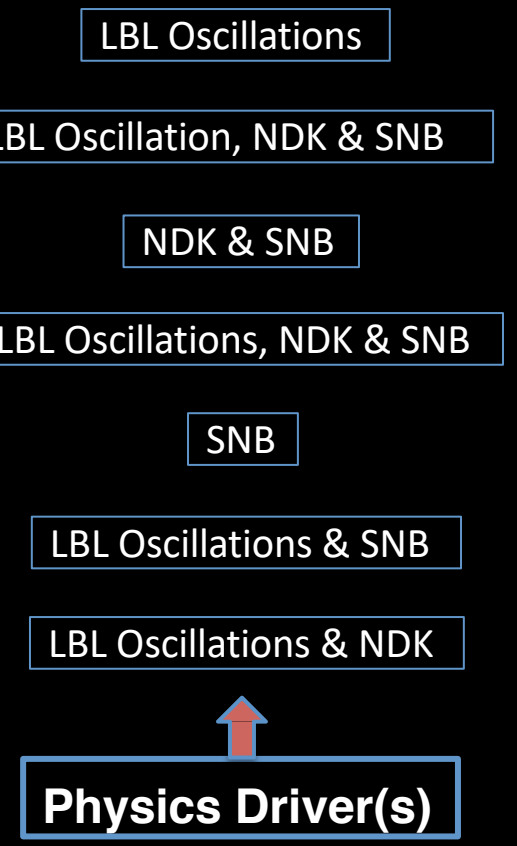
Physics objectives set goals for key detector performance requirements, e.g.

- Electron/Photon separation
- Tracking: Distinguish MIP deposits from noise
- Continuous data collection
- Particle Identification/Energy Reconstruction
- Energy Threshold
- Electron Energy Resolution
- Hadronic Energy Resolution
- …



Detector parameters chosen to meet performance requirements

The deliverables on requirements underscore specific important attributes

1. Requirements documentation / database
   - What the requirement is
   - What is the source of the requirement
2. Requirements breakdown structure
   - Highlights requirements hierarchy
   - Illustrates the source of derived requirements
3. Requirements traceability matrix
   - Records where requirements originate
   - Records what scope the requirements impact

Often all are contained in one platform

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This is all related to systems thinking and engineering

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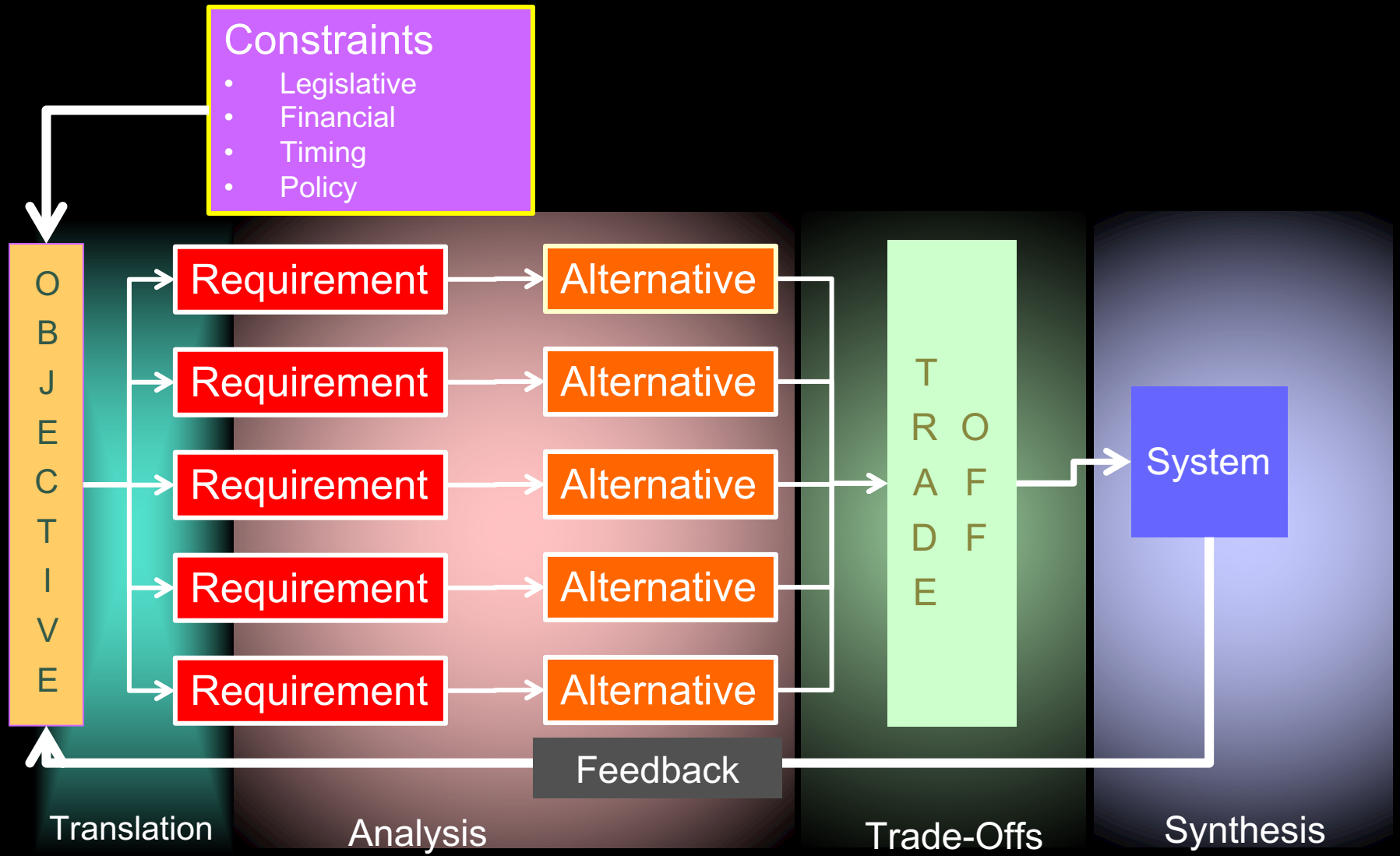
- All requirements on the project must be understood in order to be successful
  - Origin – what is it derived from?
  - Solidity
  - Impact
- The quality or solidity of a derived or external requirement is essential in the development of a project
  - Is it a guesstimate,
  - Does it have conservative factors added to it
  - Is it based on formal legal requirements or simple operational aspects

Systems approach and development has traceability as a critical aspect



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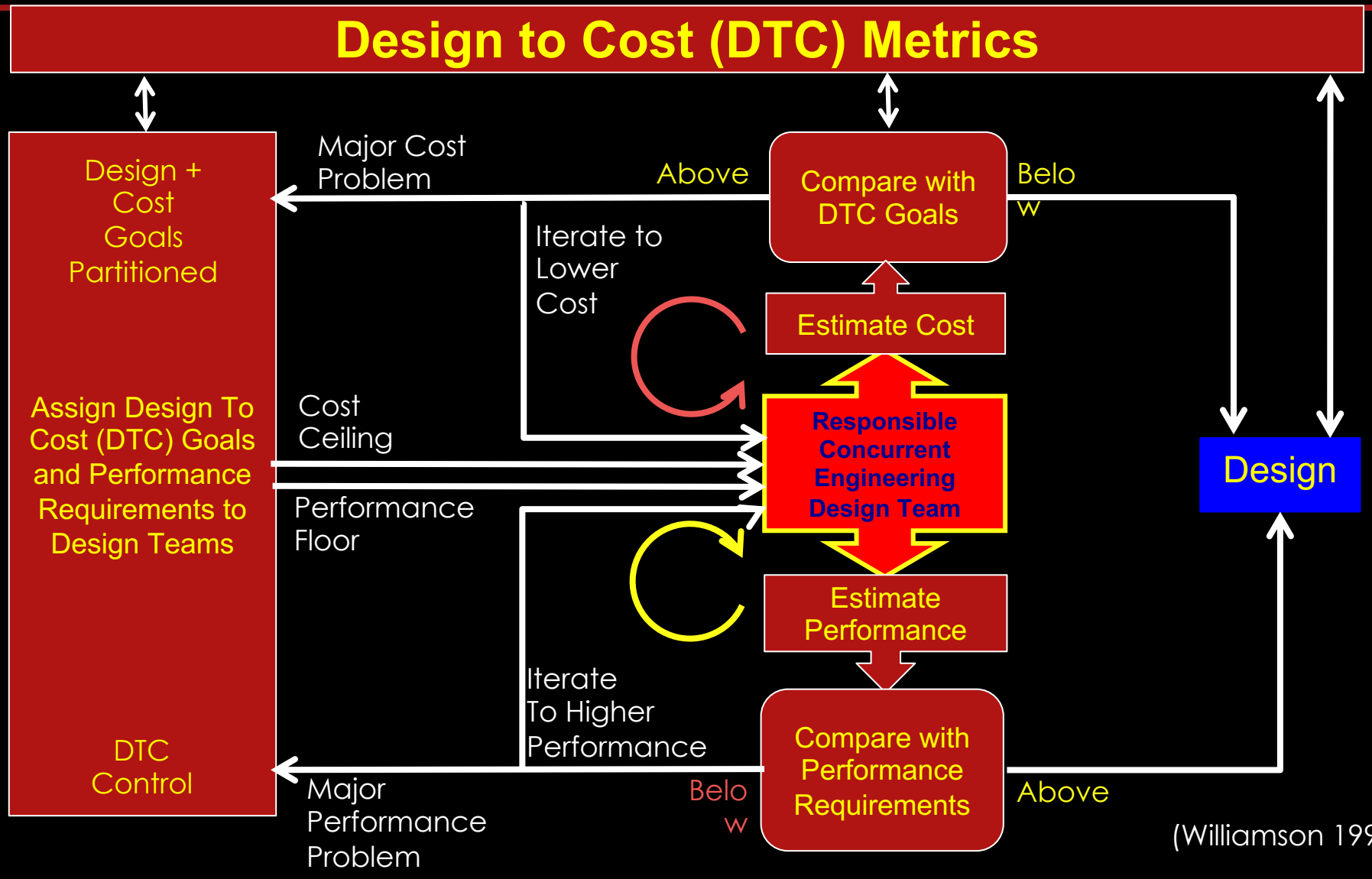
Cost requirements often must be considered to a level often equal or greater than technical requirements



(Williamson 1994)

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Invest the time upfront to get it right – It will save you

- After a contract is placed changes can be particularly costly
- You will reap what you sow

- Cost of change example from Hewlett Packard*
  - Requirements phase = $1
  - Design phase = $3 - $6
  - Coding phase = $10
  - Development testing = $15 - $40
  - Acceptance testing = $30 - $70
  - System operation = $40 - $1000

- Scientific hardware projects have significantly worse ratios

*R.J. Graham & R.L. Englund, *Creating an Environment for Successful Projects*

A list of characteristics is not adequate requirements management

- Often the approach is to make large tables of *required characteristics*
  - Required beam properties
  - Stability requirements
  - Operational requirements
  - Etc.

- Such *flat-file* lists are not adequate and a risk to the project
  - Do **not** clearly indicate the
    - The *origin* of the requirement
    - The *pedigree* of the requirement

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Project requirements must have a hierarchy as the project develops

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- All requirements, like constraints on the dependent variables cannot all be equally important
  - In a system where all requirements are equal no trade-offs can be realized
- There will be a few key requirements (Key Performance Parameters or KPPs)
  - They would constitute part of the kill criteria if they are not met
- Iteration and *proofing of* requirements necessary parts of a project development

Technology Readiness Levels (TRLs)

SCOPE PLANNING

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In the development of the scope, understanding the maturity of a technology is important

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- For those systems, subsystems, components, items in the WBS that are commercial off-the shelf (COTS) or commercially available (ComA)
  - Don't bother detailing below
  - The "make/buy" decision is easy
- For those systems, subsystems, components, items in the WBS that are not COTS or ComA then it is important to understand the state of development
- Does the project require the research and or development to use it
- What needs to be understood or achieved before full deployment / incorporation into the project
- This is known as Technology Readiness Assessment
- A scale has been developed – Technology Readiness Level

Technology Readiness Levels (cf. g413.3-4a)

Relative Level of Technology Development	Technology Readiness Level	TRL Definition
System Operations	TRL 9	Actual system operated over the full range of expected mission conditions.
System Commissioning	TRL 8	Actual system completed and qualified through test and demonstration.
	TRL 7	Full-scale, similar (prototypical) system demonstrated in relevant environment
Technology Demonstration	TRL 6	Engineering/pi lot-scale, similar (prototypical) system validation in relevant environment
Technology Development	TRL 5	Laboratory scale, similar system validation in relevant environment
	TRL 4	Component and/or system validation in laboratory environment
Research to Prove Feasibility	TRL 3	Analytical and experimental critical function and/or characteristic proof of concept
	TRL 2	Technology concept and/or application formulated
Basic Technology Research	TRL 1	Basic principles observed and reported

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Technology Readiness Levels (TRLs)

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Research to Prove Feasibility	TRL 3	Analytical and experimental critical function and/or characteristic proof of concept
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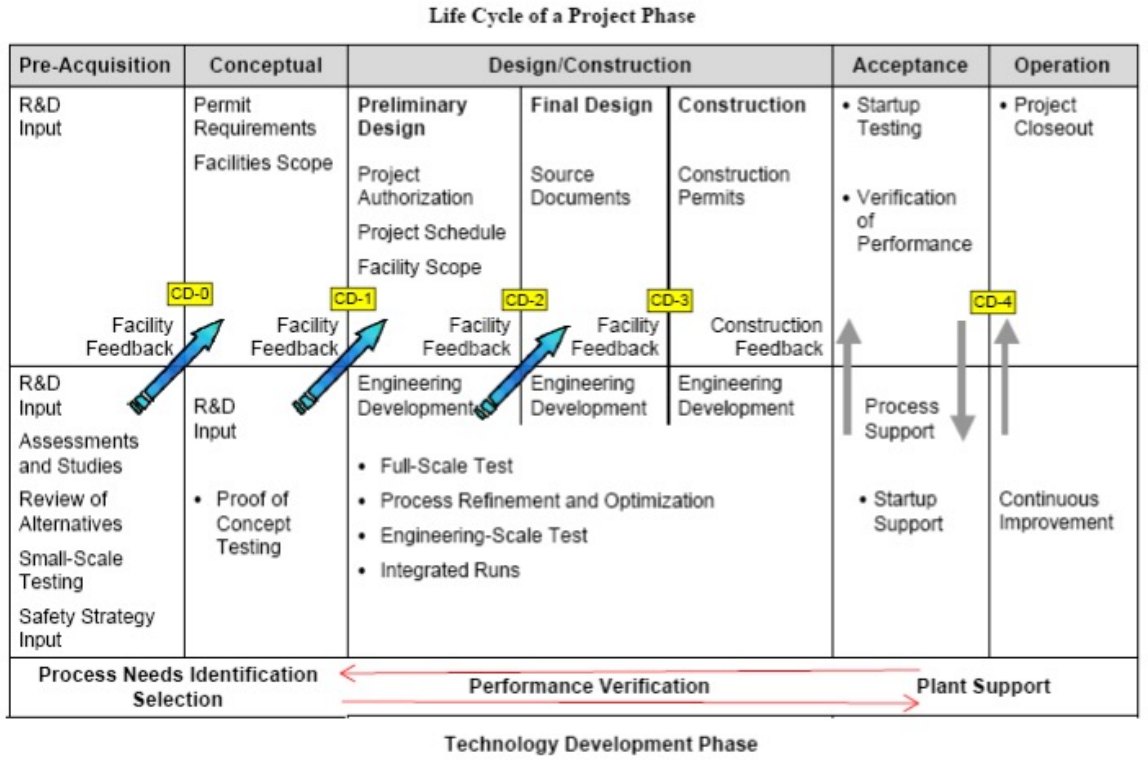
	TRL 1	Basic principles observed and reported

Figure 1. Technology Development Integration with Project Management.



While other parts of DOE depend on TRL assessments, DOE-SC relies on the inputs / assessments / judgment of the review committees conducted by OPA.

The approach for TRL assessment

1. Identify critical technology elements (CTEs)
2. Assess the technology readiness Level (TRL)
3. Develop a technology maturation plan (TML) if required
   - Concept development
   - Design verification testing
   - Prototyping

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Work Breakdown Structure (WBS)

Your mother always told you to take small bites

WBS Definition

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- A project work breakdown structure (WBS) is a deliverable or product-oriented grouping of project work elements to organize and subdivide the total work scope of a project.
- 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. (PMBOK® 6th Ed.)

WBS Characteristics

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- **The Work Breakdown Structure (WBS) is**:

The single - most important Project Scope Management tool.

The "Skeleton" of the project

  - Developed by the project team; approved by the Project Manager and Group Leader

- The WBS provides the basis for planning and controlling a program or project and serves many masters.

Don't rush to scheduling software.

Without the work, the breakdown structure is just BS.

The WBS is a logical decomposition

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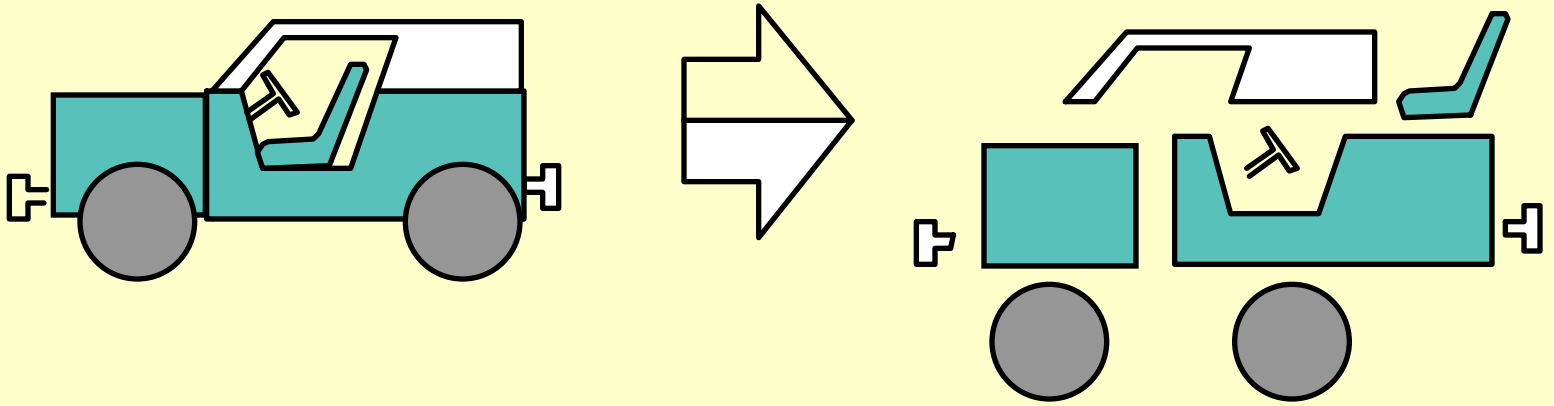
- **A Method to Achieve Logical Decomposition of a Large/Complex Thing**

The Whole **Its Pieces**



- **Pieces are successively decomposed into smaller and smaller pieces until each piece is a manageable size**

Aspects of a WBS

- The 100% rule: **EVERYTHING** in a project **MUST** be in the WBS
- Work not in the WBS is **outside** of the scope of the project
- It is used to define the project's work in terms of **deliverables**
- Serves as a basis for developing the schedule
- Forms the basis for estimating the effort/cost
- Serves as a basis for assigning responsibility for deliverables, subprojects, tasks and work packages

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Additional WBS Considerations

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- The WBS is broken down to increasingly smaller pieces until it get to the work packages.

- **Work Packages** are:
  - More precisely defined
  - Require smaller amounts of time and resources to complete
  - Most generally will be further detailed to individual activities for schedule and cost estimation

- Estimating resources for a number of small, well-defined tasks is easier than estimating a large, complex project
  - Each work package is evaluated by an expert (or experts) in the task
  - The person responsible for the work package will subsequently *own* its estimate

WBS Uses in Project Management

Planning

- Project planning & control
- Translating requirements into work allocation
- Developing schedules
- Estimating cost
- Formulating/allocating budget
  schedule, cost)
- Defining tech. And programmatic requirements and plans
- Risk analysis
- Make-or-buy planning

Executing

- Collecting, controlling and reporting costs
- Assessing and measuring
- Status reporting (technical, schedule, cost)
- Preparing Statement of work
- Proposal preparation
- Assigning responsibilities

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Attributes of a Project WBS

- Be product or deliverable oriented
- Include **all** necessary effort required to achieve an end objective
  - Developed from top downward
  - No deliverable, aspect, or contributing task should be overlooked
- Hierarchical in nature, with each element appropriately placed
- Contain appropriate level of detail
- Element descriptions should be clear, concise and easy to understand
- All elements properly integrated to reflect internal WBS element relationships

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WBS and Delegation of Authority

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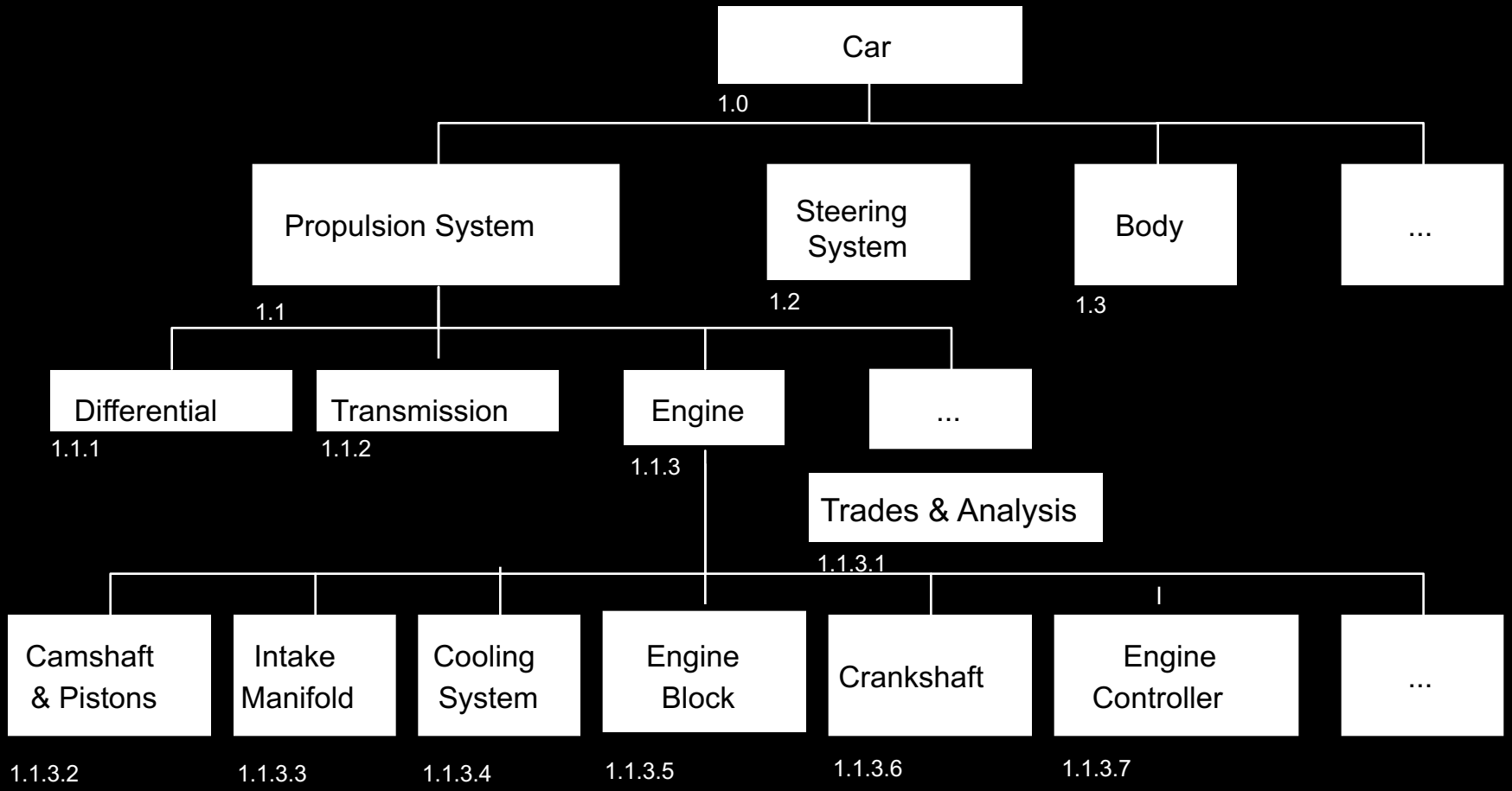
- The Project Manager cannot personally supervise every detail

  Generally the Project Manager should not be personally responsible for a critical area on a large project

  - There needs to be a delegation of authority to a manager at each level

- The WBS structure establishes a clear deliverable hierarchy
  - The project organization often follows the WBS
  - Each WBS element will have a single owner/manager
  - Each *owner* will have one or more WBS elements

An Example of a WBS



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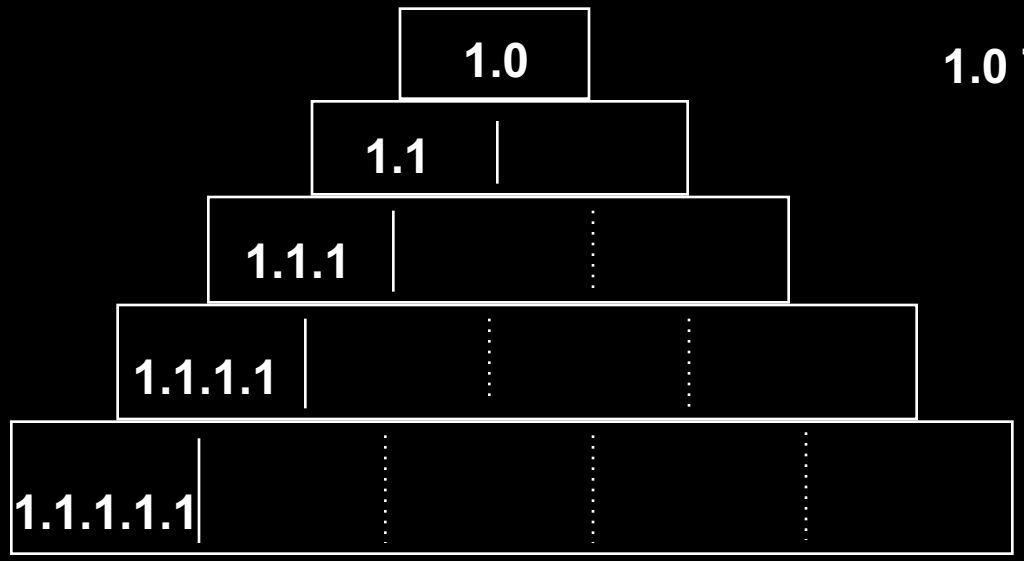
Subdivisions Of The Work

Arrangements or configurations of a WBS which is a hierarchy or indenture of work elements required to complete an end objective.

Hierarchy



Indenture

1.0 Total System

1.1 Major Subsystems

1.1.1 Major components

1.1.1.1 Subcomponents

1.1.1.1.1 Work Packages

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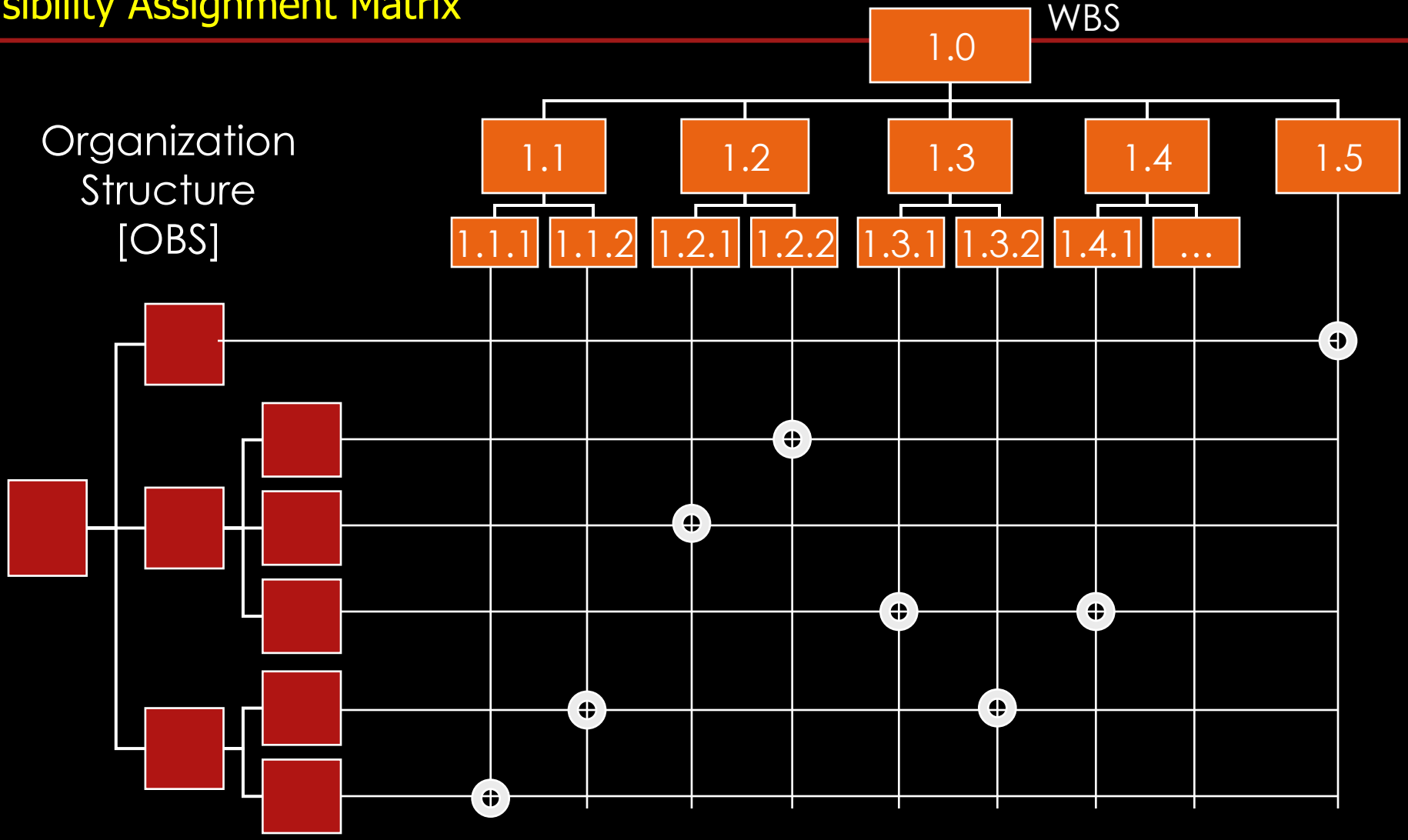
WBS Elements Should Have Unique Owners

The Responsibility Assignment Matrix



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Example WBS: Changing a Bicycle Tire – Outline Hierarchical Format

1. Tool preparation
   - 1.1 Prepare tire levers
   - 1.2 Prepare pump
   - 1.3 Prepare water bath
   - 1.4 Prepare marker
   - 1.5 Prepare patch
   - 1.6 Prepare glue
2. Inner tube removal
   - 2.1 Deflate tire
   - 2.2 Remove outer tire with tire levers
   - 2.3 Remove inner tube
3. Leak detection
   - 3.1 Inflate inner tube with pump
   - 3.2 Look for leak in water bath
   - 3.3 Mark leak with marker
4. Inner tube repair
   - 4.1 Deflate inner tube
   - 4.2 Apply glue to mark and patch
   - 4.3 Allow glue to dry
   - 4.4 Apply patch to mark
5. Inner tube verification
   - 5.1 Inflate inner tube with pump
   - 5.2 Look for leak under water
   - 5.3 Deflate inner tube˘
6. Tire Remounting
   - 6.1 Remove valve
   - 6.2 Insert valve stem through rim
   - 6.3 Replace valve stem retaining ring
   - 6.4 Insert inner tube in tire
   - 6.5 Replace tire with levers
   - 6.6 Inflate tire with pump
7. Cleanup and Storage
   - 7.1 Replace water bath
   - 7.2 Replace marker
   - 7.3 Replace glue
   - 7.4 Replace patches
   - 7.5 Replace tire levers
   - 7.6 Replace pump

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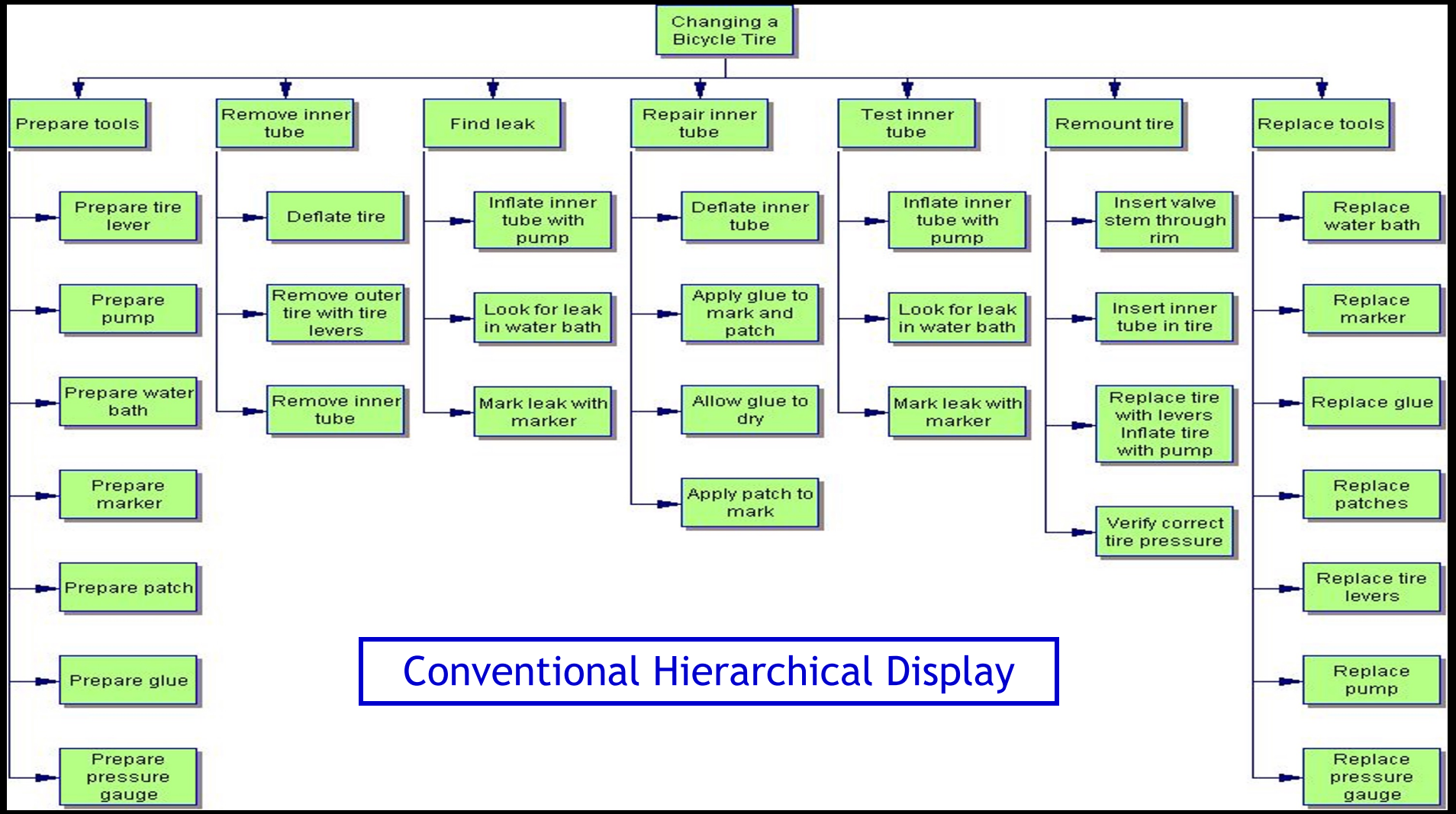
Example WBS: Changing Bicycle Tire



Conventional Hierarchical Display

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Alphanumerics – An Alternative To Numbers

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- The use of the *Legal* outline form for WBS organization is historic and has been enshrined in scheduling software.
- Alphanumeric designator levels are being used by more and more projects
  - Thirty-Meter Telescope (TMT)
  - Deep Underground Science and Engineering Laboratory (DUSEL)
  - Next Generation Light Source (NGLS)
  - LBNF/DUNE

- Note: If using an alphanumeric WBS, keep identifiers at the same level equal length

OK	NOT OK
PRJ.TOOL.FIX	PRJ.TOOL.FIXTURES
PRJ.STND.FLR	PRJ.STAND.FLOOR
PRJ.MNT0.SEI	PRJ.MOUNT.SEISMIC

Alphanumeric WBS Example – DUSEL

- DUS – DUSEL
  - DUS.PRJ – Cross-cutting Project Systems
    - DUS.PRJ.MGT – Project Management
    - DUS.PRJ.PMO – Project Controls / Support
    - DUS.PRJ.SYS – Systems Engineering / Integration
    - DUS.PRJ.EHS – Environment, Health and Safety
    - DUS.PRJ.EDO – Education and Outreach
  - DUS.FAC – Facility
    - DUS.FAC.SUR – Surface Facilities
    - DUS.FAC.UGI – Underground Infrastructure
    - DUS.FAC.MLL – 4850L Mid-Level Laboratory
    - …
  - DUS.SCI – Scientific Program and Experiments
    - …
  - DUS.OPS – Operations
    - …

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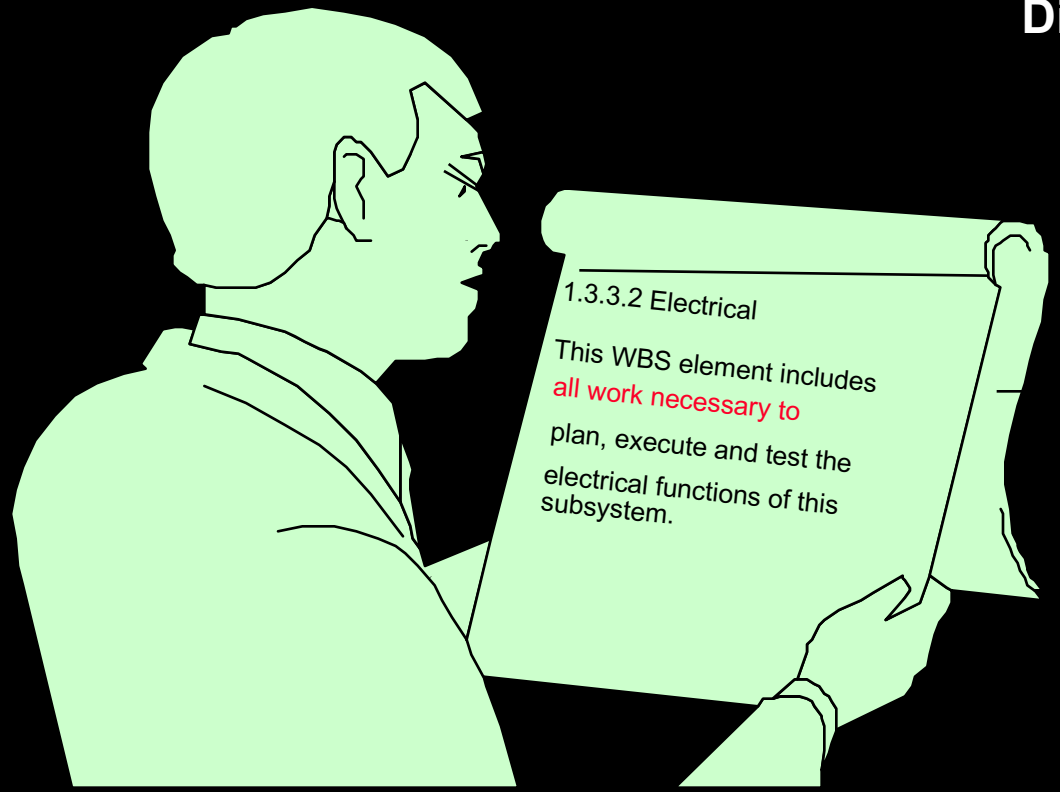
A WBS Dictionary is

A narrative description of the total content of each element appearing on the WBS.



Dictionary should include:

- **Work to be performed**
- **Quantity of Hardware Developed or delivered**
- **Software to be developed**
- **Service provided**
- **Other non-recurring work descriptive data**

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WBS Dictionary Example

DESI

Work Breakdown Structure Dictionary

Project Title: Dark Energy Spectroscopic Instrument (DESI)	**Date:** July 2015	**Identification Number:** Project #41ZA
WBS Element: 1.4.4	**WBS Title:** Fiber Positioners Production	
Revision No. and Authorization:	**Rev. Date:** July 2015	**Funding Source:** DOE/Common
Approved Changes:		
Level 2 Manager: Silber	**Project ID:**	
Responsible Scientist:	**Institution:** Michigan	

WBS Description:

This summary WBS includes mass production of 5200 fiber positioners. It includes an early EM production of up to 10 positioners to test tooling and assembly techniques. It includes production of mechanical assemblies, local electronics, and external electronics. The electronics and firmware developed under this WBS will be capable of driving two types of devices: fiber positioners and illuminated fiducials. This WBS includes integration of mechanical assemblies to local electronics. It includes integration of fibers into positioners. It does not include integration of positioners into focal plate.

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What is a Work Package?

- Represents a unit of work
- Distinguishable from other Work Packages (unique)
- Assigned to a single individual / organization to the maximum extent possible
- Should have interim milestones* and inch-pebbles#

*a milestone is a point in the project when a specific activity is completed

an inch-pebble is a point in the task when a specific interim tangible deliverable/activity is completed

- Will eventually have a Scheduled Start Date
- Will eventually have a Scheduled Completion Date
- Will have manpower and budget estimates

Will be included as the schedule is developed

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WBS Nouns/Verbs/Phases/$

- WBS will follow be influenced by the project development cycle
  - For DOE O413.3B and non-adaptive development cycles noun/deliverable based is STRONGLY Preferred
- Noun based
  - Systems centric
  - Design – BOM relationship
- Verb based – Functional
  - Activity – Centric
  - Less advisable as deliverables can be lost and not easily isolated
- Phased
  - Designed to follow principal project phase
    - CD-1 Preliminary Design
    - CD-2 Detailed Design
    - CD-3 Construction
- $ - Different types of funding (colors of $)
- Often a complex WBS may have aspects of each

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WBS Cautions

- Concentrate on deliverables
  - Noun based (system centric) vs. verb based (activity centric)
- Interfaces
  - The connections between higher level WBS elements greatly influences ease of integration
- Warning Flags
  - Interfaces
  - Deployment
  - Verification
  - Integration
  - Assembly
  - Checkout
  - Design
  - Fabrication
  - Management
  - Configuration

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Setting up a WBS Structure

- Start from the top to break down the work into pieces that can be separately managed
- Ideally, work should be:
  - A coherent piece
  - Managed by a single manager
  - Built by a single group

- The important thing is that each WBS entry must have an owner
  - The owner is accountable for completing the task within the time, cost and performance constraints
    - A senior manager will be responsible for a high level WBS entry (e.g. 1.2 Booster)
    - A junior manager will be responsible for a low level WBS entry (e.g. 1.2.1.1.2 Booster Magnet Type A)

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How Much Detail in the WBS?

- The WBS must satisfy two levels of needs
  - Accounting
  - Managing
- The *accounting* aspects of a WBS will tend to drive the limit to higher levels than the *managing* aspects
- It is not unusual for a WBS to be detailed at levels lower than directly tracked in the financial system to aid in control, monitoring and execution
- Typically, a *published* WBS stops at the work package level
  - Further breakdown into activities is needed for scheduling
  - This is best done by the work package owner/manager

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Setting up WBS entries

- There are often several equally acceptable ways to break up the work
- The particular choice depends on the skills of the project staff, how the orders are to be placed, and the development cycle
  - e.g. installation can be a separate WBS or included in the WBS of the item (or group of items) being installed
    - Main power transformer will normally be built, delivered, installed, and tested by the same company – same WBS number
    - Vacuum chambers will normally be built, and delivered by a vendor, tested by the lab staff and installed with the magnets – different WBS numbers
- Ideally, the project organization should be easily mapped on to the Work Breakdown Structure
  - Select the way the work is broken down to match the skills of the managers to the size and content of the work packages

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WBS Trap: Interfaces

- The connections between higher level WBS elements greatly influences ease of integration and management
- Crucial if multiple site teams
- Ideal “flange type”
- Worst case “fractal type”
- Alternative to fractal – distributed lower levels
- Higher level summary level integration is often overlooked

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Drilling Down in the WBS

- How many levels?
  - To the level that is desired to track progress
  - Not necessarily at level of accounting
- Accounting Rule of thumb: 0.5% to 2.5% *chunks* of total budget
  - Need fine enough to track deviations from plan before major problems develop
- Avoid *level of effort chunking*
  - That is WBS elements without measurable deliverables (milestones or inch pebbles)
  - Without measurable deliverables, monitoring and control is very difficult
- Every element is someone's responsibility
  - *Single valued:*
    - A team member can be responsible for many WBS elements
    - A WBS element cannot the responsibility of many team members

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Work Breakdown Structure and Project Scheduling

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- The **Work Breakdown Structure (WBS)** is a project scope definition framework
- It identifies organizes and all of the deliverables
- This then is used for identifying and displaying all activities which must be conducted in order to complete the project
- The tasks included in the WBS provide a basis for:
  - Developing the project schedule
  - Estimating the resources required to complete the project
  - Assigning responsibility for project work
- Project scheduling includes:
  - Identifying all activities to be performed
  - Determining the interdependencies between them
  - Estimating the time required to complete each activity
  - Developing an overall schedule for the performance of all activities
  - Displaying the final schedule

A Way to Set up WBS

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- **Done by a project team of the system(s) being broken up into sub-systems**
  - The group should contain all the people who are expected to be the managers of the system and sub-systems
- **Use controlled *brain storming* / *mind mapping***
  - Agree on Level 1 elements/components
  - Encourage everyone to participate
  - Capture relationships
  - Debate about what is best for the project
  - Do not allow personal interests to take precedence
- **Compare results against checklist and requirements**
  - Project Manager analyzes WBS and refines for final output
  - Final configuration both visual and text

WBS Mind Mapping Tips*

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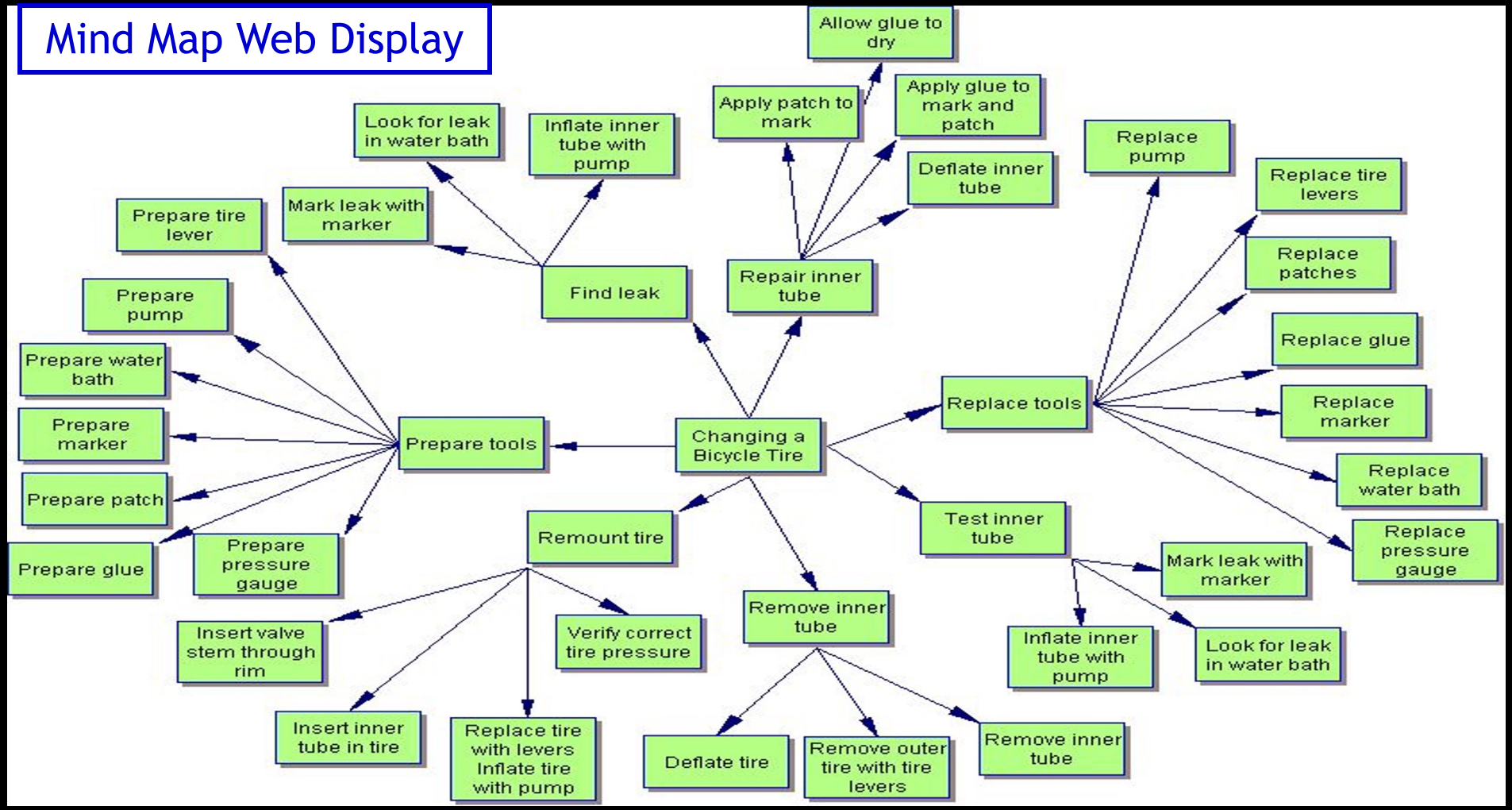
1. Use a large white board, expanse of paper, or online collaborating platform
2. If using paper, orient it in landscape mode on the wall
3. Use multiple-colored pens, dry erase markers, font/line colors
4. If using a white board or paper use Post-it® type notes for elements, use textboxes on online collaborating platforms
5. It's OK (and preferred) to have more than one person working on the WBS at the same time
6. It's OK to be messy
7. Pictures and sketches are good
8. Key words not sentences
9. At the lowest level look to have a noun and verb.

*Adapted from K.A.Brown & M.L.Hyer, *Mind Mapping as a WBS Development Tool*, PMI 2001

Example WBS: Changing Bicycle Tire



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WBS Checklist – Completeness

- Are all major phases of the project included?
- Are all major deliverables included?
- Are all key sign-off points included?
- Are all activities required for the project included?
- Does the WBS provide a logical subdivision of all project work?
- **Does the breakdown of activities under each element of the WBS include <u>all</u> work to be performed in order for that element to be completed?**
- Is the description of each WBS element clear and unambiguous?
- Have the people most knowledgeable about an activity been consulted when breaking down that activity into constituent parts?
- Has relevant experience from similar projects been considered when developing the WBS?

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WBS Checklist – Completeness (2)

- Are the following aspects of the project clearly reflected and defined within the WBS?
  - Interfaces
  - Deployment / Installation
  - Verification
  - Integration
  - Assembly
  - Checkout
  - Design
  - Fabrication
  - Management
  - Configuration

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WBS Checklist – Resource/Schedule Estimates

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- Resource estimates
  - Is it possible to develop accurate and realistic estimates of
    - The personnel required to complete all project work packages?
    - The funds required to complete all project work packages?
    - The equipment and facilities required to complete all project work packages?
  - Is it possible to identify all technology and information required to complete all project work packages?
- Schedule estimates
  - **Is it possible to develop accurate and realistic estimates of the span times for every project work package?**
  - Are all work packages broken out in sufficient detail to enable the identification of independent activities to allow simultaneous scheduling?

WBS Checklist: Assignment of Responsibility and Troubleshooting

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- Assignment of work package responsibility
  - Is each work package defined specifically enough to ensure that the person or department that will be assigned the responsibility for it will understand clearly what is to be done and/or produced?
  - Does the work package clearly identify work to be performed, as well as organizational responsibilities for performing the work?
- Troubleshooting
  - Which of the work packages involve work that either is exploratory or has not been successfully performed by the organization before?
  - Which activities have been overlooked on similar projects in the past?
  - Which activities appear to be least understood and/or most unpredictable?
  - Which activities have the greatest complexity and therefore most likely least understood or estimated?

Time for Dessert – WBS Example: Lemon Pie

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The Recipe

Ingredients

- 6 whole cinnamon graham crackers
- 2 Tbsp butter
- 11 oz sweetened condensed milk
- 2 large egg(s)
- 1/2 cup(s) fresh lemon juice
- 1 Tbsp lemon zest

Instructions

- Preheat oven to 350ºF.
- Grind graham crackers in a food processor until fine crumbs form. Or place crackers in a resealable plastic bag and crush with a rolling pin. Place crumbs in a small bowl.
- Melt butter on stove top or in microwave and pour over graham cracker crumbs, mixing with a fork until completely moistened. Press crumbs evenly onto bottom of a 9-inch pie pan; place crust in refrigerator while preparing lemon filling.
- Separate Egg whites from yolks and place into a medium mixing bowl and beat until white form soft peaks
- In a separate medium bowl, combine condensed milk and egg yolks; mix until smooth. Add lemon juice and zest; stir until incorporated. Fold in whipped egg whites until incorporated and pour into prepared crust.
- Bake pie for 15 minutes. Cool completely and for best flavor, serve chilled. Yields 1 piece per serving.

WBS: PIE. Lemon Pie

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PIE. Lemon Pie

PIE.INIT Initial Preparations

- PIE.INIT.OVN Preheat oven 350° F
- PIE.INIT.ING Obtain Ingredients
- PIE.INIT.BOL Necessary Utensils

PIE.CRST Pie Crust

- PIE.CRST.GND Grind graham crackers
- PIE.CRST.CRS Crush graham crackers
- PIE.CRST.MLT Melt butter
- PIE.CRST.POR Pour butter into crackers
- PIE.CRST.MIX Mix crust components
- PIE.CRST.PAN Mold crust into pan
- PIE.CRST.COL Refrigerate Crust

PIE.FILL Pie Filling

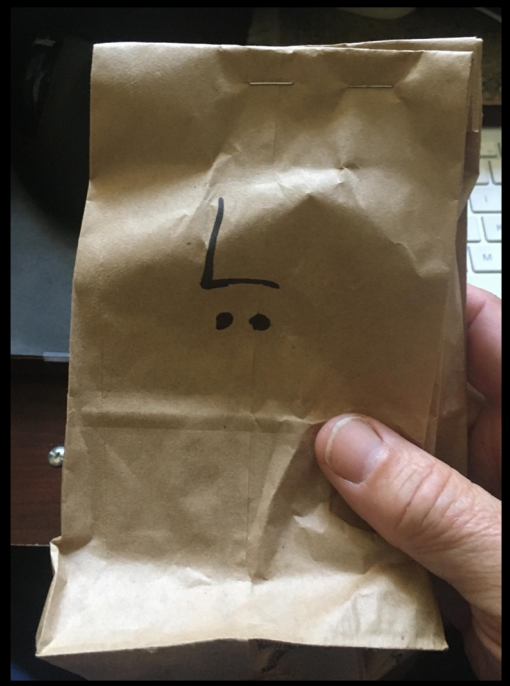
- PIE.FILL.SEP Separate egg whites/yolks
- PIE.FILL.WHP Whip egg whites
- PIE.FILL.MLK Mix condensed milk / yolks
- PIE.FILL.LEM Juice lemons
- PIE.FILL.ZST Make lemon zest
- PIE.FILL.MX1 Mix lemon juice / zest / liquid mixture
- PIE.FILL.MX2 Mix in whipped egg white to mixture

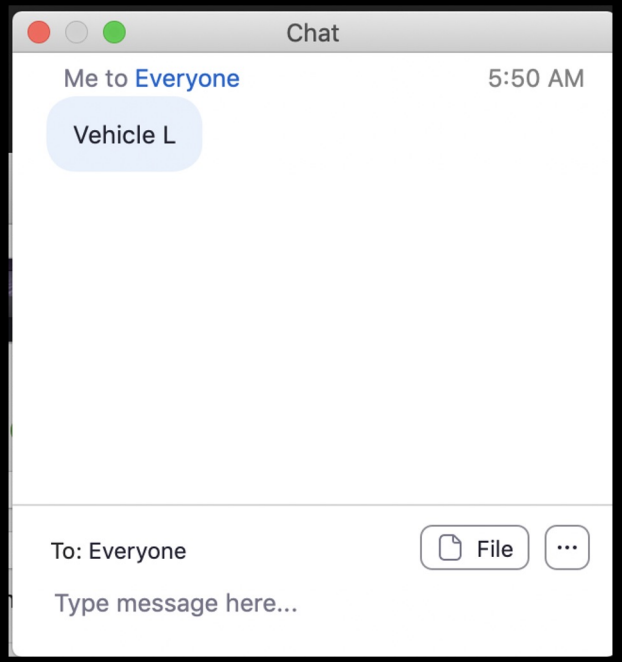
PIE.INTG Pie Integration / Cooking

- PIE.INTG.ADD Pour filling into pie crust
- PIE.INTG.COK Cook pie
- PIE.INTG.CL1 Cool pie
- PIE.INTG.CL2 Refrigerate pie
- PIE.INTG.CL3 Clean up

WBS Exercise #1

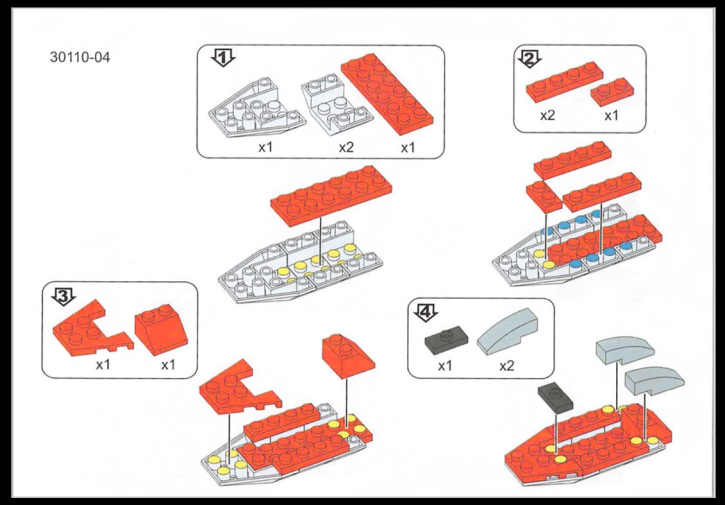
- Take the small paper bag you received and report the letter
  - (in the Chat if you are remote)

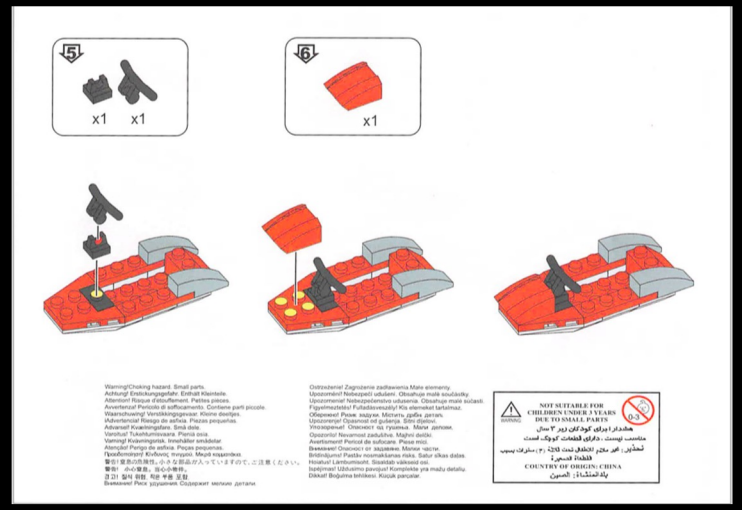




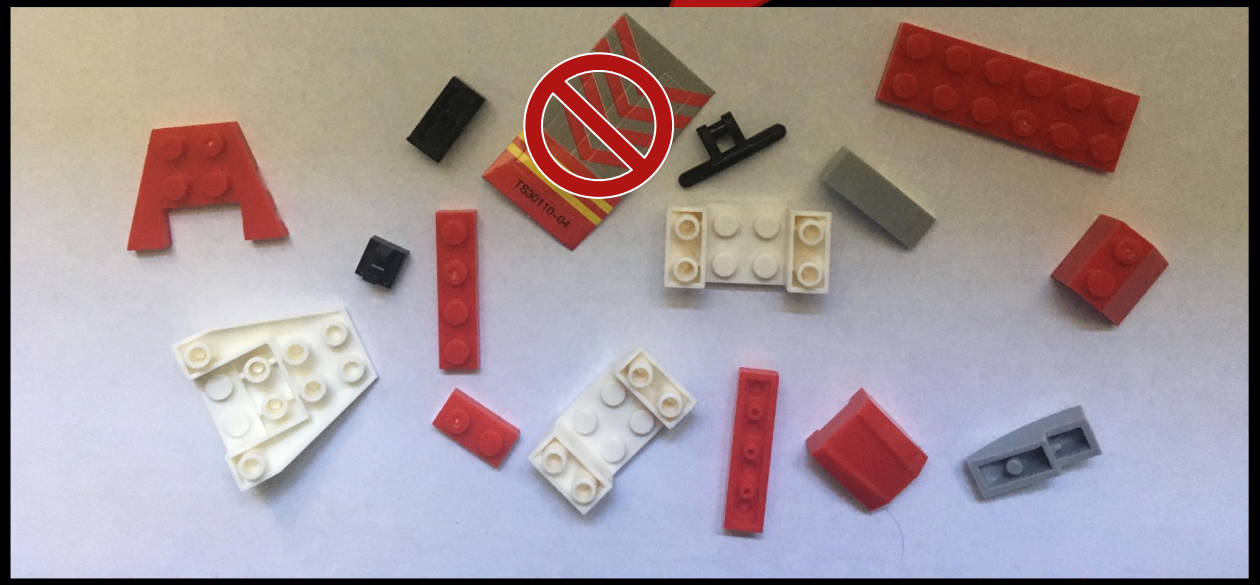
- Develop a WBS of the *project* to to put together and *deliver* the building block vehicle.
  - Name the parts
  - Establish their assembly hierarchy in the WBS and
  - Make certain to label subassemblies as such
- Your WBS will be reviewed by your project team during tomorrow during a breakout

Example: – Jet Ski Kit (1)





N.B.: If you received stickers with your kit, don't put them on. You'll likely be taking the kit apart putting back together several times



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Example: L – Jet Ski (2)

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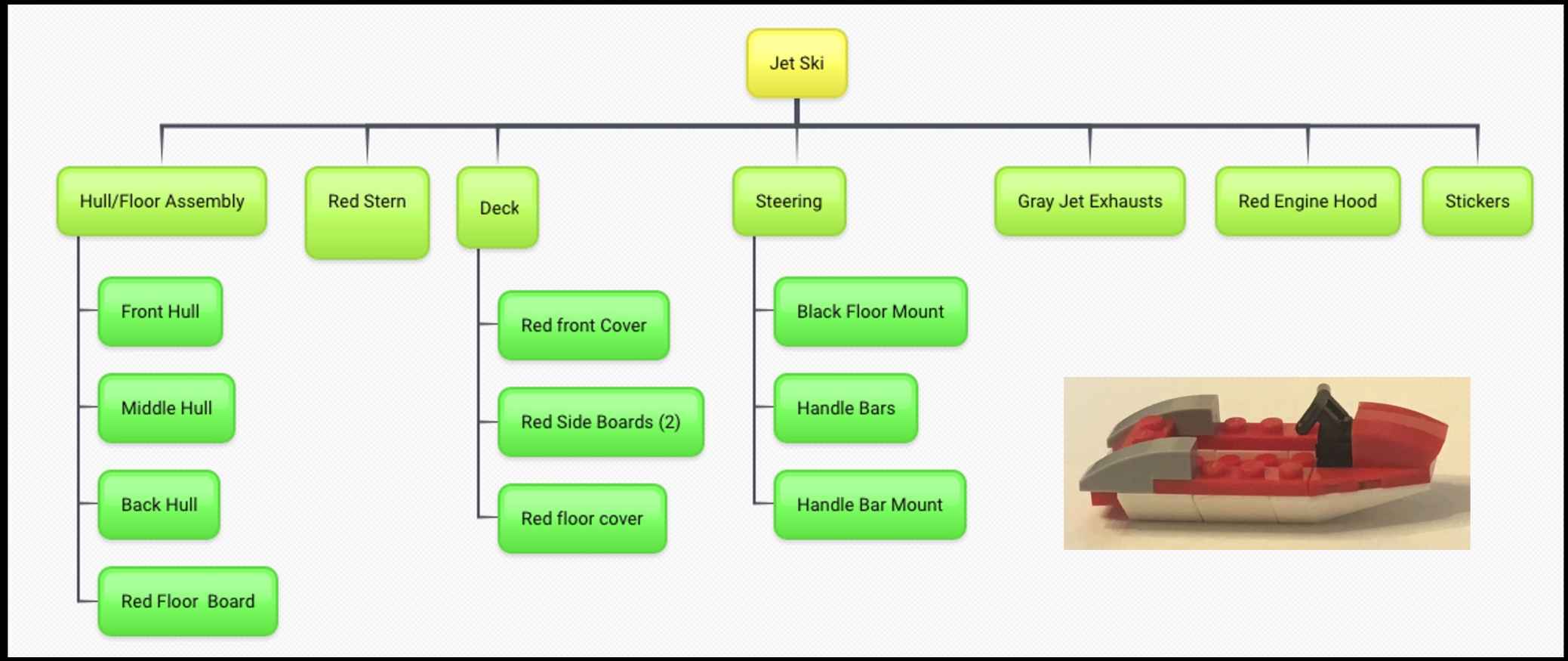

WBS Group Exercise: Your Projects

- Develop the WBS for both of your projects
  - Accelerator
  - SuperKEKB site visit / case study and personal time
- Don’t worry about schedule for moment
- Don’t worry about estimates for moment

(You’ll get to do both later)

- Remember to use the checklists to verify quality & completeness

Assignment addendum

- When developing the WBS, flag those items that will require technology development or have large uncertainties

- For the SuperKEKB Case Study, flag those areas where uncertainties are large

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WBS evolution from CD-0 to CD-1

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- At CD-0 it is quite often the case that the WBS is pre-conceptual
  - Little, if any, significant design development has occurred
- At CD-1 as a result of the development of the conceptual design, the WBS is much more complete.
  - Areas needing development should be identified and understood
    - Any R&D should occur during the CD-1 phase as it is usually not acceptable to be part of the TPC
  - Interfaces should have been established, but likely not detailed
  - Areas of uncertainty and risk should be known, and corrective/mitigating actions identified and included in the WBS

During the CD-1 conceptual phase, reviews become both prevalent and important

Internal & External Reviews are Tools for Verifying, Controlling, and Managing

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- Reviews are not a *necessary evil*
  - If approached properly they highlight
    - Progress
    - Areas for improvement
    - Blind spots and oversights
    - Risks
- External reviews are a communication tool as well
- Internal reviews and advisory committees are forums for issue and risk examination
  - Design maturity and technical readiness
  - Process and management effectiveness
- Provide *plausible deniability* as a means for highlighting subsystem shortcomings

Who should attend an expert review

- Include local experts because:
  - You may learn something
  - They may pick up something
  - Encourage exchange
  - Facilitate consensus
- Include people responsible for associated systems because:
  - Improves likelihood of smooth integration of the systems
- Include external experts because:
  - You will learn something
    - Experience is extremely valuable
  - They can help you avoid mistakes they have made in the past
  - They can put you in contact with others who have solved the same kind of problems
- DOE O 413.3B requires that conceptual design reviews use project independent committees

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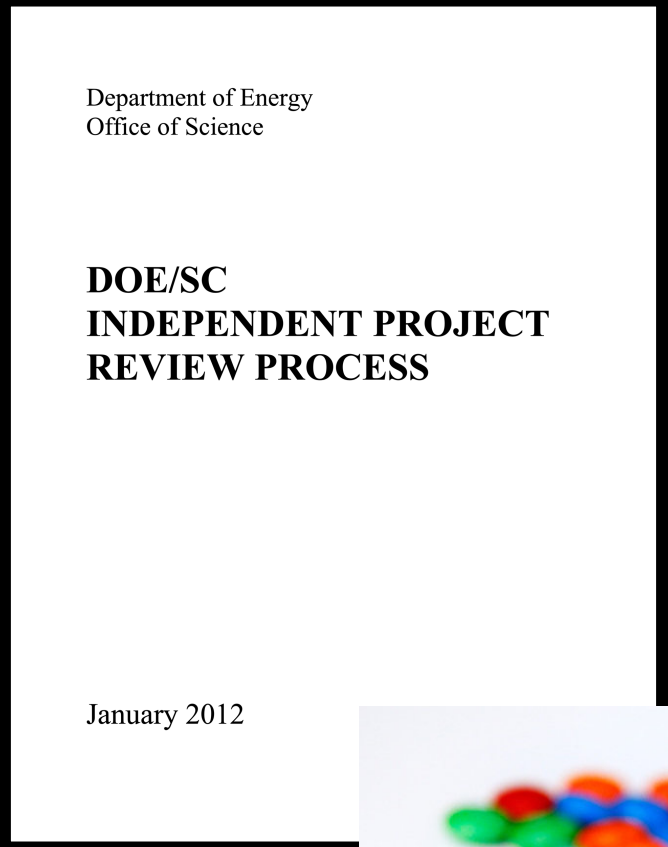
DOE/SC-OPA led Independent Project Reviews

Office of Science *Lehman Reviews* are a well-established and respected approach to Independent Project Reviews (IPR)

- Understand and study the approach
- Make it as easy as possible for the review committee to give you a favorable review report
- Volunteer to serve as a reviewer
- Pay attention to details

"If you can't run a review, how do you expect to run a project?"


Department of Energy
Office of Science

**DOE/SC
INDEPENDENT PROJECT
REVIEW PROCESS**

January 2012

Review Etiquette: Make Miss Manners proud of you

- Understand that the reviewers are from the same communities as you
  - Treat them as you would want to be treated
- Focus all presentation organization & content and helping the committee properly assess the project
  - Leave adequate time for discussion during plenary and breakout sessions
  - Don't include too much material – only essential, but have everything readily available
  - Every slide in a presentation should have a clear message communicated
  - Point out where information relevant to specific charge questions are being addressed
  - Don't try to *hide, whitewash, or dismiss* issues
    - It makes you look like you are either trying to deceive the committee or that you are incompetent
    - Present approaches and plans for solutions conveying understanding of the issues
- Avoid arguing with the committee members
  - Point out diplomatically where they have incorrect conclusions/opinions
  - Do not be dismissive of the committee. It will be perceived as arrogance
- Do not interrupt or ask questions during the closeout. Use the *page-turn* before the closeout for that
- Dry-run all presentations for conciseness, messaging, clarity, and relevance
- Conduct a director's review sufficiently before the DOE IPR to allow correction of shortcomings
  - Work to select as director's review committee that is more rigorous than the DOE IPR committee will be

CD-1 DOE/SC-OPA Reviewer Checklist – Summary (1)

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✓Assess whether the **acquisition strategy** has considered the **full range of alternatives** to achieve the mission need in the most effective, economical, and timely manner.

✓Were the **life-cycle cost and benefit** of the alternatives developed and are they realistic and appropriate?

✓Has the project selected the **most appropriate alternative** considering the **life-cycle cost and life-cycle benefits**?

✓**Assumptions**—assess that the assumptions (technical, cost—escalation, shift work, learning curve, schedule, funding, regulatory, resource availability—labor, material, equipment, etc.) are **realistic for the selected alternative**.

✓Ensure that **scope and preliminary KPPs** are clearly defined and achievable.

✓Are **stakeholders** or **users involved** in the development of project scope?

✓**Design Review**—was an independent conceptual design review conducted?

✓**Conceptual Design**—is the conceptual design sufficiently mature for this stage of the project?

✓Has a **Work Breakdown Structure** and dictionary been developed at the appropriate level for CD-1?

✓Have the **risk management approach/plan** been developed? Assess whether **the key risks** for the recommended alternative have **been identified**.

✓Is the **funding profile consistent with the proposed schedule** and are the funds (Other Project Cost versus Total Estimated Cost, Project Engineering and Design, Major Item of Equipment, etc.) appropriately used?

✓**Project Team—Number and skill mix** of full and part-time members, organizational structure, division of roles/responsibilities, lines of communication and authority established.

CD-1 DOE/SC OPA Reviewer Checklist – Summary (2)

✓Are **appropriate** members with needed experience (budget, legal, real estate, ES&H, procurement, QA, etc.) included as part of **IPT**?

✓Assess key **inter-site and intra-site coordination and integration** issues and determine if they are identified and appropriately accounted for.

✓Review **basis of preliminary cost and schedule estimates** for reasonableness. Determine the basis of the cost and schedule estimate (vendor quotes, historical data, engineering judgment, etc.), when were they developed or updated, and who owns/developed the estimates (Note: For CD-1 a detailed logically linked schedule is not 'required' as the project scope definition and cost are preliminary).

✓Is the **cost and schedule contingency estimate reasonable** for the risks associated with the early-phase of the project?

✓Assess whether the **preliminary critical path is identified**. Assess whether the preliminary cost and schedule estimates reflect cost contingency and schedule contingency needed to address early major risks to the project.

✓How much of the **schedule contingency is funded**?

✓**Compliance with requirements met or in place**—value management, hazard analysis, ES&H, QA, LEED/HPSB, one-for-one replacement, all documents prepared and ready for approval, etc.

✓Is the **project documenting and sharing lessons learned** and have incorporated the risks and lessons learned from other relevant projects?