

Module 3

Project Planning and Scheduling

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Project Planning

- There are several reasons to use considerable care when planning projects.
- The primary purpose of planning, is to **establish a set of directions** in sufficient detail to tell the project team exactly - **what must be done, when it must be done, what resources will be required** to produce the deliverables of the project successfully, and **when each resource will be needed**.
- The plan must be designed in such a way that the project outcome also **meets the objectives** of the parent organization, as reflected by the project portfolio.

- The plan is only **an estimate** of what and when things must be done to achieve the scope or objectives of the project, it is always carried out in an environment of **uncertainty**. Therefore, the plan must include **allowances for risk and features** that allow it to be **adaptive**, i.e., to be **responsive** to things that might disrupt it while it is being carried out.
- Eg: **Scope creep** i.e. the tendency of project objectives to be changed by the client, senior management, or individual project workers with little or no discussion with the other parties actively engaged in the work of the project
- The plan must include any **constraints on activities** and input materials prescribed by law and society. Among the many sources of outside constraints are the Food and Drug Administration, the Occupational Health and Safety Administration, various engineering societies, the PMI, Labor Unions, and the “Standards Practices” of many different industries.

- The purpose of planning is to facilitate later accomplishment.
- The world is full of plans that never become deeds.
- The planning techniques are intended to smooth the path from idea to accomplishment. It is a complicated process to manage a project, and plans act as a map of this process. The map must have sufficient details to determine what must be done next but be simple enough.

Project Plan Elements:

1. **Overview:** This is a short summary of the objectives and scope of the project
2. **Objectives or Scope:** This contains a more detailed statement of the general goals noted in the overview section
3. **General Approach:** This section describes both the managerial and the technical approaches to the work
4. **Contractual Aspects:** This critical section of the plan includes a complete list and description of all reporting requirements, customer-supplied resources, advisory committees, project review and cancellation procedures, proprietary requirements, any specific management agreements, as well as the technical deliverables and their specifications, delivery schedules, and a specific procedure for changing any of the above

5. **Schedules:** This section outlines the various schedules and lists all milestone events.
6. **Resources:** There are two primary aspects to this section. The first is the budget. Second, cost monitoring and control procedures should be described.
7. **Personnel:** This section lists the expected personnel requirements of the project.
8. **Risk Management Plans:** This covers potential problems as well as potential lucky breaks that could affect the project.
9. **Evaluation Methods:** This section contains a brief description of the procedure to be followed in monitoring, collecting, storing, and evaluating the history of the project.

3.1. WORK BREAKDOWN STRUCTURE

A WBS in project management organizes & defines the project scope by breaking it down into manageable sections.

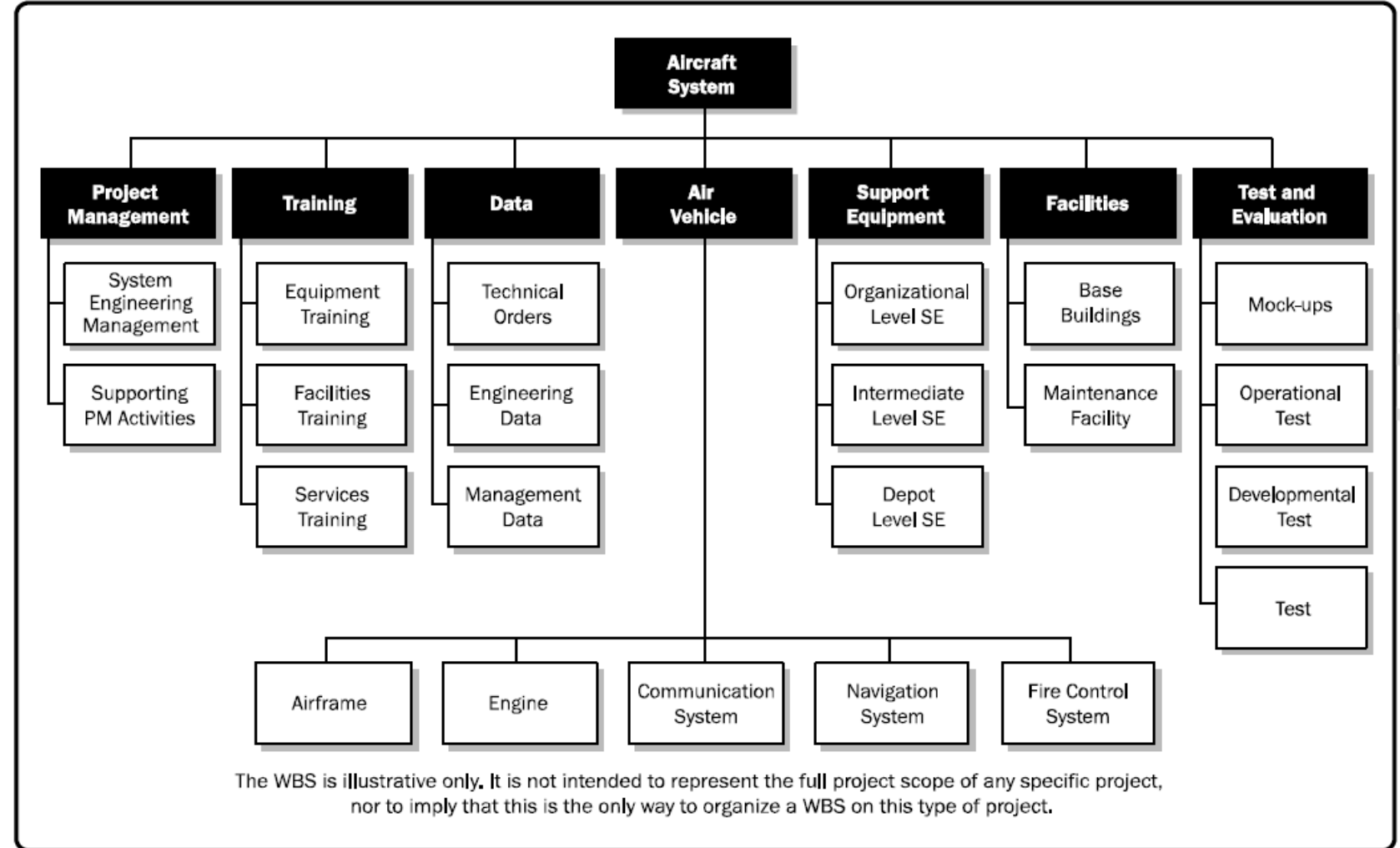


Figure 5-14. Sample WBS with Major Deliverables

Developing the Work Breakdown Structure:

WBS development is one of the most critical activities in project planning. The definition of the required work activities for the project provide the ability to develop the project schedule, make assignments, and estimate the project budget using a definitive (bottom-up) estimating technique.

- ◆ Depends on development of project objectives and scope statement
- ◆ Requires participation by all project team members
- ◆ Is used to validate the project scope
- ◆ WBS is input for responsibility matrix and master/detail schedule development

Benefits of the WBS:

Creating a WBS can be challenging, but it yields numerous benefits.

It helps the project team to specify and analyze all the work that a project must accomplish and to show how the work elements are related to one another and to the end product.

Seeing how elements relate to one another and to the end product helps the team analyze relationships among parts of the project. It establishes a foundation for preparing the master summary schedule (MSS) and the CPM plan.

The family-tree structure of the WBS is a model for structuring (1) the project cost summary system, (2) the project budget, (3) the work package management system, and (4) the framework for activity scheduling and tracking with CPM.

Preparing the WBS also may cause the project team to break the work into smaller elements to produce more manageable units and develop ownership in the project implementation plan.

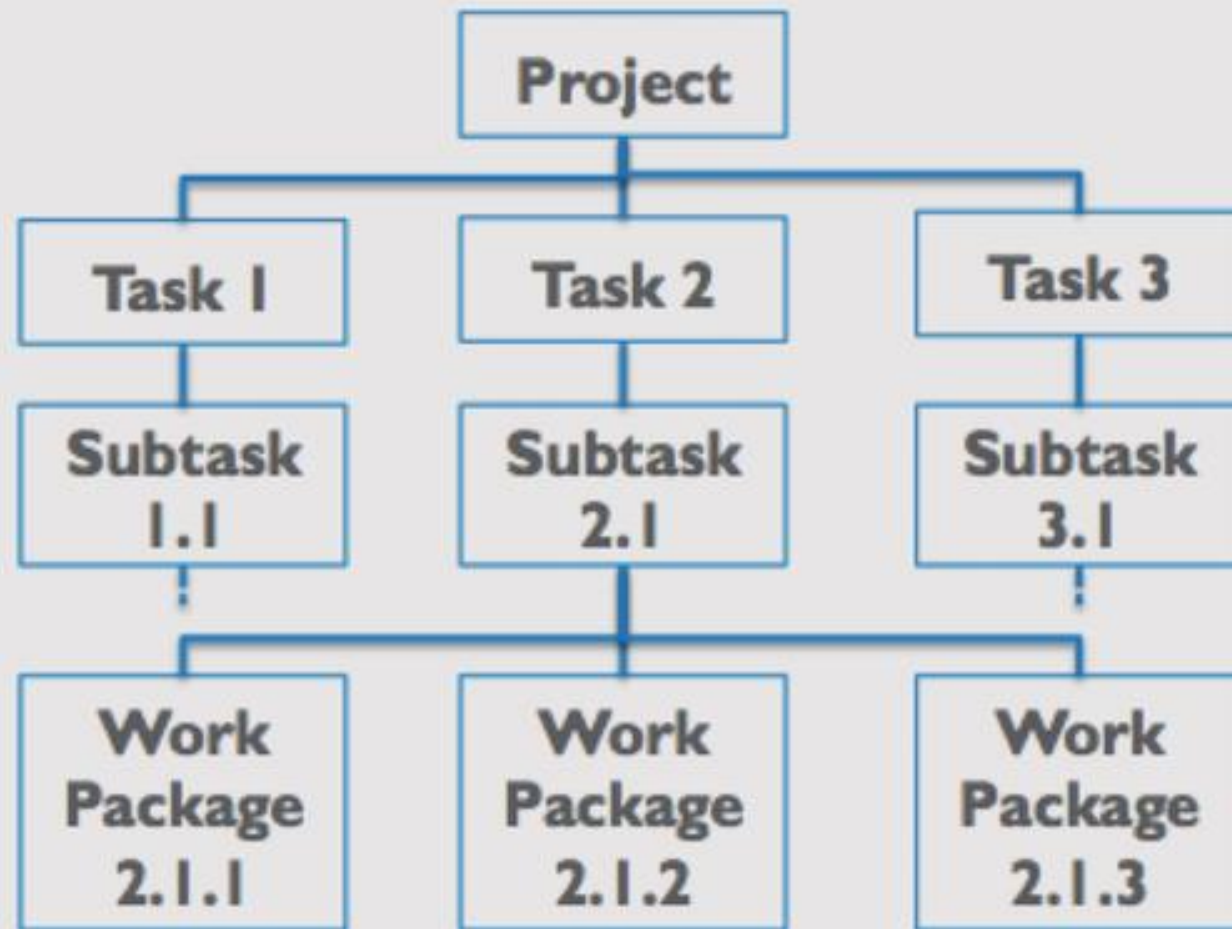
- ◆ Graphically depicts all project work
- ◆ Relates work elements to each other and to the end product
- ◆ Provides structure for organizing
 - Cost summary system
 - Project budget
 - Work package management
 - The detailed schedule (CPM)
- ◆ Improves manageability of project

WBS Components:

The *work breakdown structure* is a hierarchical, product-oriented “family tree” that accounts for *all* the work to be performed within a project.

The WBS can be created using a top-down or bottom-up approach. We recommend the top-down approach, especially for complex projects, because it reduces the chance of forgetting to include an important element of work.

The top-down approach involves combining and categorizing information from the product structure, the life cycle (process structure), and the project’s organization chart.



The **bottom-up** approach usually involves a **brainstorming** technique so that the project team can **list as many activities, deliverables, components, and elements of work as possible** (usually without concern for sequence, relationships, or coherence). These items are then **grouped into broader and broader categories until a hierarchy of work elements is built up**. This hierarchy of grouped work elements forms the basis for the WBS.

Regardless of which method one uses, the information must be combined so that *all* project-related work has a place on the WBS and only one place (i.e. categories are mutually exclusive). This includes work related to “HARD” deliverables, such as schools or roads “SOFT” deliverables, such as feasibility study or training, and *any other work that must be performed that is not directly related to any one deliverable*. This latter category includes process-related work, such as assemble and test, and organizational work, such as project management.

- ◆ All project work is accounted for on the WBS
- ◆ The WBS displays the *scope* of the project

The work breakdown structure is usually organized so that it emphasizes the product structure, but sometimes it is organized in terms of process structure (life cycle) or geography. The WBS also can involve combinations of these formats, for example, process and geography or product and geography. Each phase of the project life cycle can have different deliverables. For example, the product at the feasibility phase would be a report. Thus each phase might have a different WBS.

Our recommendation is to use the product-oriented structure, because it highlights the deliverables better than the other approaches. Any time a project has more than one deliverable, the product-oriented organization should be used for the WBS. This approach helps ensure that all product components are included in the planning and none are omitted.

Although the WBS may be displayed as either a tree diagram or an outline, the tree diagram makes it easier to see the hierarchical relationships among the work elements on complex projects. However, many project management software programs for CPM planning require the use of an outline organization

1. Highlights deliverables (objects to be developed or produced)
2. Each phase of life cycle may have different products
3. Best when project includes more than one deliverable
4. Better for CPM planning

Display as tree diagram or outline

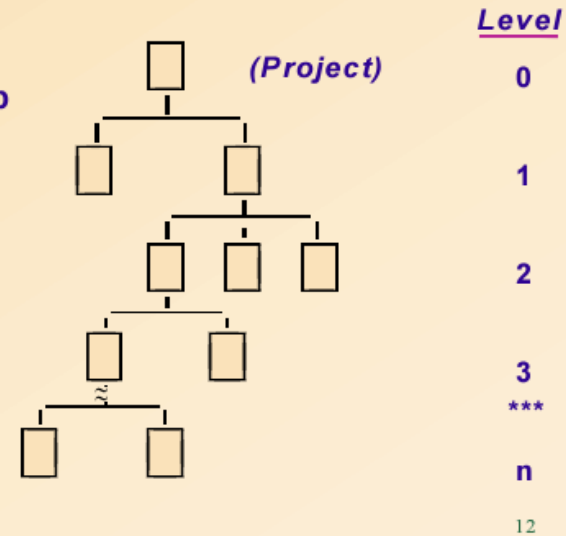
While there are many formats for WBS in use, the most common that is used across all industries include the definition of sub-elements down through the task level.

Work Breakdown Structure - Format

<u>Level</u>	<u>Name</u>	<u>Level</u>	<u>Name</u>
0	Program	0	Project
1	Project	1	Project Phase
2	Project Phase	2	Activities
3	Activities	3	Tasks
4	Tasks	4 - ?	Sub-tasks
5 - ?	Sub-tasks		

The Work Breakdown Structure (WBS)

- Structured from the top down
- More detail at each successive level
- Stops before reaching individual activities



The WBS is organized from top down. Each successive level of indenture gives more detail than the previous level.

WBS Labeling Convention:

Labeling the different levels of indenture in the WBS may vary from organization to organization and from project to project. The convention we are using is the following:

The top level of the WBS describes the project, for example, building a house. It is labeled *Level 0* in the visual.

Level 1 is used to list:

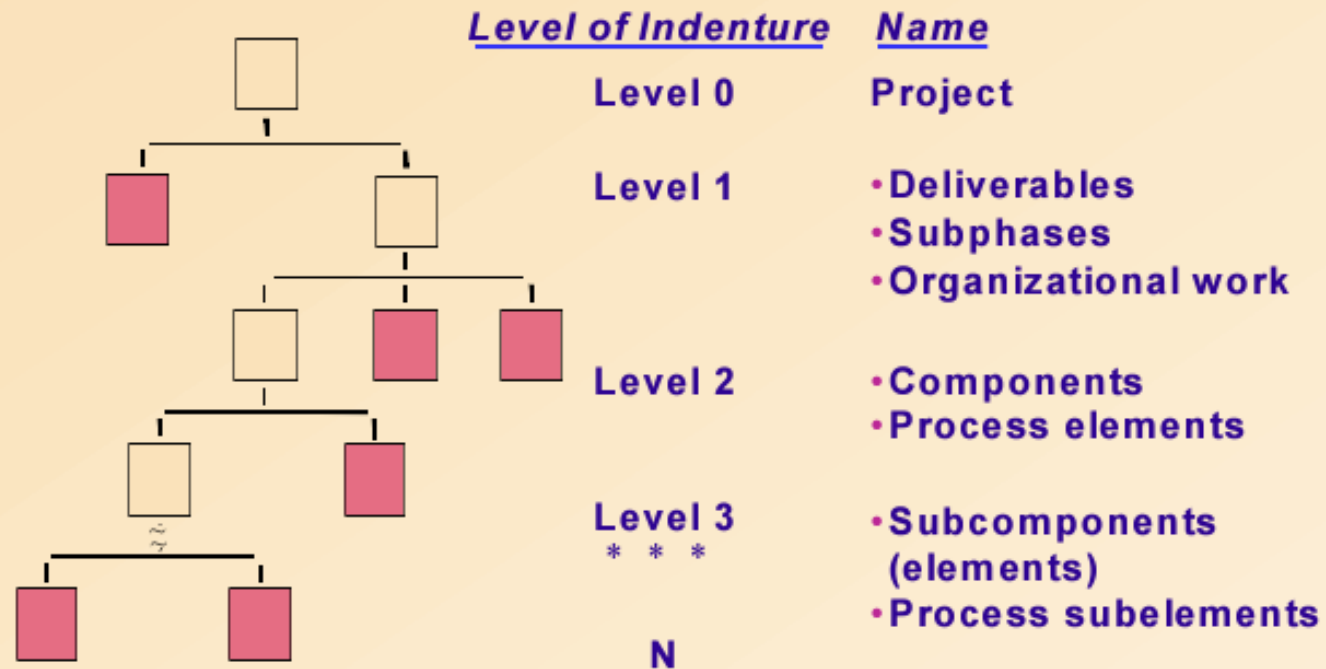
- ☐ The deliverables
- ☐ The process subphases not picked up in the product structure, such as Planning, Assembly or Inspection
- ☐ Any organizational work that spans the entire project and is not accounted for in work already listed on the WBS, such as project management.

Level 2 is where the *components* that make up the deliverables are shown, along with the *process elements* that make up the sub-phases. Project management and organizational work specific to a component, rather than the project as a whole, also is listed at this level.

Level 3 is used to show further detail. (*Complex projects have additional levels.*) This level is used to show the *sub-components* (elements) that result from disaggregating components (of deliverables). Similarly, *process sub-elements* that result from the disaggregation of process elements are shown at this level, although such disaggregation rarely occurs.

Some deliverables require more levels of detail than others, even within the same project. Consequently, not every branch of the WBS will be broken down to the same level of detail. The levels of indenture may vary from one deliverable to another.

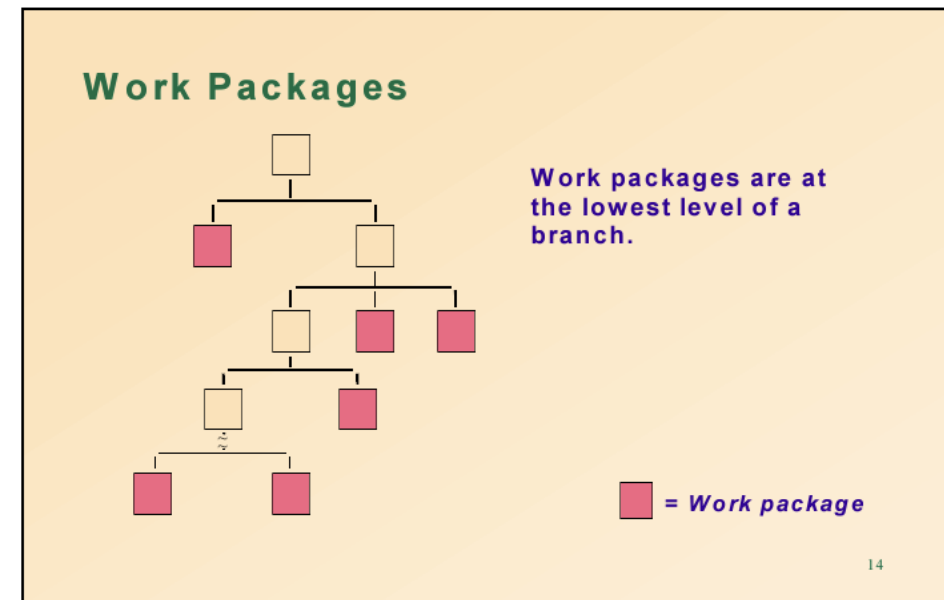
WBS Labeling Convention



Work Packages:

The work package is usually the smallest element of a WBS. Work packages can occur at *any* level of the WBS, as you can see in the visual.

Perspective is important when thinking about work packages. Work package is a relative concept and it is not always easy to define. One person's work package can be another person's component or someone else's project.



Work Package Attributes

- One clear accomplishment
- One owner
- Easy to identify expenses
- Bounded
- Easy to assess quality
- Unique
- Can formally or informally assign work

15

Work packages have these attributes:

One clear accomplishment—Each results in the achievement of a single visible outcome, for example, the roof of a house.

One owner—One organizational entity (or person, such as a subcontractor) is responsible for the completion of the activities that constitute the work package.

Easy to identify expenses—A single accounting number can be given to the package for budgeting and cost accounting purposes.

Bounded—There are clear start and finish points.

Easy to assess quality—There are clear quality criteria associated with the set of activities.

Unique—Each work package can be clearly distinguished from all other work packages and none share any work elements.

Work packages are as a means of assigning work to entities or people within the organization or of letting the work to contractors.

House Project - Work Breakdown Structure (WBS)

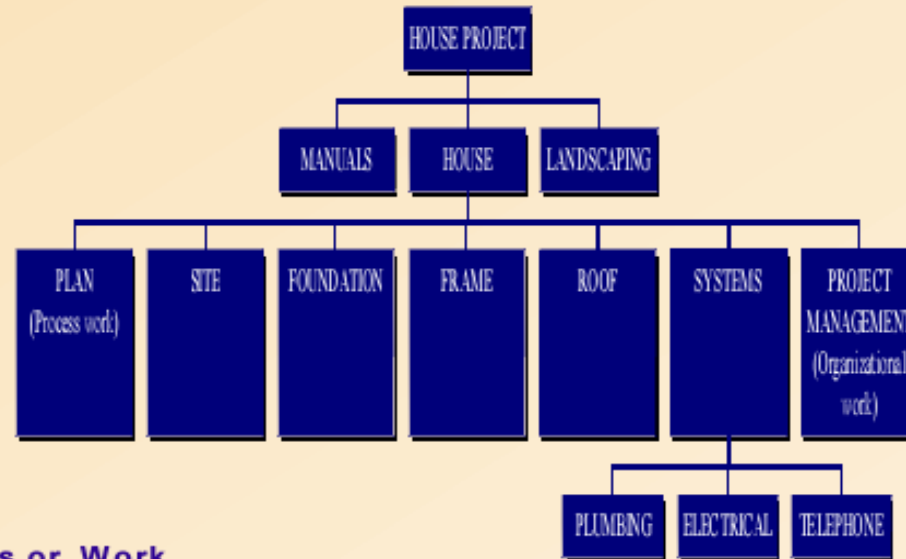
Level Label

0 Project

1 Deliverables
or
Subprojects

2 Components
or
Work
packages

3 Sub-components or Work
packages



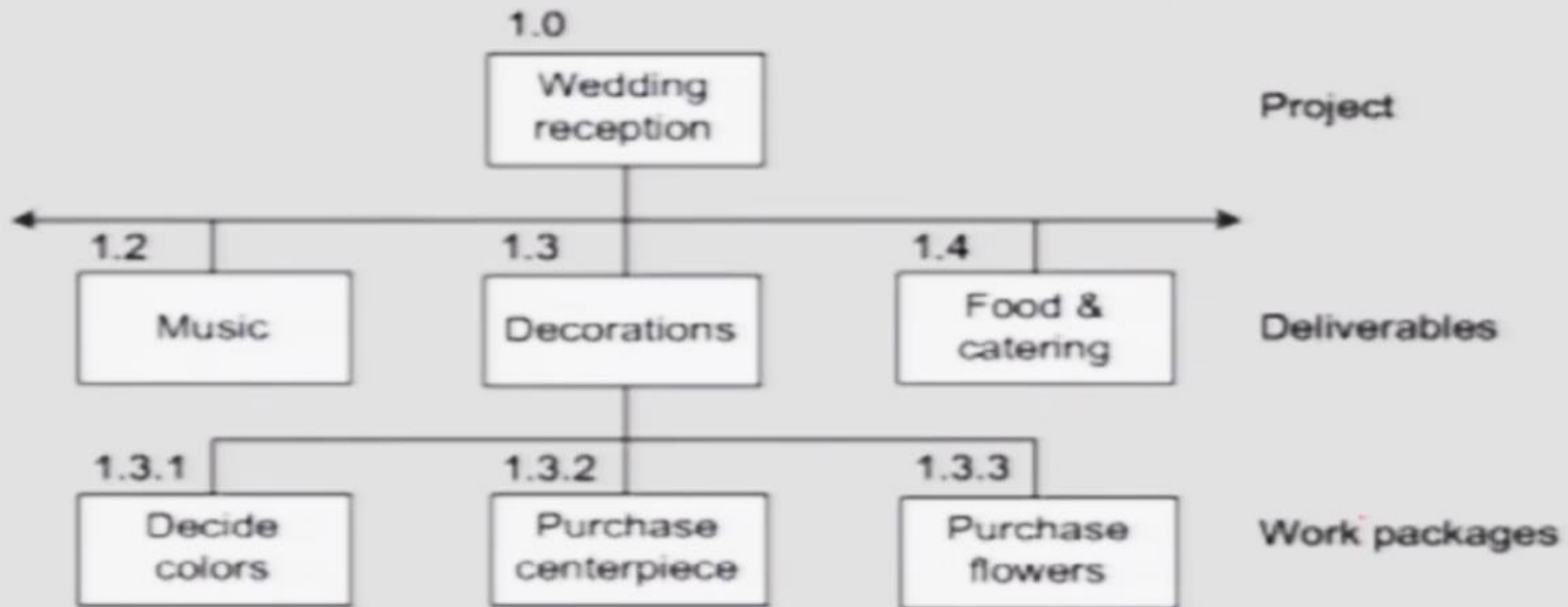
This is a sample work breakdown structure for the construction phase of the house project. Work elements are hierarchically listed. This is also referred to as *levels of indenture*.

Level 0 is the project name.

Level 1 lists the deliverables for the project: manuals, house, and landscaping.

The next level of indenture (Level 2) is where we account for the work that is required to produce the house deliverable. This work includes components of the house deliverable, plus any process-related deliverables, such as the plan for the house, or organizational work, such as project management, that relates only to the house deliverable (and not to the project as a whole).

Schematic Diagram of WBS



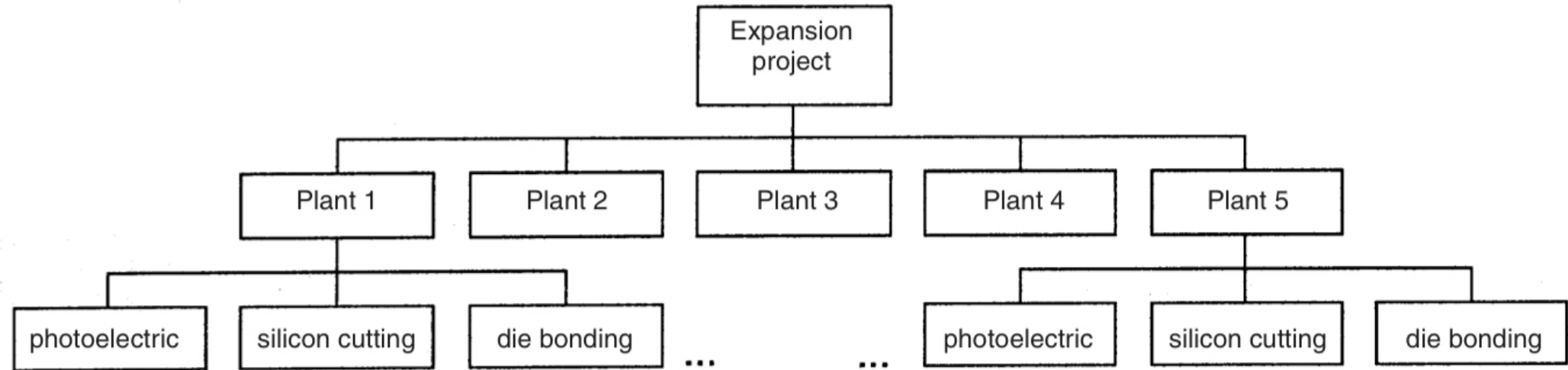


Figure 3 WBS by Geography.

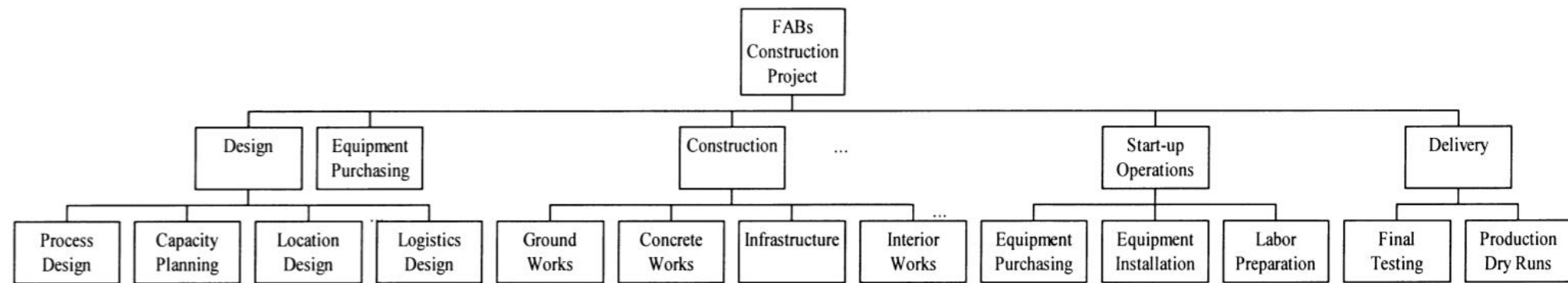


Figure 2 WBS by Project Life Cycle.

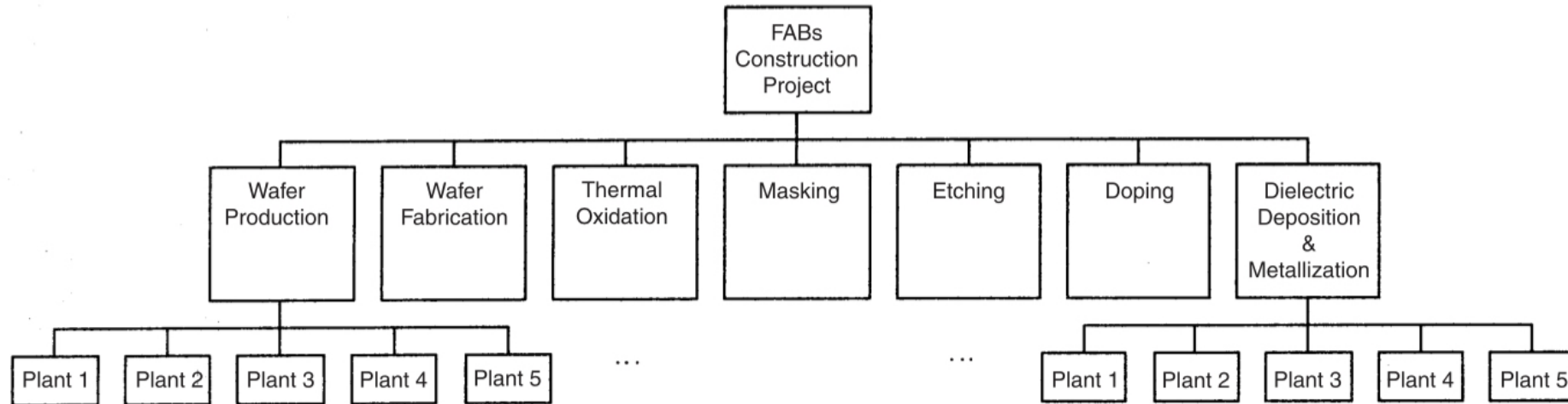


Figure 1 WBS by Technology.

Practice Example

R&D Projects

Managing R&D projects is among the toughest areas in project management. These projects are characterized by a high degree of uncertainty, and consequently a large proportion of them is never completed. The importance of careful planning in this environment cannot be overstated. Create a WBS planned for an R&D project aimed at developing a new product. The second level of this WBS is organized to be made by the project life cycle, and the third level corresponds to functional departments that are involved in the project.

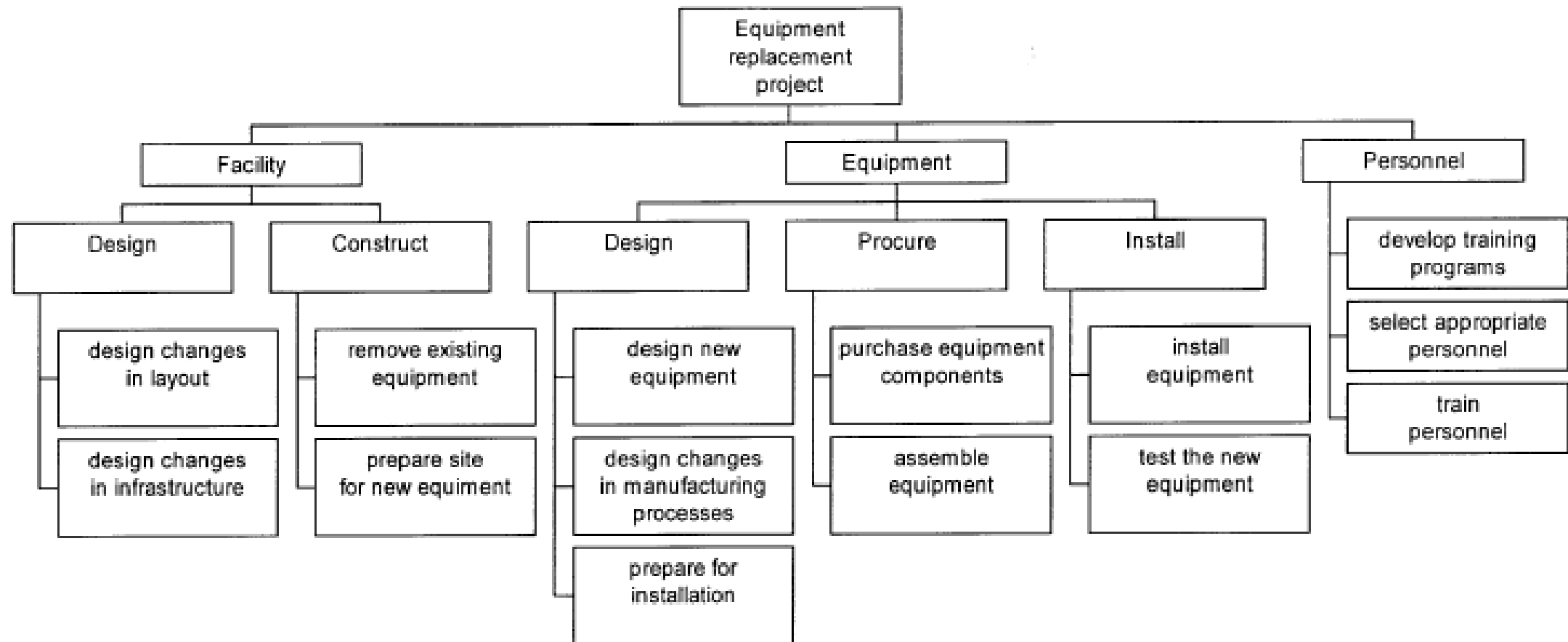


Figure 5 WBS for an R&D Project.

3.2. LINEAR RESPONSIBILITY CHART

The Linear Responsibility Chart (LRC), also known as the Responsibility Assignment Matrix (RAM), is another visual depiction of the roles and responsibilities on a project.

These charts list tasks on one axis and the responsible persons or departments on the other.

Often a coding system (such as a set of symbols) is used to indicate the type of responsibility of each person or department for each task.

Responsibility Charting is a technique for identifying functional areas where there are process ambiguities, bringing the differences out in the open and resolving them through a cross-functional collaborative effort.

Linear Responsibility Chart

WBS		Responsibility					
		Project Office				Field Oper.	
Subproject	Task	Project Manager	Contract Admin.	Project Eng.	Industrial Eng.	Field Manager	
Determine need	A1	○		●	▲		
	A2	■	○	▲	●		
Solicit quotations	B1	○	■	▲		●	
Write approp. request.	C1	■	▲	○	●		
	C2		●	○	▲		
	C3	●	■	▲		■	
"	"						
"	"						
"	"						

Legend:
 ▲ Responsible
 ● Support
 ■ Notification
 ○ Approval

Figure 6-7 Linear responsibility chart.

Responsibility Assignment Matrix (RAM) is also called a RACI chart by PMI. These charts show the connections between work that needs to be done and the project team members, or decisions that need to be made on the project.

The chart attempts to clarify the authority and working relationships that are intended to exist in the project team. It also allows a person to see all activities associated with one person, or to see all people associated with one activity.

R - Responsible
A - Accountable
C - Consults
I - Informed

	Define Deliverables	Develop Plan	Develop Program	Test Version A	Develop Interface	Live Test	Deliver to Customer
Sponsor	R	A	I	I	I	A	R
User	A	I	A	I	A	I	A
PM	C	R	R	A	C	R	C
Planner	I	C	I	I	I	I	C
Tech Staff 1	I	C	C	R	R	C	C

RESPONSIBLE....."R" "The Doer": The "doer" is the individual(s) who actually complete the task. The "doer" is responsible for action/implementation. Responsibility can be shared. The degree of responsibility is determined by the individual with the "A".

ACCOUNTABLE....."A" "The Buck Stops Here": The accountable person is the individual who is ultimately answerable for the activity or decision. This includes "yes" or "no" authority and veto power. Only one "A" can be assigned to an action.

CONSULT....."C" "In the Loop": The consult role is individual(s) (typically subject matter experts) to be consulted prior to a final decision or action. This is a predetermined need for two-way communication. Input from the designated position is required.

INFORM....."I" "Keep in the Picture": This is individual (s) who needs to be informed after a decision or action is taken. They may be required to take action as a result of the outcome. It is a one-way communication.

Linear Responsibility Chart

	Vice-president	General manager	Project manager	Manager engineering	Manager software	Manager manufacturing	Manager marketing	Subprogram manager manufacturing	Subprogram manager software	Subprogram manager hardware	Subprogram manager services
Establish project plan	6	2	1	3	3	3	3	4	4	4	4
Define WBS		5	1	3	3	3	3	3	3	3	3
Establish hardware specs		2	3	1	4	4	4				
Establish software specs		2	3	4	1		4				
Establish interface specs		2	3	1	4	4	4				
Establish manufacturing specs		2	3	4	4	1	4				
Define documentation		2	1	4	4	4	4				
Establish market plan	5	3	5	4	4	4	1				
Prepare labor estimate			3	1	1	1		4	4	4	4
Prepare equipment cost estimate		3	1	1	1			4	4	4	4
Prepare material costs			3	1	1	1		4	4	4	4
Make program assignments			3	1	1	1		4	4	4	4
Establish time schedules		5	3	1	1	1	3	4	4	4	4

1 Actual responsibility
2 General supervision
3 Must be consulted

4 May be consulted
5 Must be notified
6 Final approval

Figure 6-8 Simplified linear responsibility chart.

Responsibility Chart The 5-Step Process

Responsibility Charting is a way of systematically clarifying relationships pertaining to: 1. Communication or actions required to deliver an acceptable products or service 2. Functional roles or departmental positions (no personal names). 3. Participation expectations assigned to roles by decisions or actions.

I. Identify work process:

- Start with high impact areas first.
- Don't chart process that will soon change
- Work process must be well defined
- Fewer than ten activities implies the definition is too narrow
- Greater than 25 activities implies definition is too broad

II. Determine the decisions and activities to chart:

- Avoid obvious, generic or ambiguous activities, such as:
 - “Attend meetings”
 - “Prepare reports”
- Each activity or decision should begin with a good action verb:

Evaluate
Operate
Approve
Publish

Schedule
Monitor
Conduct
Report

Write
Prepare
Develop
Review

Record
Update
Inspect
Authorize

Determine
Collect
Train
Decide

III. Prepare a list of roles or people involved in those tasks:

- Roles can be individuals, groups or entire departments
- Can include people outside your department or outside the company - Customers, suppliers, etc.
- Roles are better than individual names.
- RACI chart should be independent of personal relationships so the chart would still be valid if all new people filled the roles tomorrow

IV. Develop the RACI chart:

As a general rule, first assign R's then determine who has the A, then complete C's and I's .

For larger groups or more complex issues, an independent facilitator is required.

Meeting time can be significantly reduced if a “straw model” list of decisions and activities is completed prior to meeting.

The ideal group size is four to ten people

V. Get feedback and buy-in:

- Distribute the RACI chart to everyone represented on the chart but not present in the development meeting.
- Capture their changes and revise chart as appropriate
- Reissue revised RACI chart
- Update as necessary on a on-going basis

A follow-up meeting may be necessary if significant changes are made

3.3. PROJECT COST ESTIMATION AND BUDGETING CHART

Project Estimation

- Estimating is the process of forecasting or approximating the time and cost of completing project deliverables.



Why Estimating Time and Cost Are Important

- Estimates are needed to support good decisions.
- Estimates are needed to schedule work.
- Estimates are needed to determine how long the project should take and its cost.
- Estimates are needed to determine whether the project is worth doing.
- Estimates are needed to develop cash flow needs.
- Estimates are needed to determine how well the project is progressing.
- Estimates are needed to develop time-phased budgets and establish the project baseline.
 - Top-Down Estimation
 - Bottom-Up Estimation

Top-Down Estimation

- Usually done by senior management

Analogy

Group Consensus

Mathematical Relationship



Bottom-Up Estimation

- Performed by the people who are doing the work



SNAPSHOT FROM PRACTICE

Council Fumes as Tram Tale Unfolds*



Portland, Oregon's, Willamette riverfront development has exploded with seven condominium towers and a new health sciences center under construction. The health science complex is to be linked with Oregon Health Sciences University (OHSU), which is high on a nearby hill, with an aerial cable tram.

The aerial tram linking the waterfront district to OHSU is to support the university expansion, to increase biotechnology research, and to become Portland's icon equivalent to Seattle's Space Needle. All of the hype turned south when news from a hearing suggested that the real budget for the tram construction, originally estimated at \$15 million, is going to be about \$55–\$60 million, nearly triple the original estimate. The estimate could even go higher. Commissioners want to find out why city staff knowingly relied on flawed estimates. Mike Lindberg, president of the nonprofit Aerial Transportation Inc., acknowledged "the \$15 million number was not a good number. It was simply a guesstimate."

* *The Oregonian*, January 13, 2006, by Frank Ryan, pages A1 and A14, and April 2, 2006, page A1.



Commissioner Erik Sten said, "Those numbers were presented as much more firm than they appear to have been. . . . It appears the actual design wasn't costed out. That's pretty shoddy."

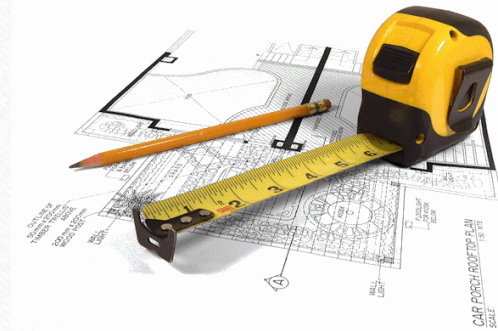
Factors influencing the quality of Estimate

- Planning Horizon
- Project Duration
- People
- Project Structure and Organisation
- Padding Estimates
- Organisation Culture



Guidelines for Estimation

- Responsibility
- Use Several People to estimate
- Normal Conditions
- Time Units
- Independences
- Contingencies
- Adding Risk Assessment to helps to avoid surprise to stakeholders

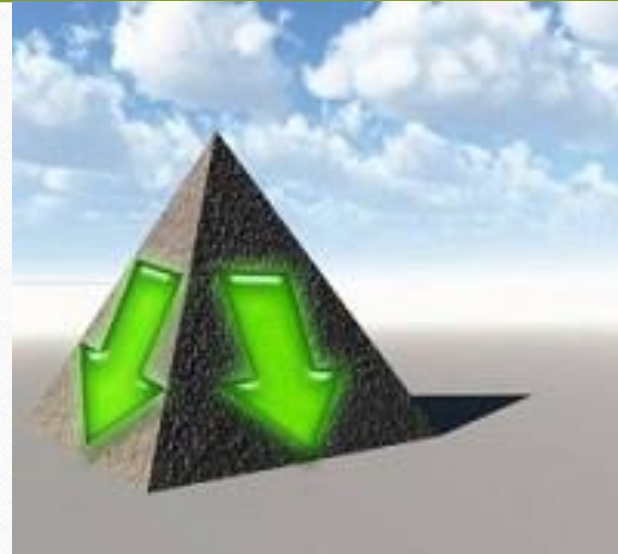


Conditions for Preferring Top-Down or Bottom-Up Time and Cost Estimates

Condition	Top-Down Estimates	Bottom-Up Estimates
Strategic decision making	X	
Cost and time important		X
High uncertainty	X	
Internal, small project	X	
Fixed-price contract		X
Customer wants details		X
Unstable scope	X	

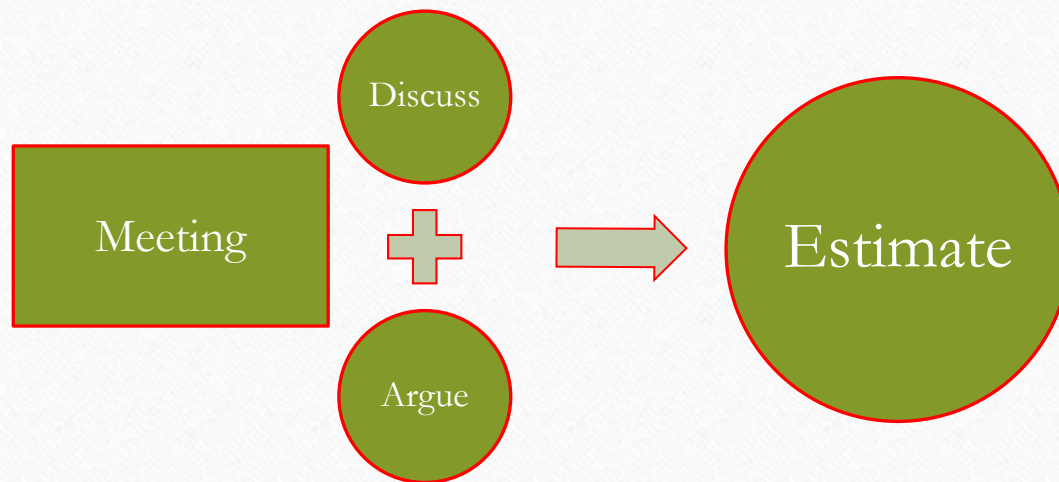
Top-Down approaches for Estimation

- Used to evaluate project proposal
- Much information may not be available at the initial phase of the project.
 - Eg: Design is not finalised
 - Used until tasks in WBS are clearly defined



Consensus

- Uses experience of senior and/or middle managers



SNAPSHOT FROM PRACTICE

The Delphi Method



Originally developed by the RAND Corporation in 1969 for technological forecasting, the **Delphi Method** is a group decision process about the likelihood that certain events will occur.

The Delphi Method makes use of a panel of experts familiar with the kind of project in question. The notion is that well-informed individuals, calling on their insights and experience, are better equipped to estimate project costs/times than theoretical approaches or statistical methods. Their responses to estimate questionnaires are anonymous, and they are provided with a summary of opinions.

Experts are then encouraged to reconsider, and if appropriate, to change their previous estimate in light of the replies of other experts. After two or three rounds it is believed that the group will converge toward the “best” response through

this consensus process. The midpoint of responses is statistically categorized by the median score. In each succeeding round of questionnaires, the range of responses by the panelists will presumably decrease and the median will move toward what is deemed to be the “correct” estimate.

One distinct advantage of the Delphi Method is that the experts never need to be brought together physically. The process also does not require complete agreement by all panelists, since the majority opinion is represented by the median. Since the responses are anonymous, the pitfalls of ego, domineering personalities, and the “bandwagon or halo effect” in responses are all avoided. On the other hand, future developments are not always predicted correctly by iterative consensus nor by experts, but at times by creative, “off the wall” thinking.

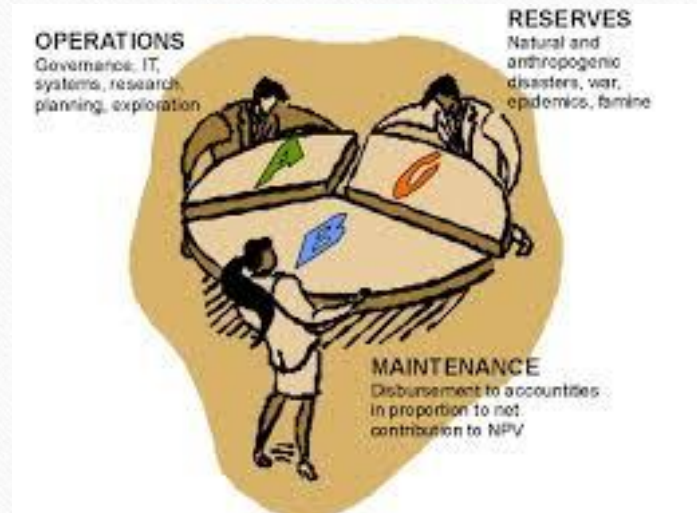
Ratio Methods

- Square feet
- Capacity size

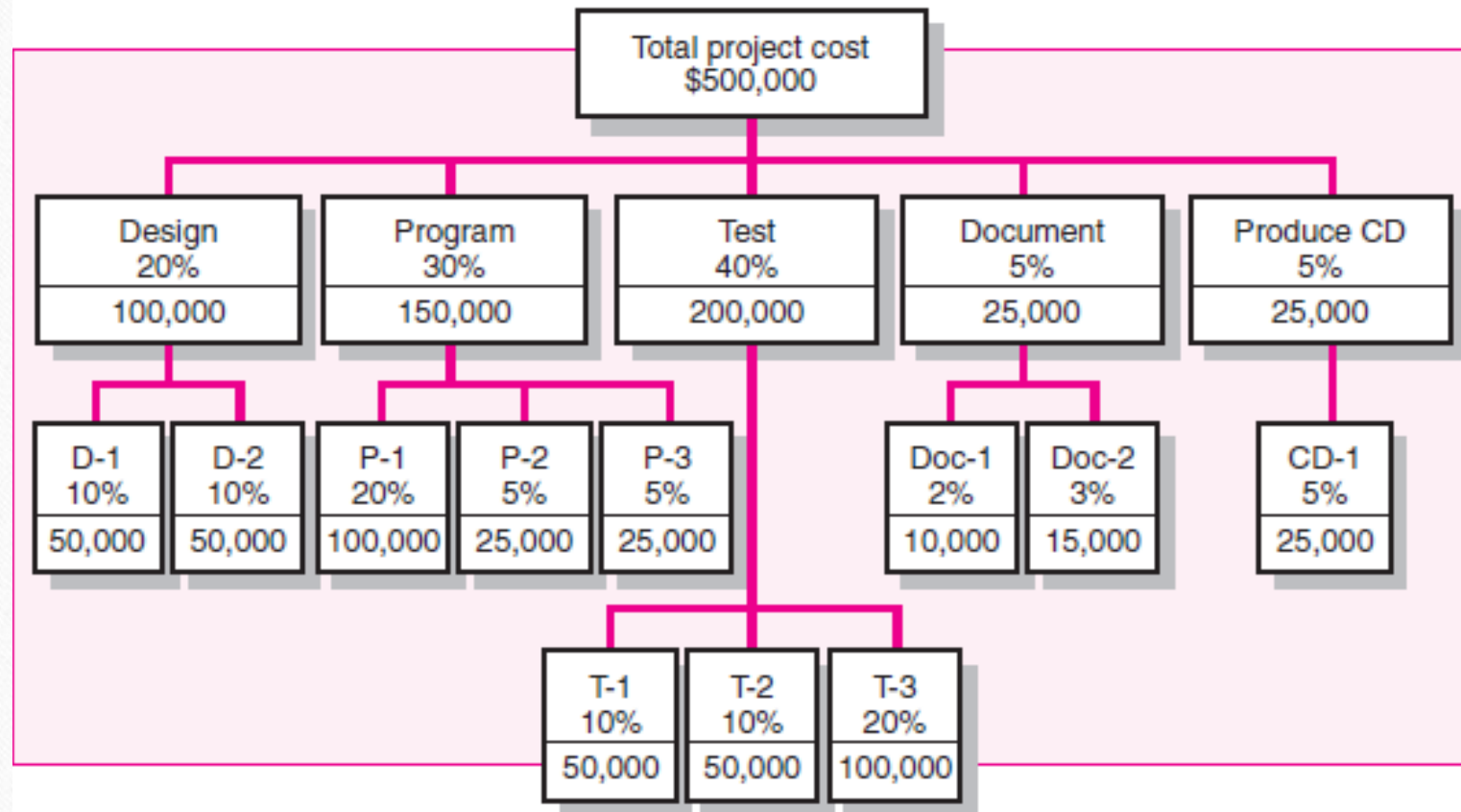


Apportion Methods

- Extension of ratio method by using historical data
- Quick estimate little effort with reasonable accuracy



Apportion Method of Allocating Project Costs Using the Work Breakdown Structure



Learning Curves

- Time to perform a task improves with repetition
- Especially true for labour intensive work



Disadvantages of Top-Down Approach

- Time and cost of a specific tasks are not considered
- Grouping many tasks into a common basket encourages errors of omission



Bottom-Up Approaches for Estimating Project Times and Costs

- ***Template Methods***
- ***Parametric Procedures Applied to Specific Tasks***
- ***Range Estimating***

Range Estimating Template

	A	B	C	D	E	F	G	H
1	Project number: 18				Project Manager: Dawn O'Connor			
2	Project description: New Organic Wine Launch				Date: 2/17/2xxx			
3		Organic Wine Launch Project						
4		Range Estimates						
5								
6	WBS	Description	Low	Average	High	Range	Risk	
7	ID		Estimate	Estimate	Estimate		Level	
8			Days	Days	Days	Days		
9								
10	102	Approval	1	1	3	2	low	
11	103	Design packaging	4	7	12	8	medium	
12	104	ID potential customers	14	21	35	21	high	
13	105	Design bottle logo	5	7	10	5	low	
14	106	Contract kiosk space	8	10	15	7	medium	
15	107	Construct kiosk	4	4	8	4	medium	
16	108	Design fair brochure	6	7	12	6	high	
17	109	Trade journal advertising	10	12	15	5	medium	
18	110	Production test	10	14	20	10	high	
19	111	Produce to inventory	5	5	10	5	high	
20	112	Business card scanner hookup	1	2	3	2	low	
21	113	Video hook up	2	2	4	2	medium	
22	114	Event rehearsal	2	2	5	3	high	