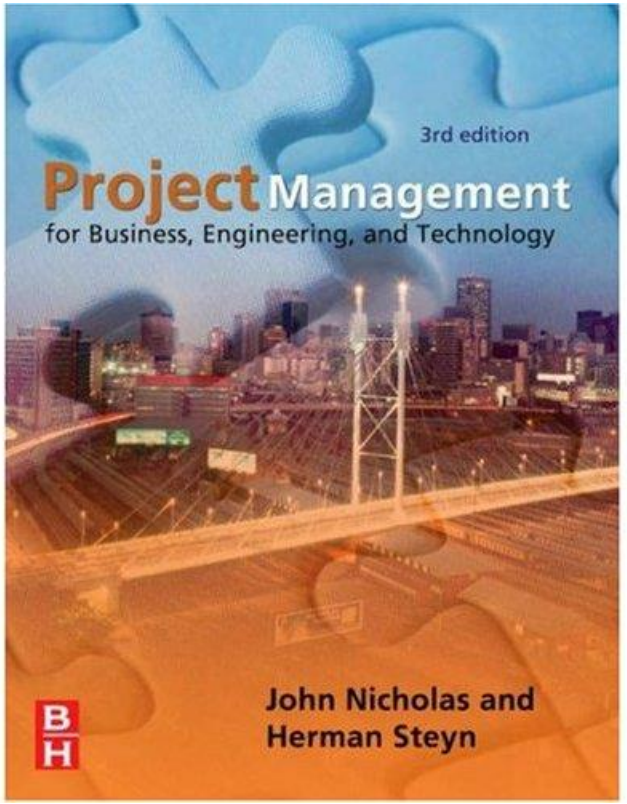
Chapter 5
Planning Fundamentals

Project Management for Business, Engineering, and Technology



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Common Elements of Project Plan

1. Scope Statement, Charter, SOW
2. Detailed requirements
3. Project organization and responsibility for tasks
4. Detailed work definition (WBS or PBS and work package/work task details)
5. Detailed schedules with milestones
6. Project budget and cost accounts
7. Quality plan

Elements of Project Plan

8. Risk plan
9. Work review plan
10. Testing plan
11. Change control plan
12. Documentation plan
13. Procurement plan
14. Implementation plan

Element 2 has already been discussed.

This chapter focuses on elements 1,3,4, and aspects of 5 and 13.

The remaining elements are addressed in later chapters.

Scope, Charter, and SOW

- Scope, charter, or SOW: Is the first item on project master plan. Variations on same theme

- Purpose
  - provide broad description of master plan/project to stakeholders
  - directed at core project team, project organization, primary stakeholders

Scope

- Describes “breadth of project,” areas to be covered by project and deliverables & areas not covered.

  Includes:

  - Objectives of project from perspective of contractor
  - Requirements
  - Deliverables
  - Milestones
  - Limits and exclusions: what project does *not* include

SOW

- SOW, Statement of Work, is the scope document for *contracted* projects
  - Appears in RFP, proposal, contract, as well as master plan

Defining the SOW

1. For contracted project work
   - Contractor and customer agree on definition of work required, work proposed, and basis for costs, schedules, and related matters.
   - There are two SOWs,
     - SOW in master plan
     - SOW in *contract* (CSOW)
   - SOW in contractor's project plan must contain same information and requirements as stated in CSOW.
   - Contractor's SOW and CSOW might be worded differently, but both should have exact same interpretation in terms of work and end results

Defining the SOW

2. Suggestions
   - Ensure that SOW and WBS correspond to each other. Both must be clear; neither contractor nor customer question what has to be done.
   - Requirements for every end-item, task, and report must be clear enough so parties *responsible* will be able to sign-off acceptance of results.
   - Never specify tasks using “as necessary” or “as required”.
     - Where judgments must be made, specify **who** will make them, *procedures* for making them, and potential impact of judgments on cost and schedule escalation.

Issues in Defining SOW

2. Suggestions:
   - Specify requirements using active terminology (“shall” or “will”)
   - Never use passive terminology (“should” or “try to”).
   - “shall” = must do
   - “will” = desirable to do

Issues in Defining SOW

2. Suggestions

   - Categorize specifications applicable to entire project separately from those applicable to only parts of project.
   - Hold meetings with customers and technical specialists to review clarity and completeness SOW and WBS.

Charter

- Charter is the scope document *internal* projects
  - May include everything in Scope Statement plus
    - risk limits
    - customer needs
    - spending limits
    - key players on project team.
  - Issued by senior management to legitimize project
  - Gives project manager authority to initiate work and apply resources to project.

Charter Contents

- Background
- Project Objectives
- Scope or SOW
- Deliverables
- Assumptions
- Constraints
- Approach
- Schedule
- Project Team
- Risk
- Management Plan

Work Definition

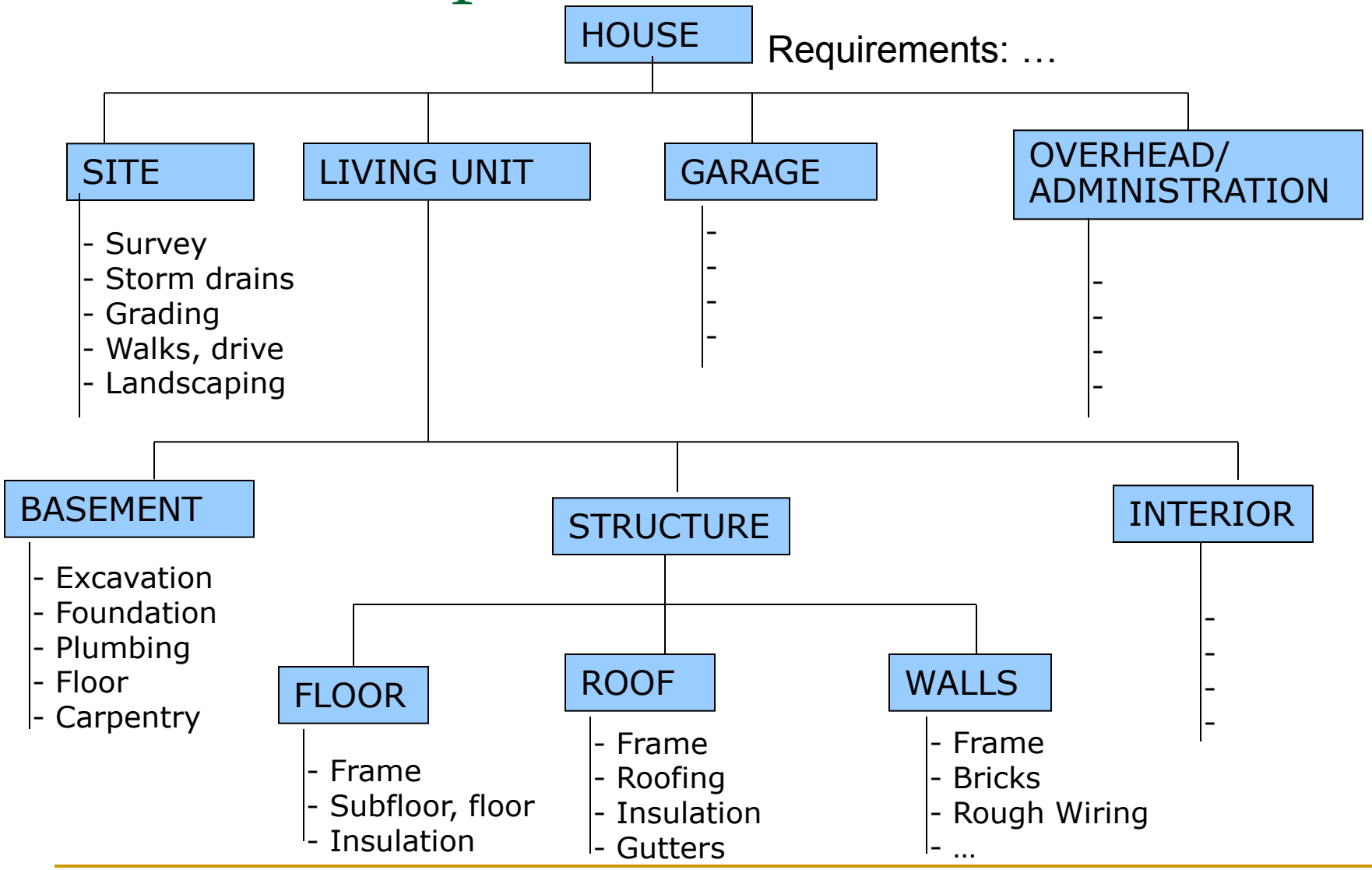
- Start with the SOW and requirements (the “what” of the project)
- Ask “how” will the SOW and requirements be met: what is the actual work to be performed to meet the requirements?
- Subdivide the project into small, well defined work packages
- Use the Work Breakdown Structure, WBS

  (a.k.a. Project Breakdown Structure, PBS)

WBS

- Divide project into “well-defined” tasks
- Well-defined tasks: the basis for project schedule, budget, resource requirements, responsibility assignments, and risk management

WBS Example for House



WBS Procedure

- Start with SOW and requirements
- Ask “what 5-10 high level activities would yield intended results?”
- For each high-level activity ask “What is involved here, what is required?”
- Questions that are difficult to answer require the activity to be further broken down
- Continue breaking down activities until all activities at bottom of WBS are well-defined

WBS Procedure

- What is well-defined?
  - Well-defined activity is called a “work package” and has following features

WBS Procedure

- Work Package contains:
  - SOW and requirements
  - Clear definition of work and all subtasks
  - Time estimates or deadlines
  - Cost estimates
  - Responsibility
  - Immediate predecessors, preconditions, inputs
  - Deliverables
  - Resources
  - Risk assessment

Work Package Definition

While going through WBS, ask following questions about each work package:

1. *Do you need better estimates of duration and cost of the work package?*
2. *Can you identify who will be responsible for work the package?*
3. *Is the size of work package too large to track and control?*
4. *Are activities within work package independent of each other?*
5. *Do some activities within work package have different immediate predecessors?*
6. *Are risky and non-risky activities combined in the same work package?*
7. *Does the work package contain many different kinds of resources?*

If answer is yes to any of questions, decompose the work package into smaller work packages.

If answer is no to all of them, the work package probably does not need to be subdivided.

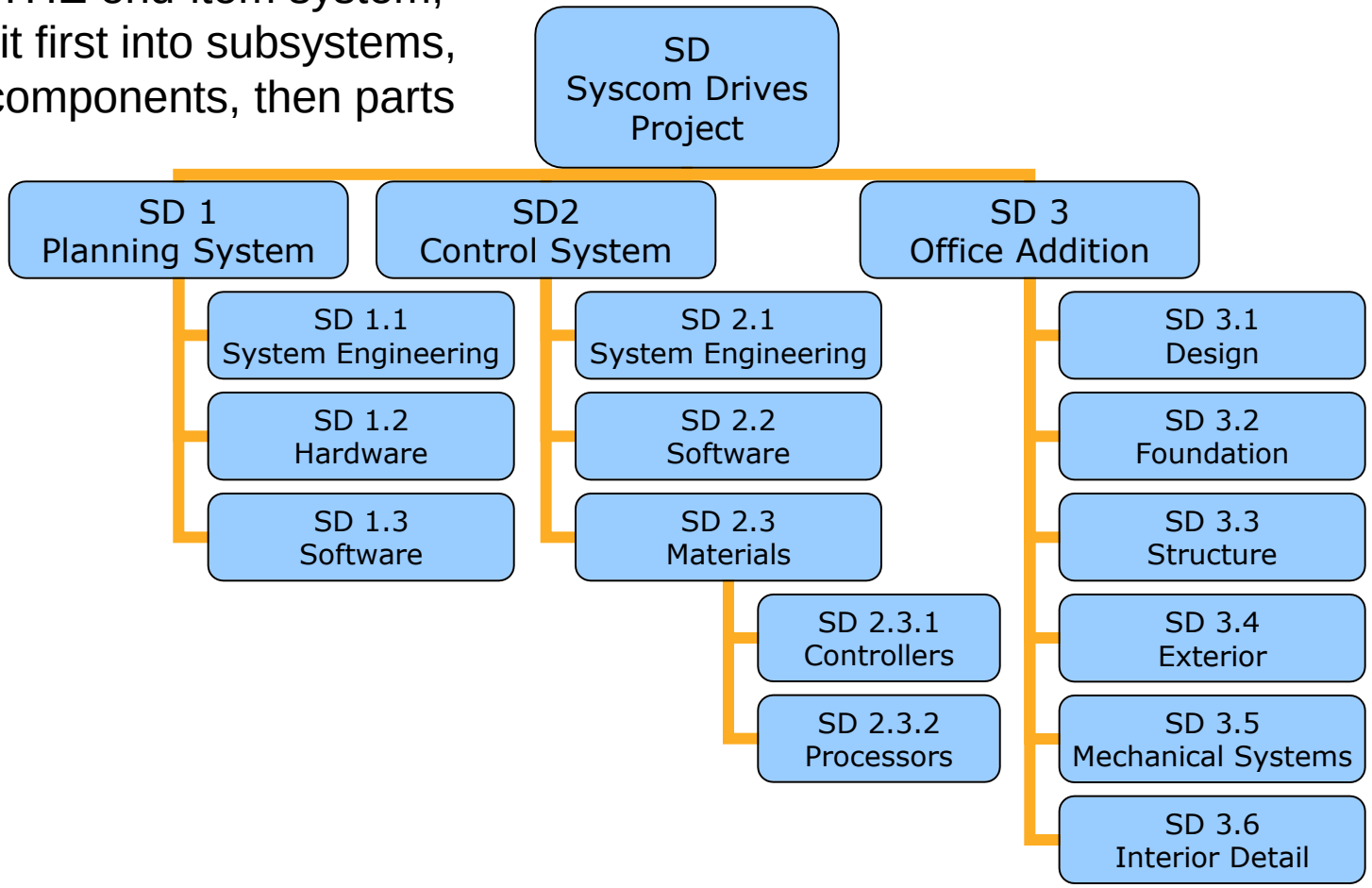
Creating WBS

- Project team
  - Brainstorm
  - Past experience
  - Templates
- Multiple teams
- Experts

Approaches

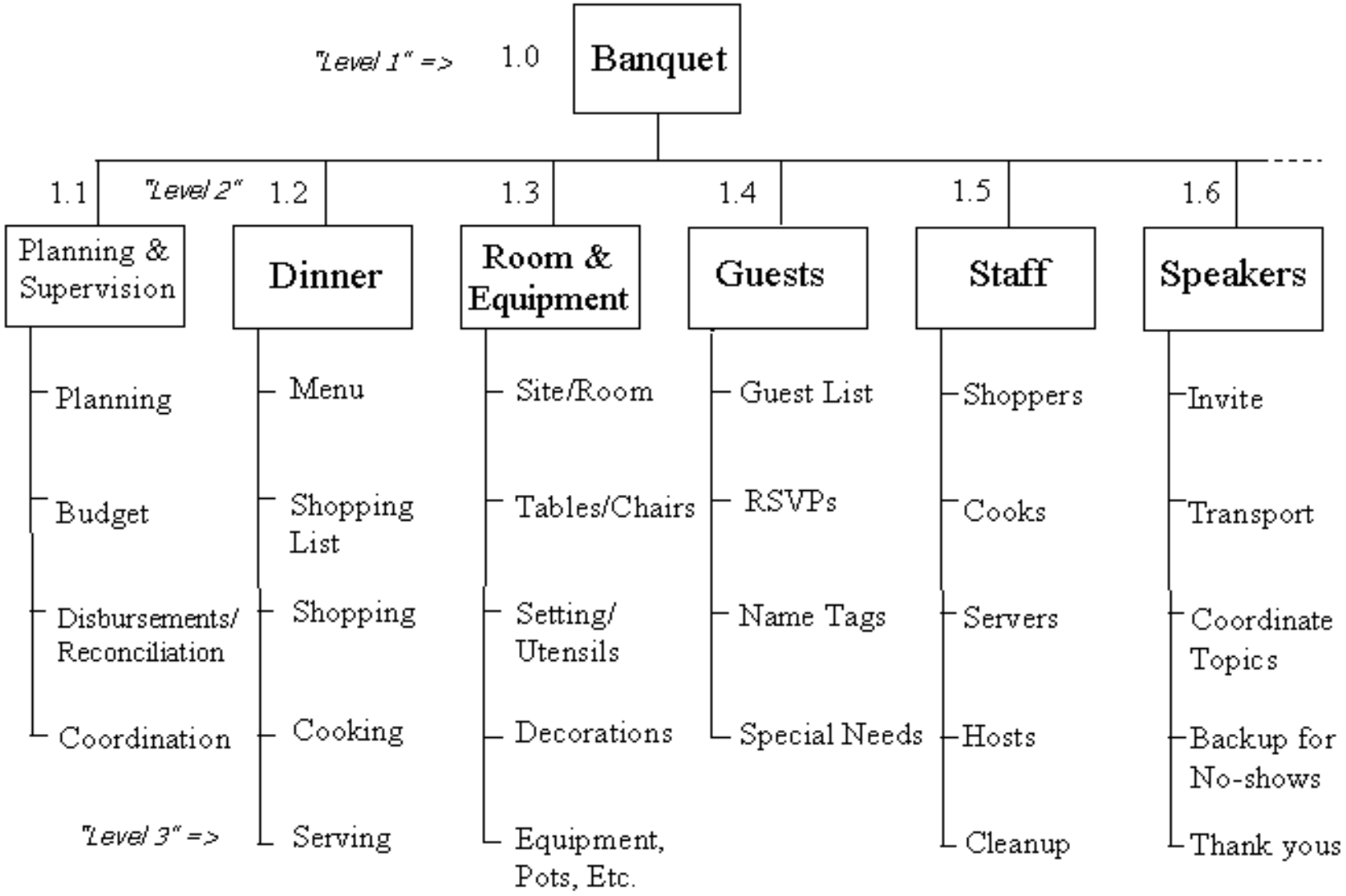
End-item Sub-systems Approach

Start with THE end-item system, subdivide it first into subsystems, then into components, then parts



Approaches

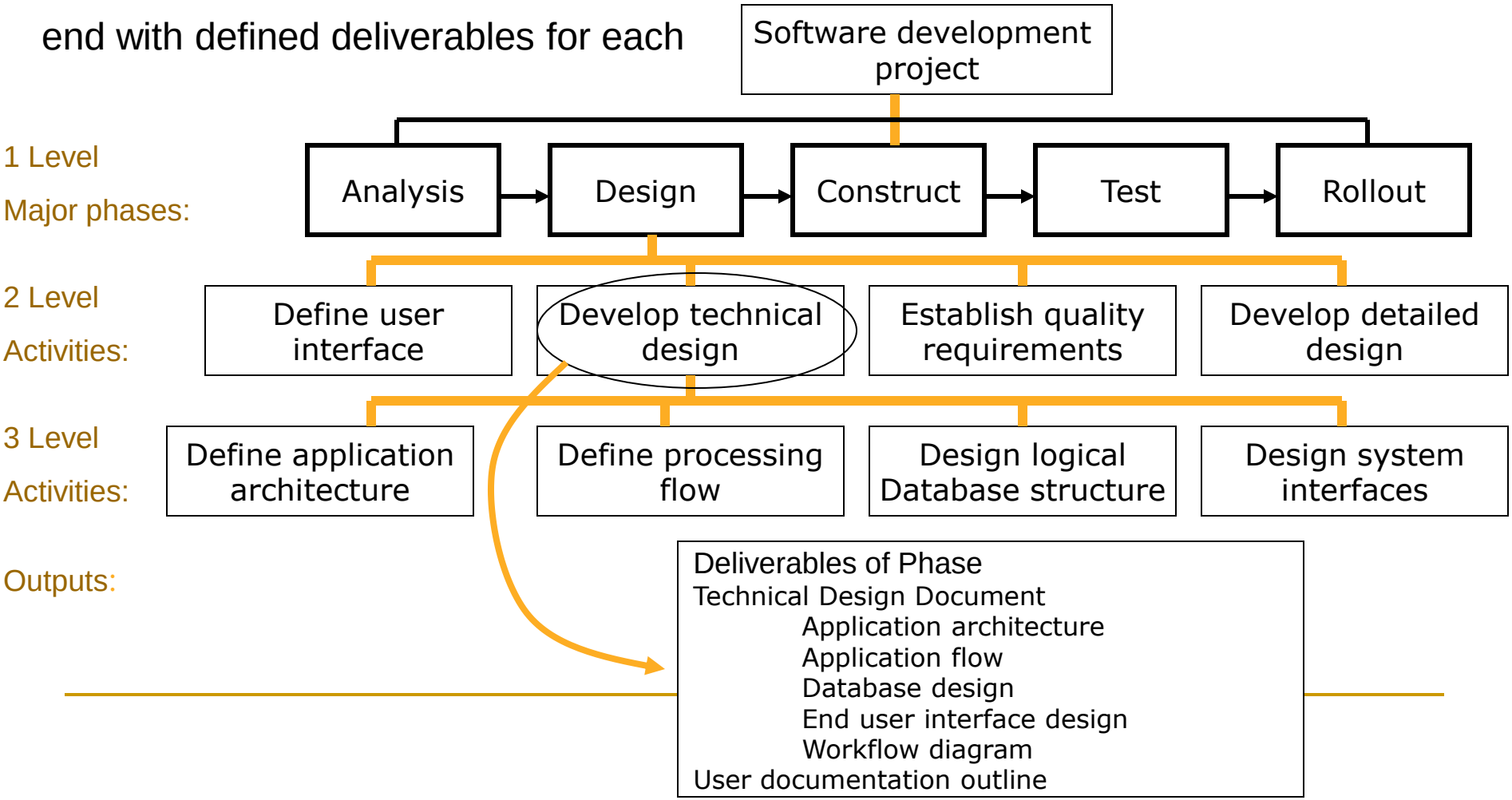
End-item Sub-systems Approach



Approaches

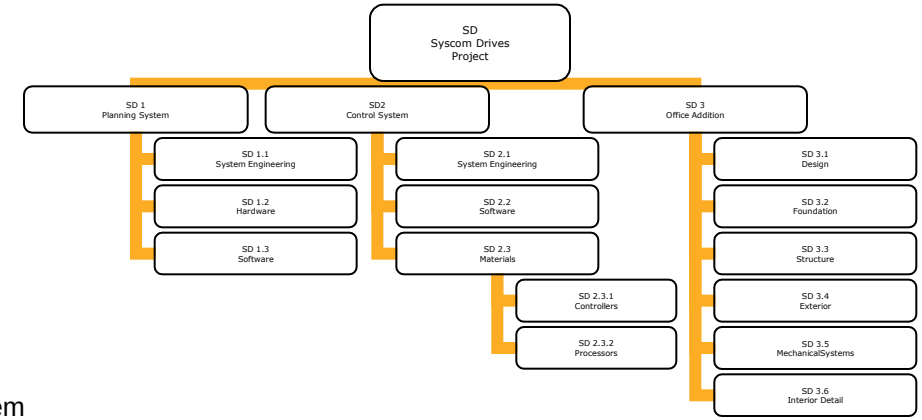
Process-Steps Approach

Start by defining phases or stages in project,
then subdivide each into detailed tasks;
end with defined deliverables for each



WBS Formats

- Tree Structure

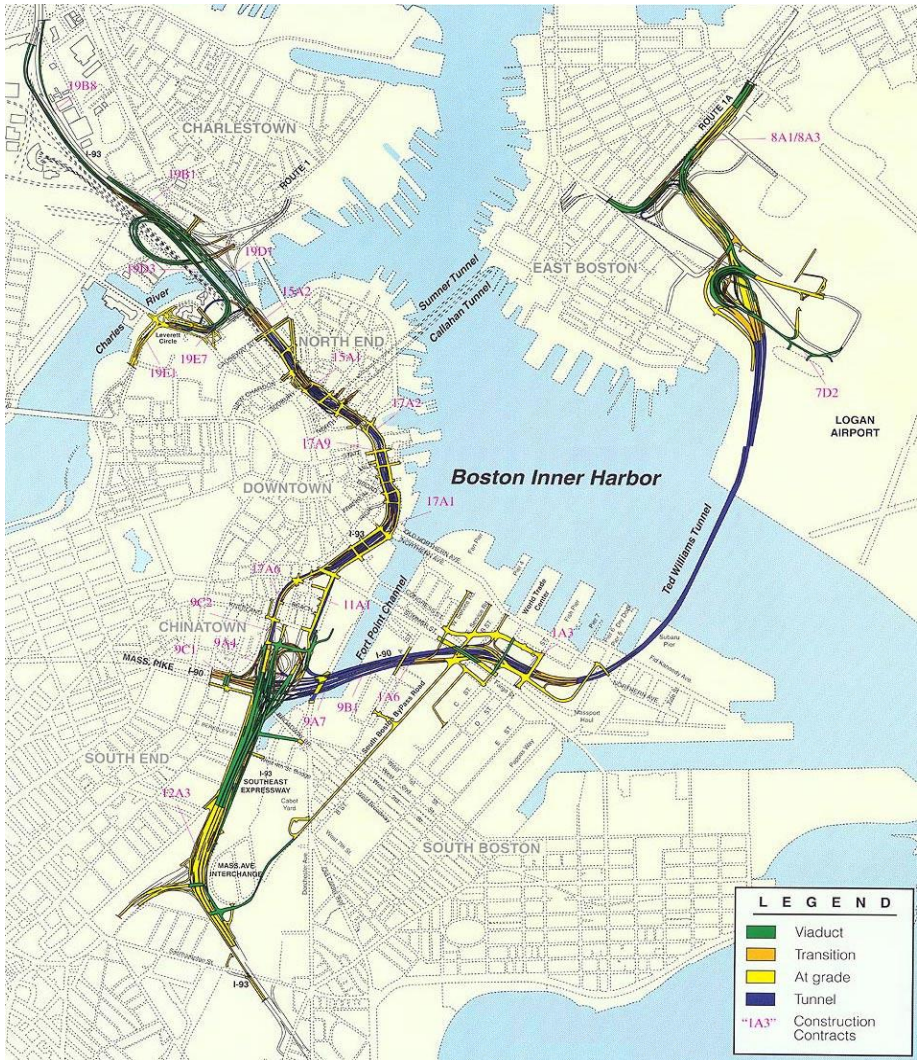


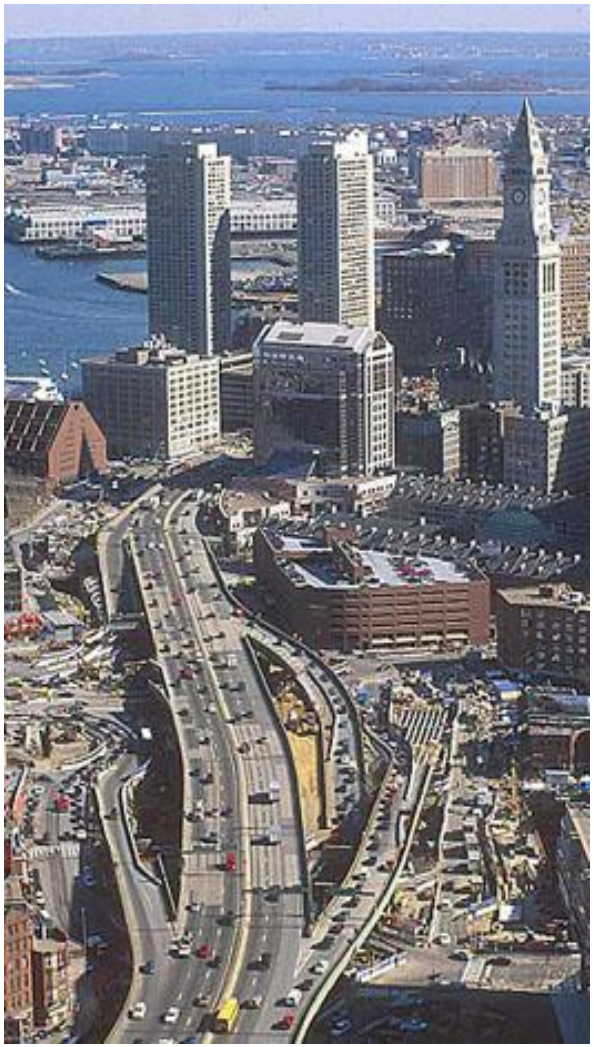
- Indented Structure

System
Subsystem
Component
Part

SD System Drives and Spaces
SD1 Planning System
SD1.1 System Engineering
SD 1.1.1 Control requirements
SD 1.1.2 Controller specifications
SD 1.1.3 Controller functions
SD1.2 Materials
SD1.2.1 Controller devices
SD1.2.2 Controller interfaces
SD2 Control System

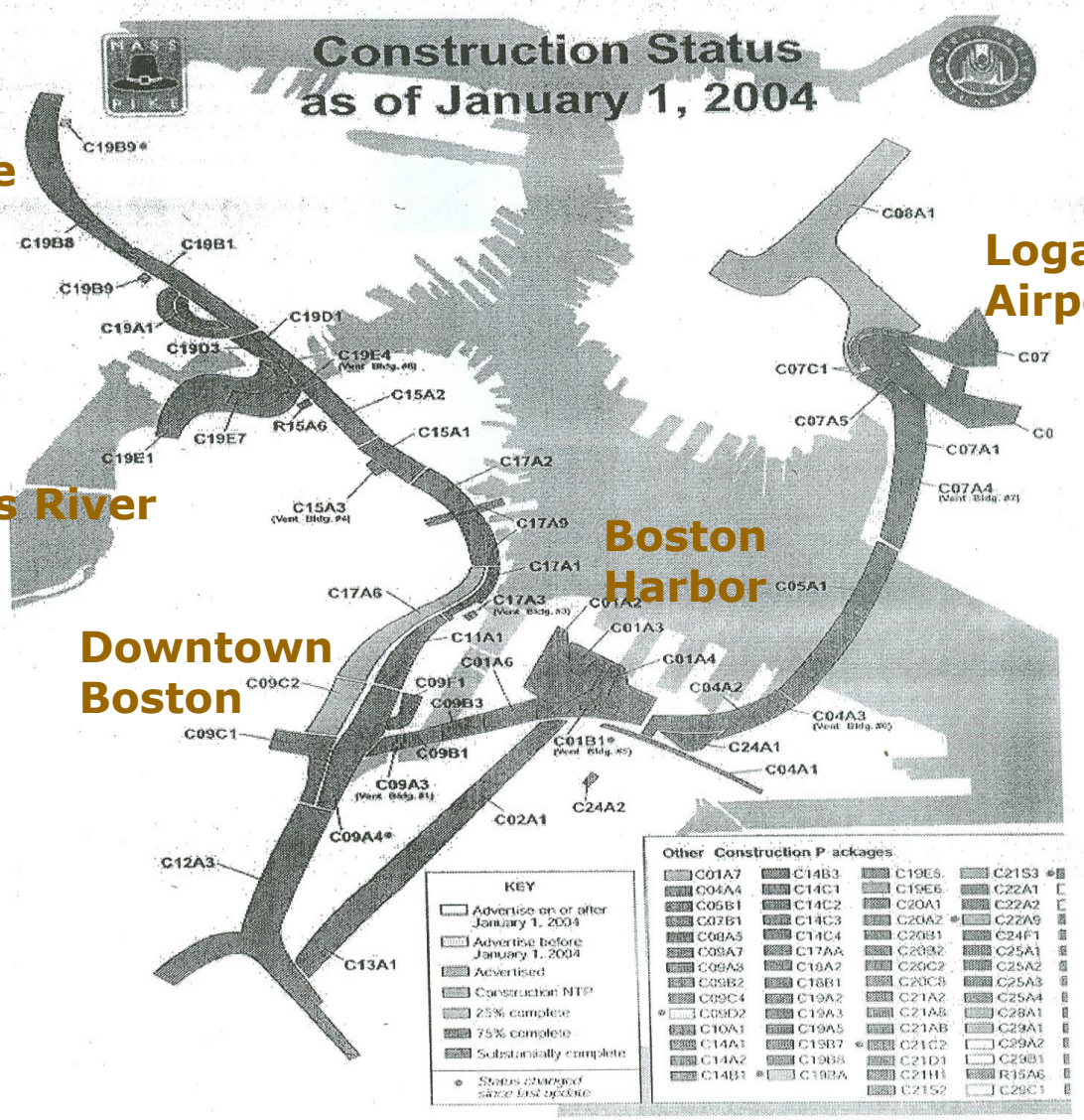
Boston's Big Dig





End-item Sub-systems Approach

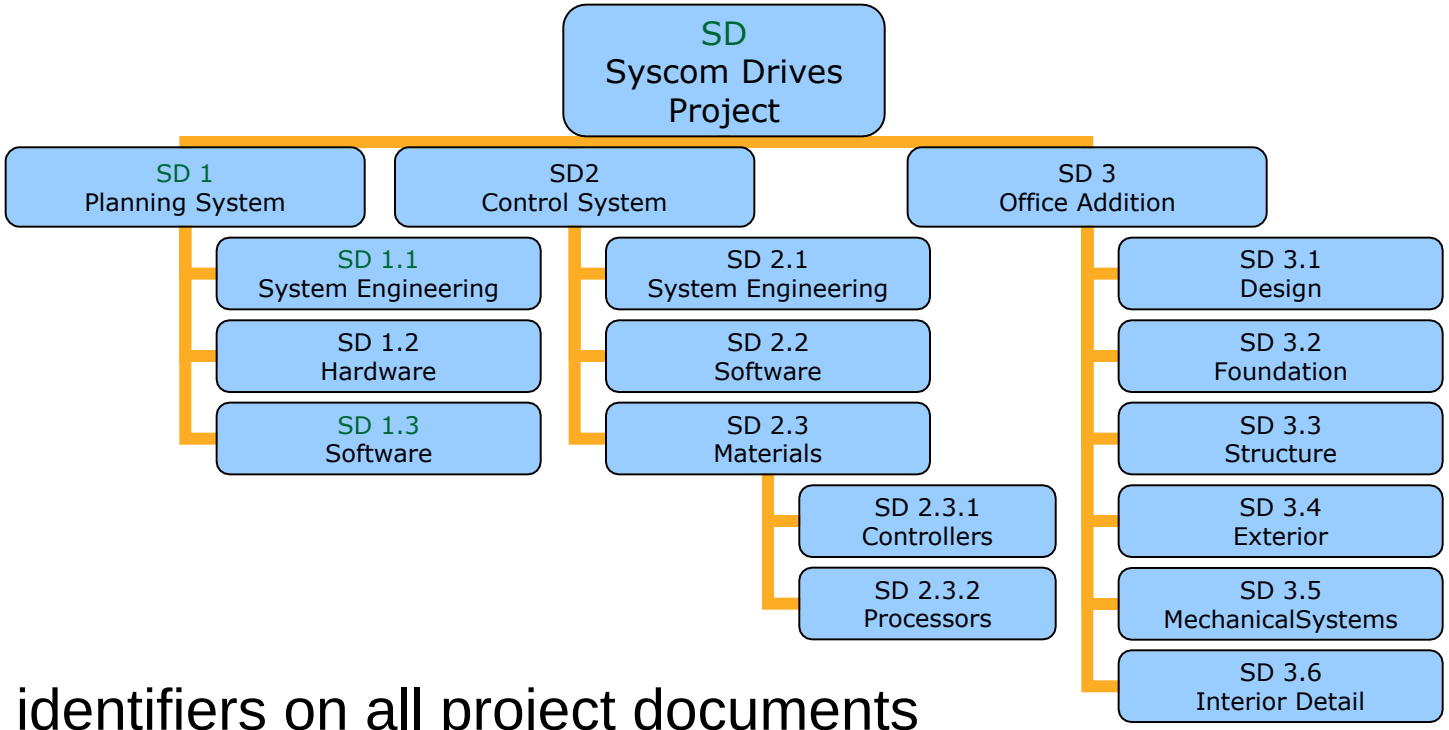
- Big-Dig work packages based on contracts
- Contracts based on a breakdown of project into physical sections and components



http://www.bigdig.com/thtml/images/map36.jpg

10/5/04

Every task or work package has a unique identifier



Use same identifiers on all project documents

- Schedules
- Budgets
- Responsibility matrix
- Change requests, etc.

WBS and Integrated Planning and Control

The WBS process and work packages provide integrated plan and control:

1. Functional managers, subcontractors, and others responsible for the work are identified and become involved during the WBS process.
2. Work packages in each phase are logically and physically related to those in earlier and later phases; predecessor requirements are met and no steps overlooked.
3. Work packages are the basis for budgets and schedules. The project budget is the sum of the budgets for all the work packages plus project overhead and indirect expenses. The project schedule is the composite of the schedules of all the work packages.
4. The project organization is formed around work packages. Resources are assembled for and management responsibility delegated to individuals in each work package.
5. The project is directed by directing people working in individual work packages.
6. Project control is exercised through control of work packages.

An integrated project plan is a systems approach to management

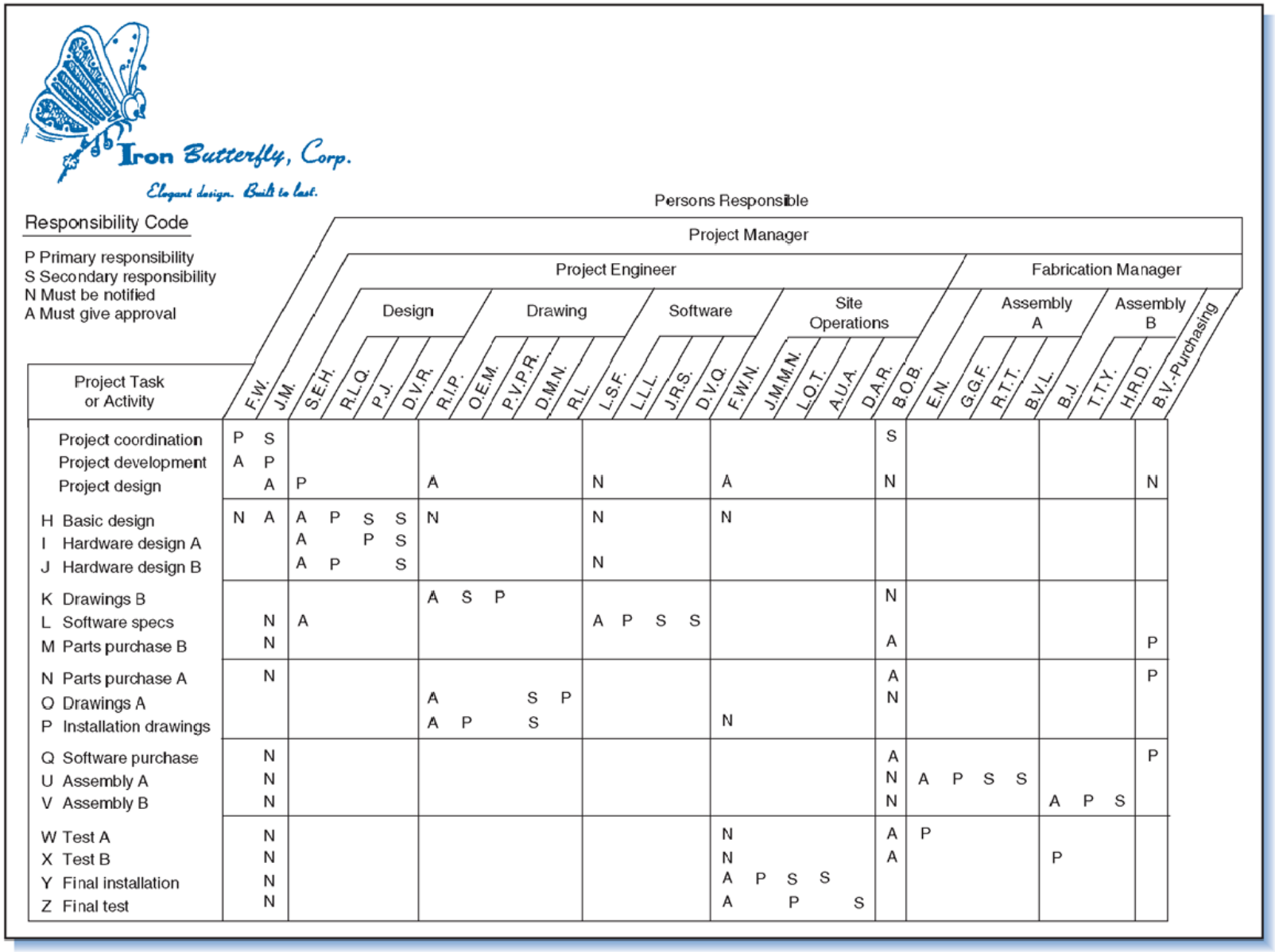
Project Responsibility

- While creating WBS, the questions “who is needed to do this” and “who will be responsible” are addressed for each package
- Answers result in responsibility assignments for all areas of project
- People responsible for areas of project, and details of that responsibility, are documented and communicated in Responsibility Matrix

Responsibility Matrix

- For each task, show who is responsible
- For each person, show kind of responsibility; e.g.
  - P: primary or lead
    - One, and only one, P per task
  - S: secondary
  - N: notification required
  - A: approval required

Responsibility Matrix



Responsibility Matrix

DesignBuild Responsibility Matrix

L - Lead P - Production I - Input A - Agree	Project Manager	Construction Manager	EFD Technical Staff	CAM	PCO	PCO Contract Spec.	ROICC/ REICC	ACO	ACO Contract Spec.	Client: Claimant/ Command	Client: Public Works / BCE	Client: Facility User	DB Contractor
Step 1- Project Initiation													
a) Team assignments	L		I		I								
b) Team kickoff meeting	L	I	I	I		I							
c) Acquisition Strategy	L	I	I	I	I	I					I	I	
d) CPM Schedule	L	I	I	I		I	I				I	I	
d) Client Orientation	L	I								A	A	A	
Step 2- Site Studies & Engr Services													
a) Obtain Engr Services	L	I	P St&C)	I		P					I	I	
b) Obtain Environmental Services	L	I	I(EnvE)	I		P					I	I	
c) Finalize NEPA actions	L	I	P(EnvP)							A	I	I	
d) Finalize Real Estate actions	L	I	P(RE)			P					I	I	
Step 3 - Develop the Project Reqmts													
Step 9 - Outfit the Facility													
a) Collateral Equip Procurment & Install		P	I	I			I		L	I	I	I	P
b) Utilities coord, procurement & activation													
c) Communications coord, proc & activation													
Step 10 - Contract Closeout													
a) Final contractor evaluation	I	L	I	I			A		I		I	I	I
b) As-built drawings	L	P											P
c) OMSI & other maintenance info	I	L	I(FM)								I	I	P
e) Permits closeout	I	L	I(EnvE)										P
f) 2nd sesaon TABS													
g) Contractor final release		P							L				P
h) Final Payment													
i) Ribbon cutting		P							L				P

Position responsibility:

L - Lead: CIBL position responsible for coordination & product delivery
P - Production: Position responsible to provide a deliverable
I - Input: Position where input may be required to produce deliverable
A - Agree: Position where agreement is desired

Notes:

(1) In absence of a P on a specific line the L is soley responsible for production
(2) In absence of a A on a specific line the L agrees with the delieverable

EFD Technical Staff Legend:

A - Architect
St - Structural Engineer
C - Civil Engineer
EE - Electrical Engineer
M - Mechanical Engineer
FP - Fire Protection Engineer
Sp - Specification Engineer
Ct - Cost Engineer
ID - Interior Designer
EnvE - Environmental Engineer
EnvP - Environmental Planner
FM - Facility Maintenance Engineer
RE - Real Estate Specialist

Responsibility Matrix

- Every task accounted for; nothing falls through cracks
- Each responsibility represents mutual agreement

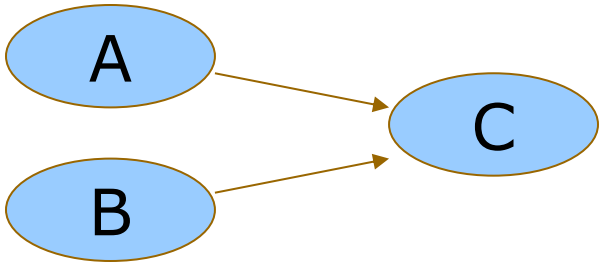
Scheduling Basics

- WBS provides information necessary to create a schedule

- Includes
  - List of tasks (work packages)
  - For each task
    - Duration (or target completion date)
    - Resources required
    - Inputs, preconditions, prior completed tasks (Logical sequencing)

Logical Sequencing of Tasks

- Predecessor: A task that must be completed before another can be started
- If task C depends upon Tasks A and B,
  then Tasks A and B are “predecessors” for Task C.



- Task C is the “successor” of Tasks A and B

Gantt Chart

- Simple, common scheduling tool
- Easy to create and understand
- Developed by Henry Gantt,
  a consultant of Frederick Taylor.

H. Gannt

- **From Wikipedia**

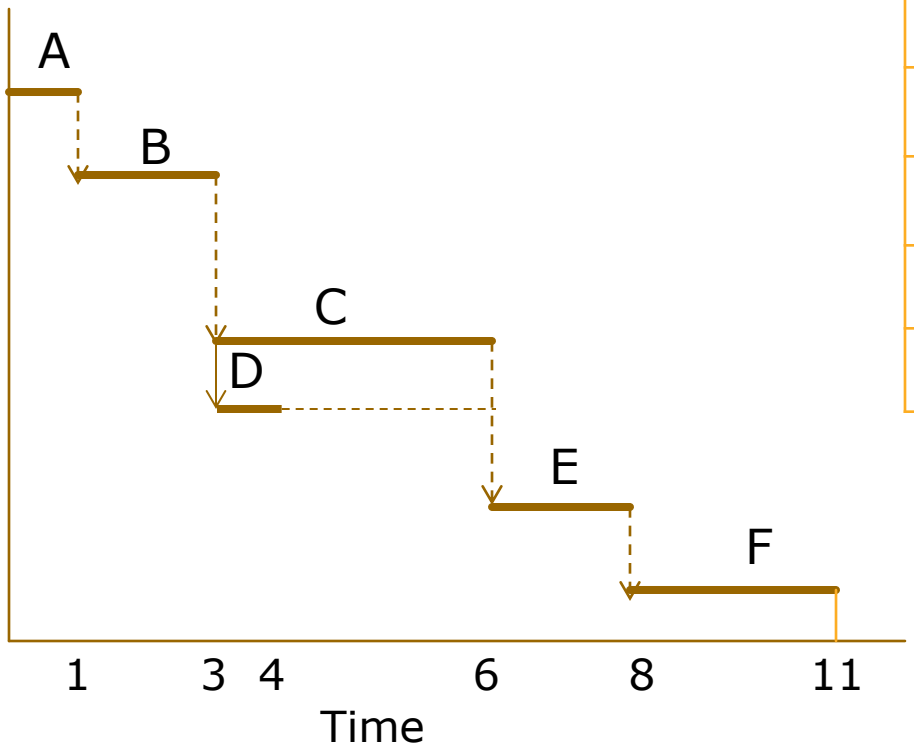
  Henry Laurence Gantt, A.B., M.E. (1861-1919) was a mechanical engineer and management consultant who is most famous for developing the Gantt chart in the 1910s. These Gantt charts were employed on major infrastructure projects including the Hoover Dam and Interstate highway system and still are an important tool in project management.

Gantt Chart

- Example

Activity	Immediate Predecessors	Time
A	--	1
B	A	2
C	B	3
D	B	1
E	C, D	2
F	E	3

Gantt Chart



Activity	Immediate Predecessors	Time
A	--	1
B	A	2
C	B	3
D	B	1
E	C, D	2
F	E	3

- Note:

  E starts at time 6 because then both C and D are completed. D is completed at time 4, but C is not until time 6. Hence, C must wait until time 6.

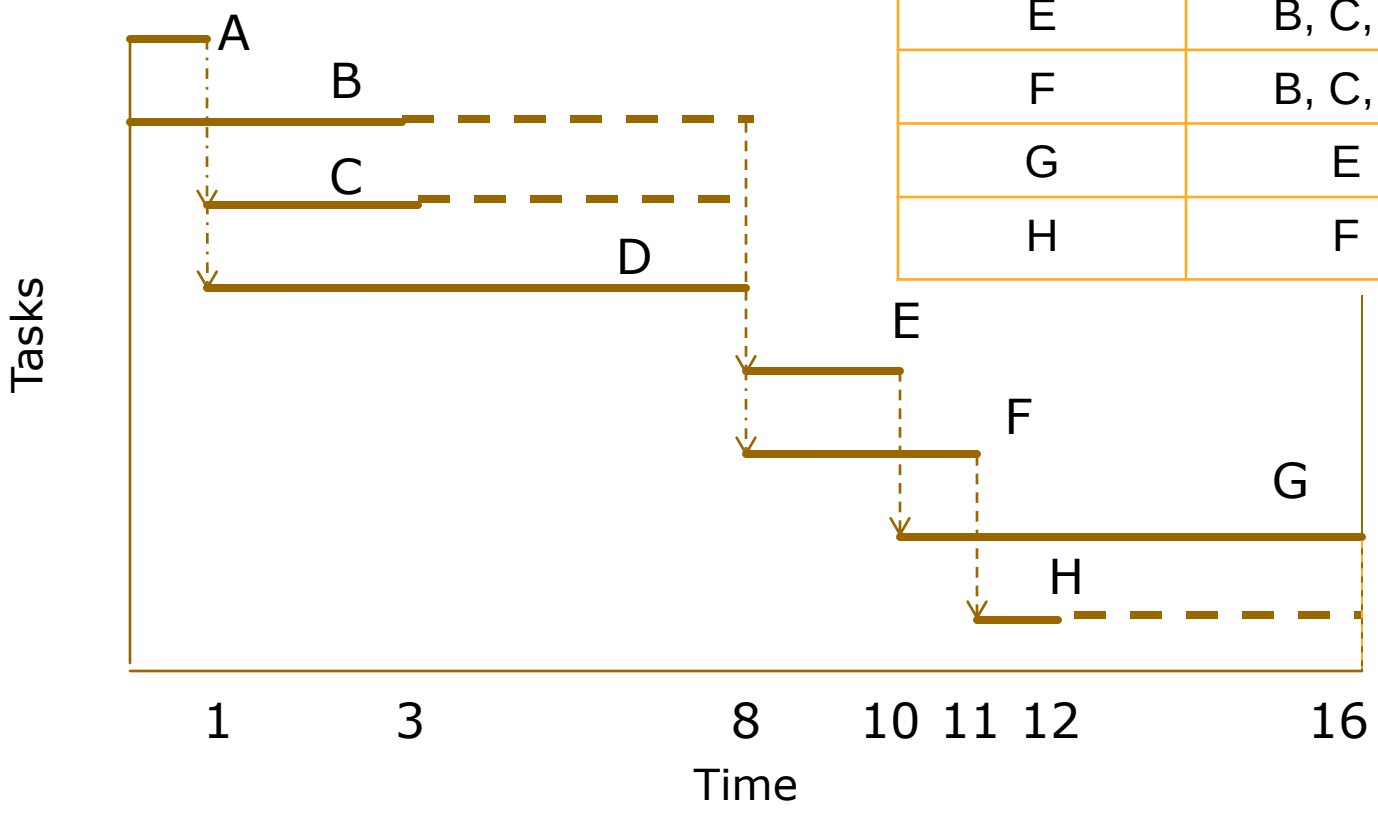
Gantt Chart

- Another Example

Activity	Immediate Predecessors	Time
A	--	1
B	--	3
C	A	2
D	A	7
E	B, C, D	2
F	B, C, D	3
G	E	6
H	F	1

Gantt Chart

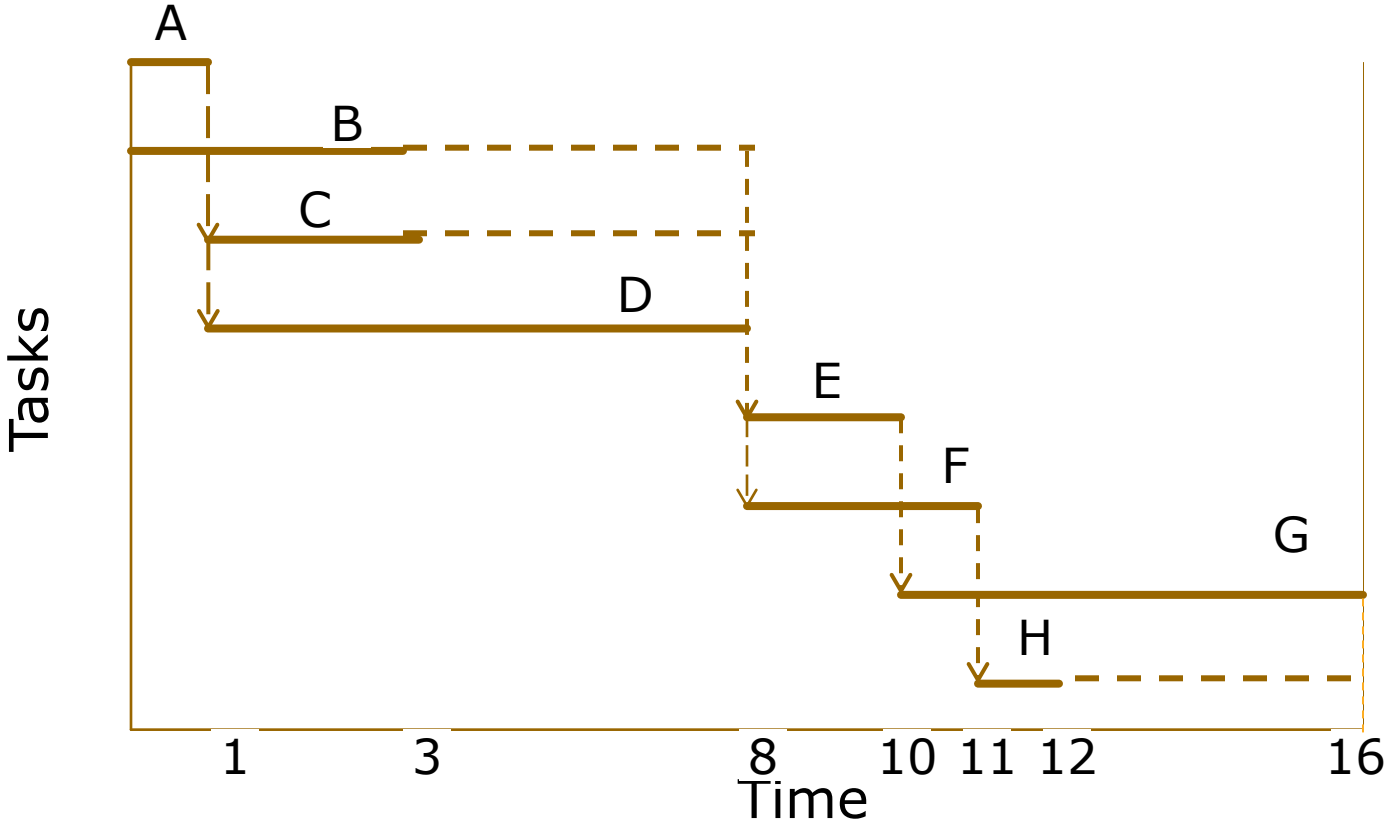
Activity	Immediate Predecessors	Time
A	--	1
B	--	3
C	A	2
D	A	7
E	B, C, D	2
F	B, C, D	3
G	E	6
H	F	1



Gantt Chart

Notes:

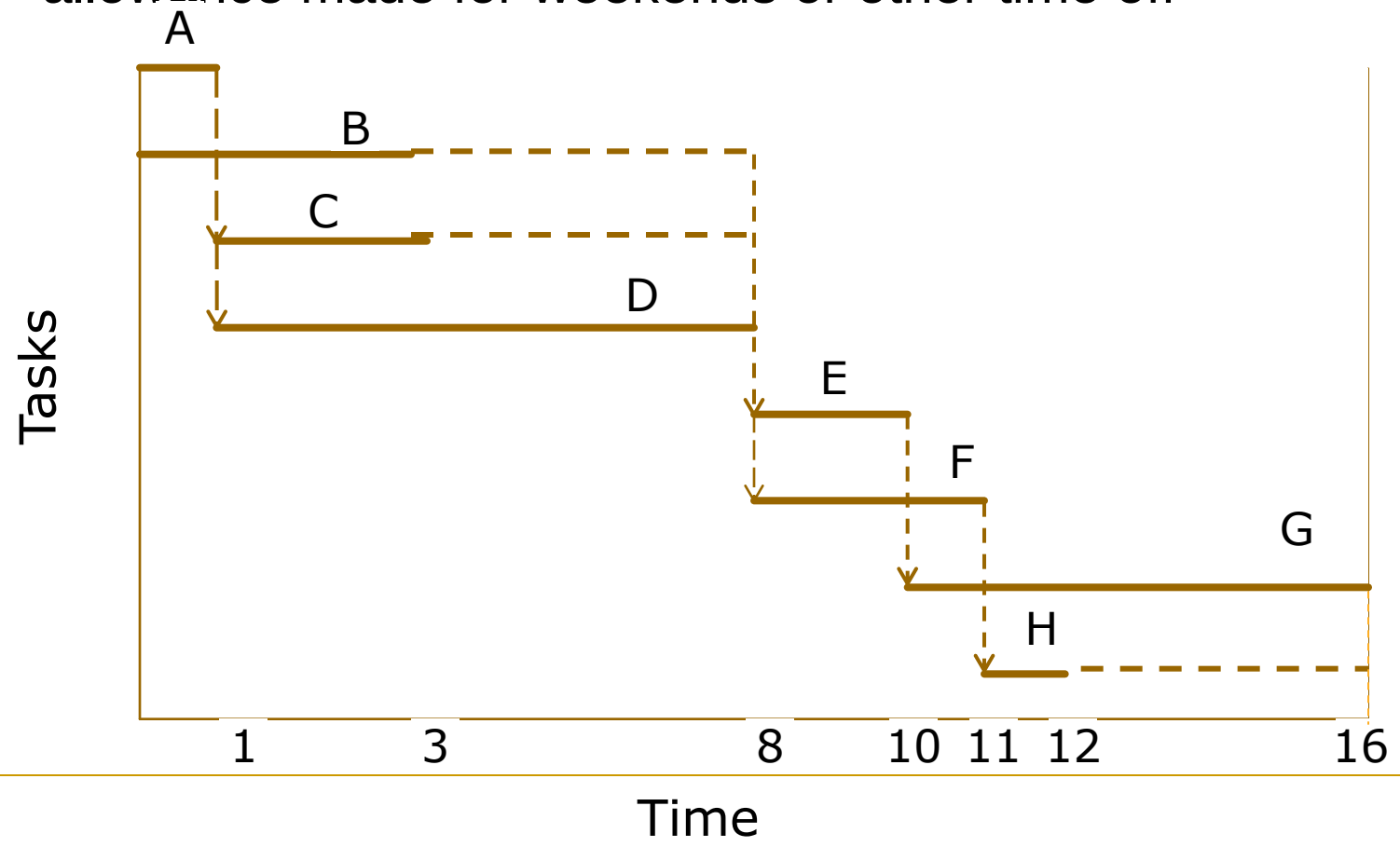
- Dotted lines show predecessor relationships
- Typically, x-axis of Gantt chart shows calendar dates and includes time off for weekends and holidays. Example shows only elapsed times.



Gantt Chart

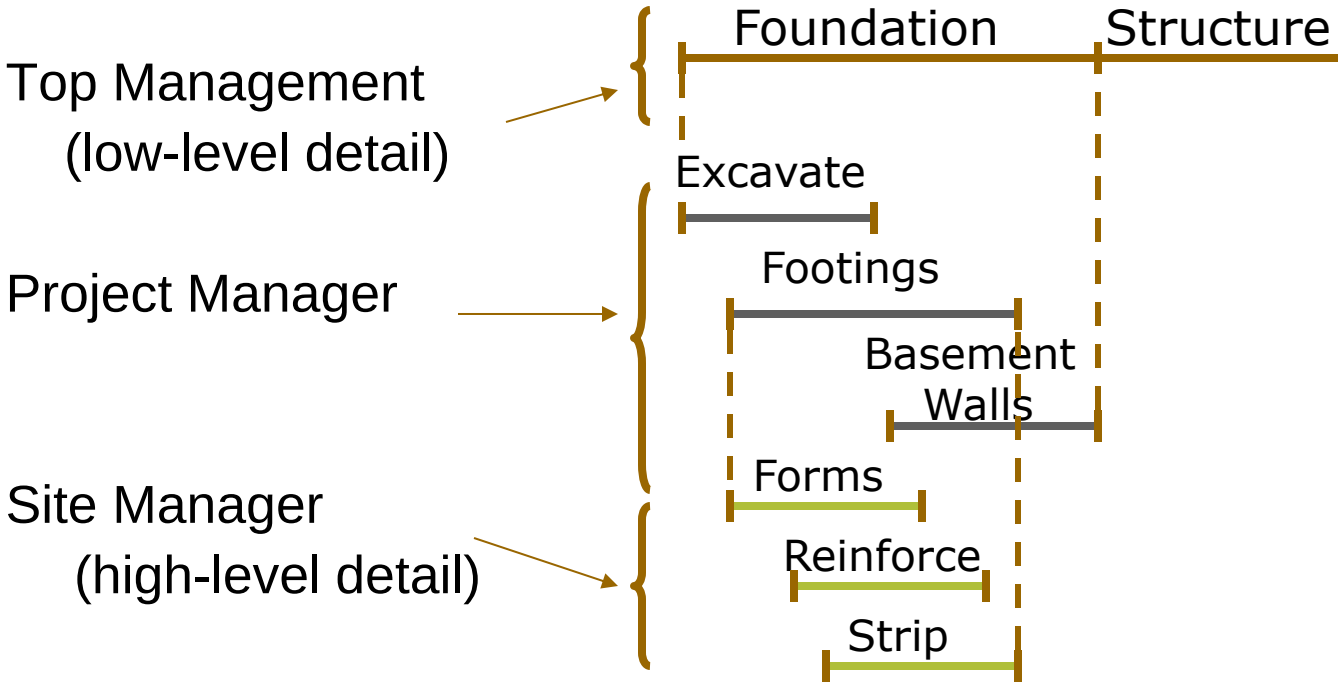
Notes (cont'd):

- This project is completed after 16 weeks
- This example shows only "events" or points in time. No allowance made for weekends or other time off

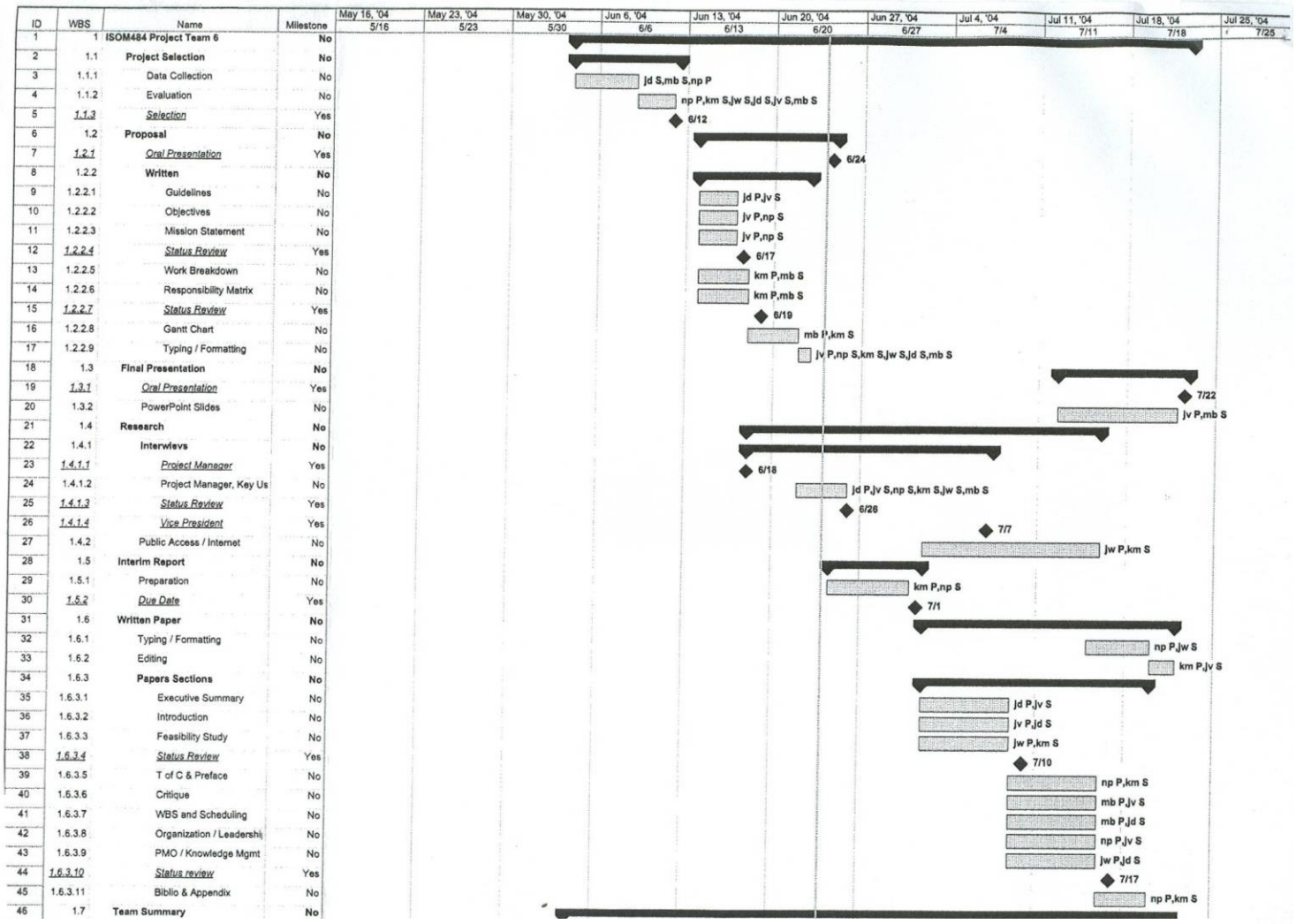


Level of Detail

- Level of detail should reflect audience
- Example



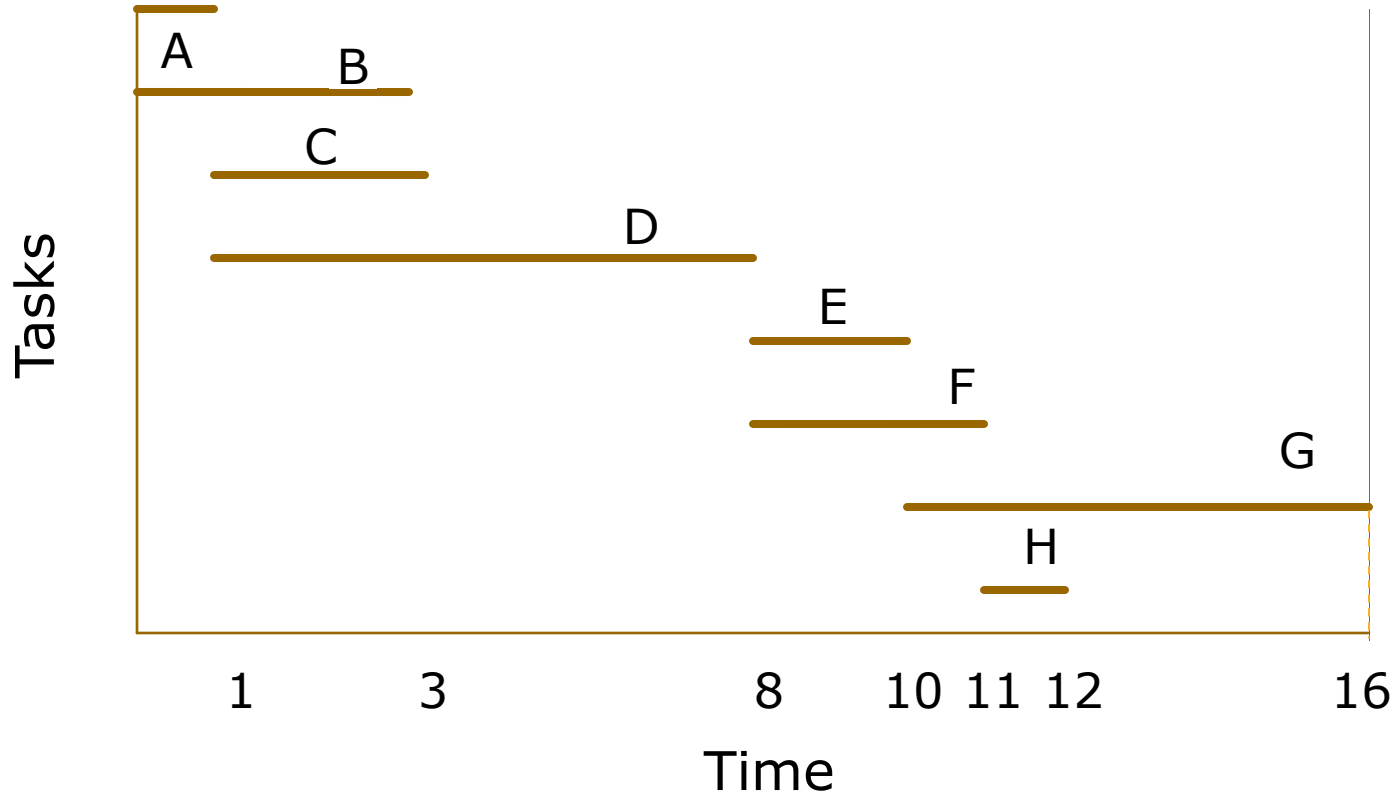
Level of Detail



ID	WBS	Name	Milestone
1	1	**ISOM484 Project Team 6**	**No**
2	1.1	**Project Selection**	**No**
3	1.1.1	Data Collection	No
4	1.1.2	Evaluation	No
5	*1.1.3*	*Selection*	Yes
6	1.2	**Proposal**	**No**
7	*1.2.1*	*Oral Presentation*	Yes
8	1.2.2	**Written**	**No**
9	1.2.2.1	Guidelines	No
10	1.2.2.2	Objectives	No
11	1.2.2.3	Mission Statement	No
12	*1.2.2.4*	*Status Review*	Yes
13	1.2.2.5	Work Breakdown	No
14	1.2.2.6	Responsibility Matrix	No
15	*1.2.2.7*	*Status Review*	Yes
16	1.2.2.8	Gantt Chart	No
17	1.2.2.9	Typing / Formatting	No
18	1.3	**Final Presentation**	**No**
19	*1.3.1*	*Oral Presentation*	Yes
20	1.3.2	PowerPoint Slides	No
21	1.4	**Research**	**No**
22	1.4.1	**Interviews**	**No**
23	*1.4.1.1*	*Project Manager*	Yes
24	1.4.1.2	Project Manager, Key Us	No
25	*1.4.1.3*	*Status Review*	Yes
26	*1.4.1.4*	*Vice President*	Yes
27	1.4.2	Public Access / Internet	No
28	1.5	**Interim Report**	**No**
29	1.5.1	Preparation	No
30	*1.5.2*	*Due Date*	Yes
31	1.6	**Written Paper**	**No**
32	1.6.1	Typing / Formatting	No
33	1.6.2	Editing	No
34	1.6.3	**Papers Sections**	**No**
35	1.6.3.1	Executive Summary	No
36	1.6.3.2	Introduction	No
37	1.6.3.3	Feasibility Study	No
38	*1.6.3.4*	*Status Review*	Yes
39	1.6.3.5	T of C & Preface	No
40	1.6.3.6	Critique	No
41	1.6.3.7	WBS and Scheduling	No
42	1.6.3.8	Organization / Leadershi	No
43	1.6.3.9	PMO / Knowledge Mgmt	No
44	*1.6.3.10*	*Status review*	Yes
45	1.6.3.11	Biblio & Appendix	No
46	1.7	**Team Summary**	**No**

Gantt Chart: Pro and Con

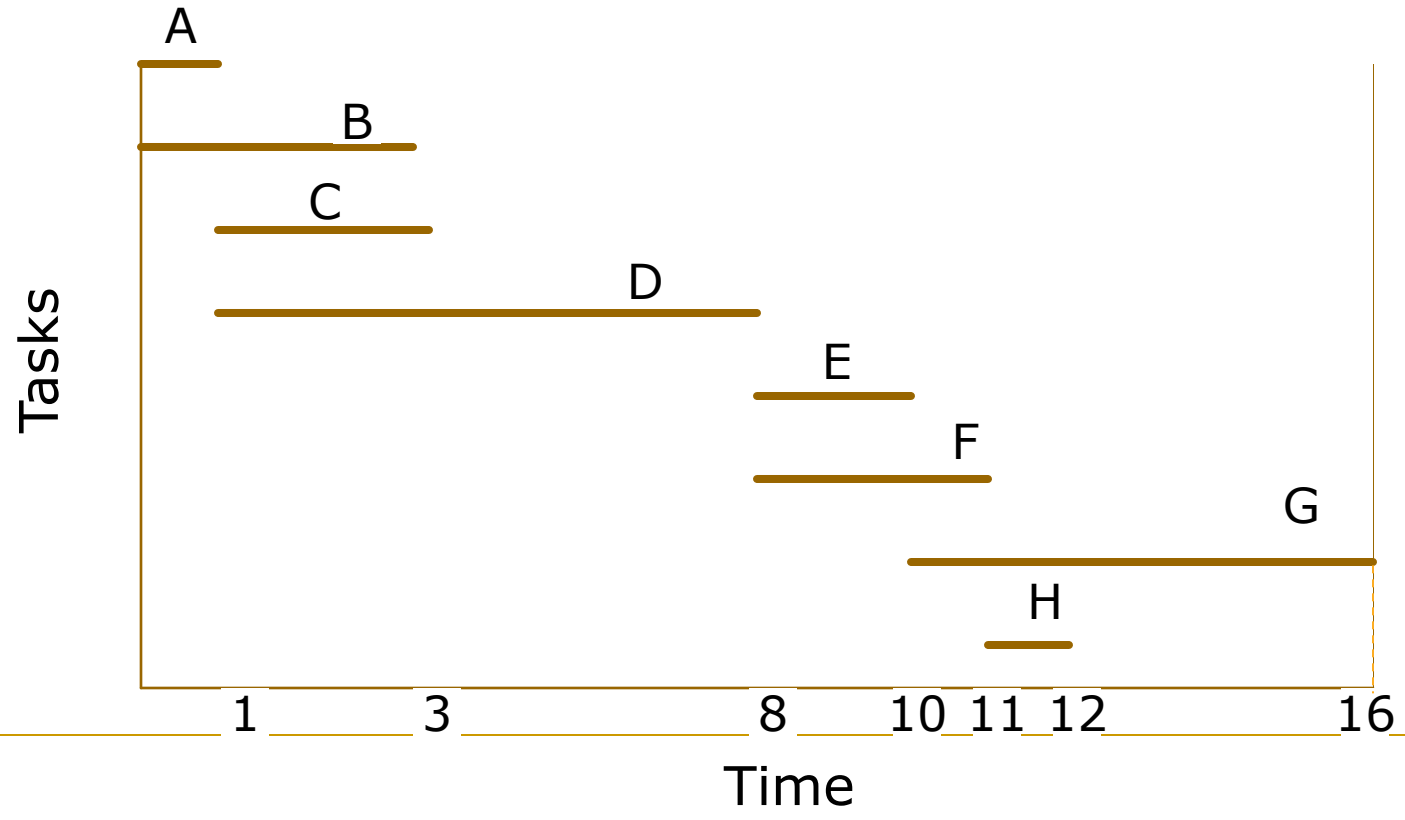
- Pro: Easy to construct and understand
- Con: does not necessarily indicate relationships among tasks, so is limited as tool for planning and control.
- Example:



Gantt Chart: Pro and Con

What is effect of

- C starting 2 weeks late?
- C starting 6 weeks late?
- E taking 3 weeks instead of 2 weeks?
- E finishing a week early?



Gantt Chart: Pro and Con

- With simple Gantt charts, such questions are not always easy to answer.
- Yet you need the answers to plan the project and create realistic schedules
- Gantt charts are good for displaying schedules,
  - Networks, described in the next chapter, are better for creating them

Line of Balance

- Used in projects that require a number of identical units, where each unit involves a number of steps.

- The method enables tracking progress of the units and identifying situations where progress is behind or ahead of schedule

Line of Balance

- Example: a project requires 80 units of an item.
- Each unit involves 4 steps: it must be produced, tested, installed, than tested again. It takes 5 weeks to complete all the steps.
- The completion of each unit is marked by a milestone

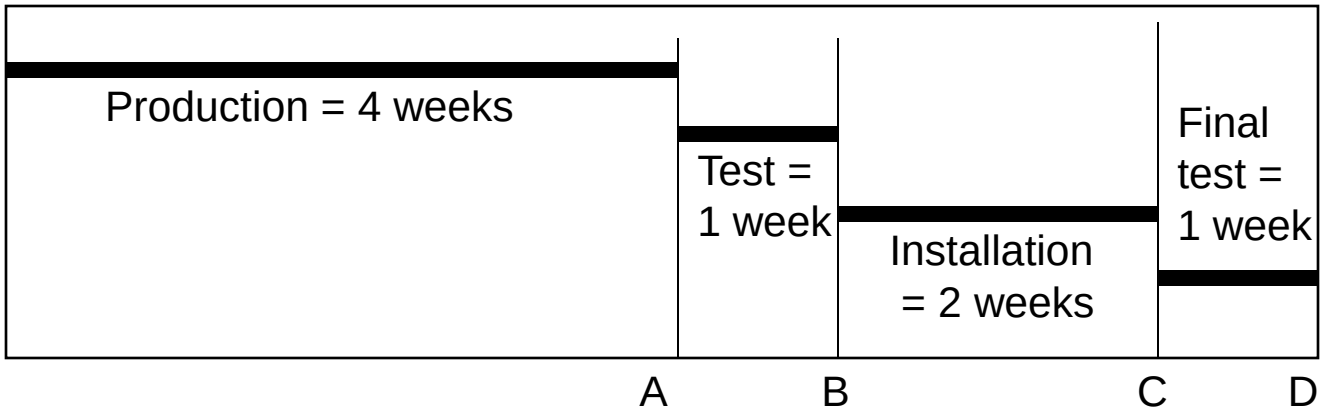
  A = production

  B = test

  C= installation

  D = final test

Line of Balance



As shown, completion of each unit is marked by a milestone

A = production

B = test

C= installation

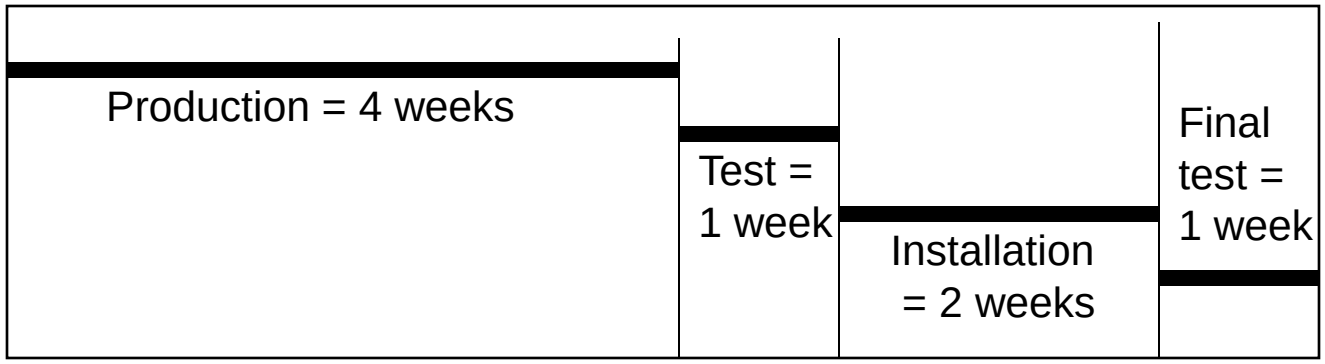
D = final test

Based on other requirements and available resources, the project schedule specifies that the following number of units must be completed (i.e., reached milestone D) by the following dates:

units completed	week
20	10
30	11
10	12
20	13

Line of Balance

Looking only at the first 20 units to be completed in week 10, the time by when these units should have reached the other milestones is shown below



initial 20 units:	week	A	B	C	D
		6	7	9	10

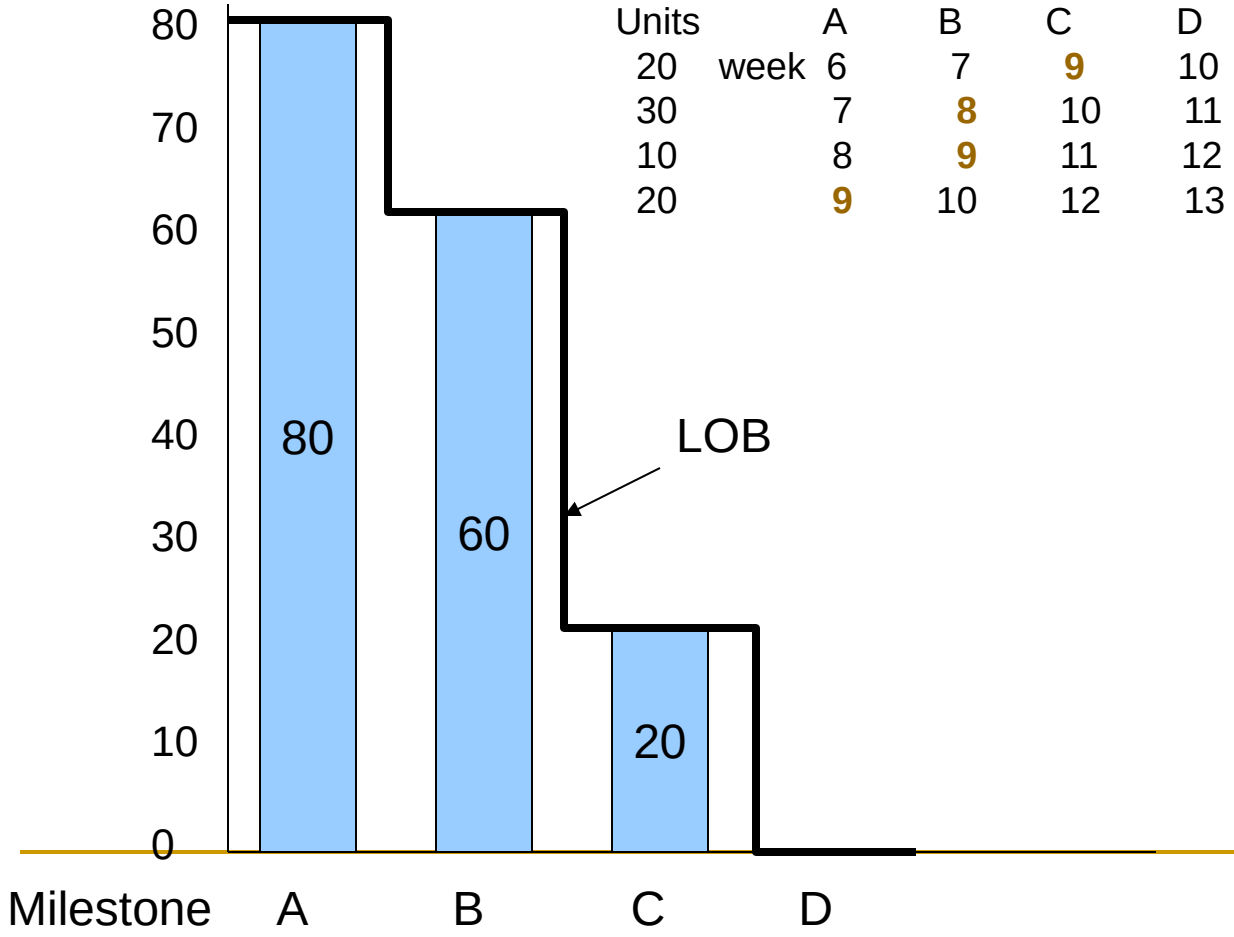
The times by when the others should reach the milestones is:

	A	B	C	D
30	7	8	10	11
10	8	9	11	12
20	9	10	12	13

Line of Balance

The total number of units that should have passed milestone D as of week 13 is 80.

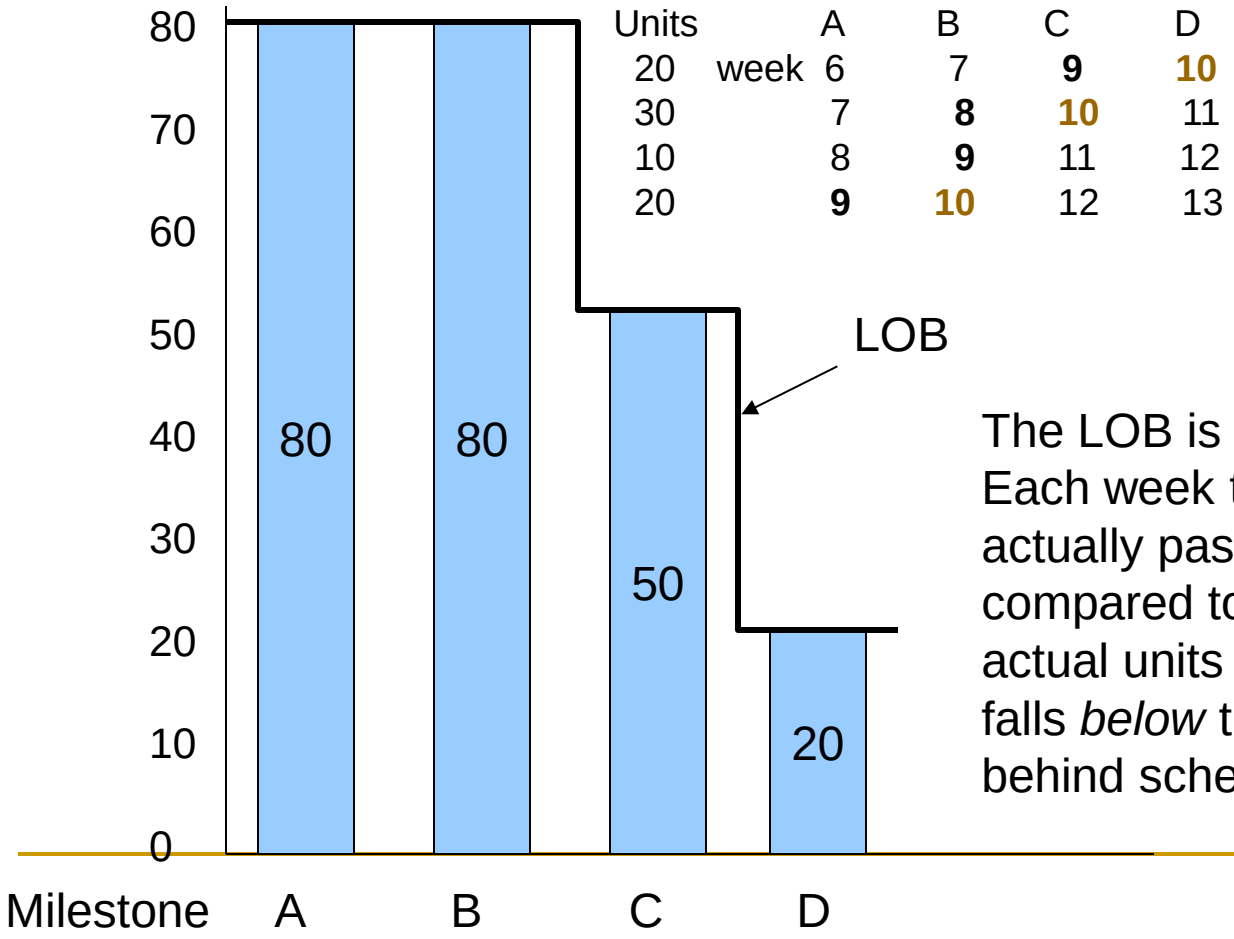
However, for tracking purposes, the number of units that should have passed any of the milestones anytime before week 13 can be represented on a graph. The graph below shows number of units that should have passed each milestone by the *end of* week 9.



Units		A	B	C	D
20	week	6	7	**9**	10
30		7	**8**	10	11
10		8	**9**	11	12
20		**9**	10	12	13

Line of Balance

This graph shows number of units that should have passed each milestone by the *end of* week 10.



Units		A	B	C	D
20	week	6	7	**9**	**10**
30		7	**8**	**10**	11
10		8	**9**	11	12
20		**9**	**10**	12	13

The LOB is used to track progress. Each week the number of units that actually passed each milestone is compared to the LOB. Whenever actual units that passed a milestone falls *below* the LOB, the work is behind schedule.

Procurement Management

Procurement management

- The planning, budgeting, scheduling, and control of ***procured*** **goods, work, or services (GWS).**
- Usually, goods are raw materials or produced items, work is contracted labor, and services is consulting

Procurement Management

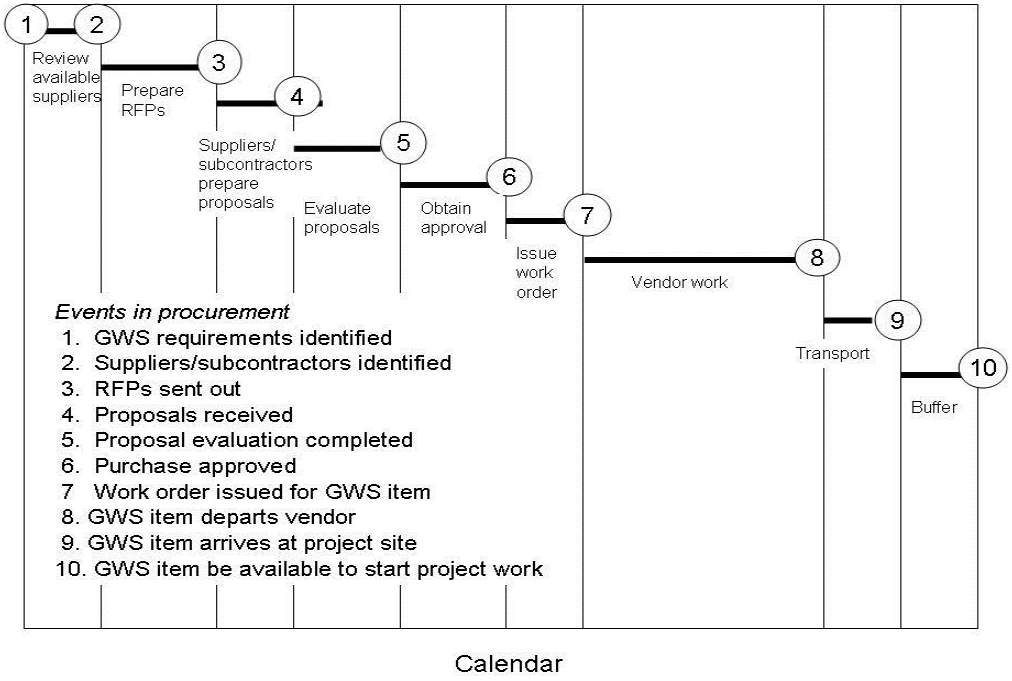
Includes

- ***Equipment, materials, or components*** designed and provided by vendors specifically for the project. Could be:
  - portions of work packages or entire work packages (e.g., design work, environmental impact study, soil analysis)
  - major portions of the project wholly ("turnkey": subcontractors fully design, build, and install equipment or components for the project end-item).
- ***Off-the-shelf (OTS) equipment and components*** supplied by vendors. (Products readily available and not specifically produced for the project.)
- ***Bulk materials*** (cement, metal tubing or framing, wire, stone, piping, etc.)
- ***Consumables*** (nails, bolts, rivets, fuel) or loose tools used for construction or fabrication
- ***Equipment not already owned*** by the contractor; e.g., includes cranes, supports, scaffolding, and equipment for machine-shops, welding, and testing.
- ***Administrative equipment not already owned*** by contractor; e.g., computers, project office facilities and office equipment.

Procurement Management

Indentifying GWS items to be procured

- Involves decision about which items are to be designed/built/ provided in-house and which to be procured (purchased or acquired)
- Happens during the WBS process or design process when the needed materials and resources are first identified.



Procurement Management

Involves

- ***Contracting*** with suppliers or subcontractors, often through the formal RFP/proposal process.
- ***Integrating procured GWS items*** into the project life cycle and project plan (i.e., schedule, responsibility matrix, budget, quality, and risk, etc.)
- ***Logistics***
  - Transport and storage of materials for the project.
    - loading, unloading, transportation, inspection, clearances and approvals, and storage of materials can be major issues.
  - Procured materials must arrive when needed according to project schedules.