



*Week 5*  
**Project Work Plan**

**457.657 Civil and Environmental Project Management**  
Department of Civil and Environmental Engineering  
Seoul National University

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# Project Work Plan

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- **Identifies the work to be done**
  - Who will do it, When
  - Costs
- **Basic components**
  - Overview/Directory
    - Project title, objective scope, organization chart
  - Tasks
    - List of tasks, groupings
  - Schedule
    - Sequencing and interdependencies, durations, start/finish
  - Budget
    - Labor hours and staff costs, billing approach
  - Measurement/Control
    - Accomplishment of tasks, completion of work package

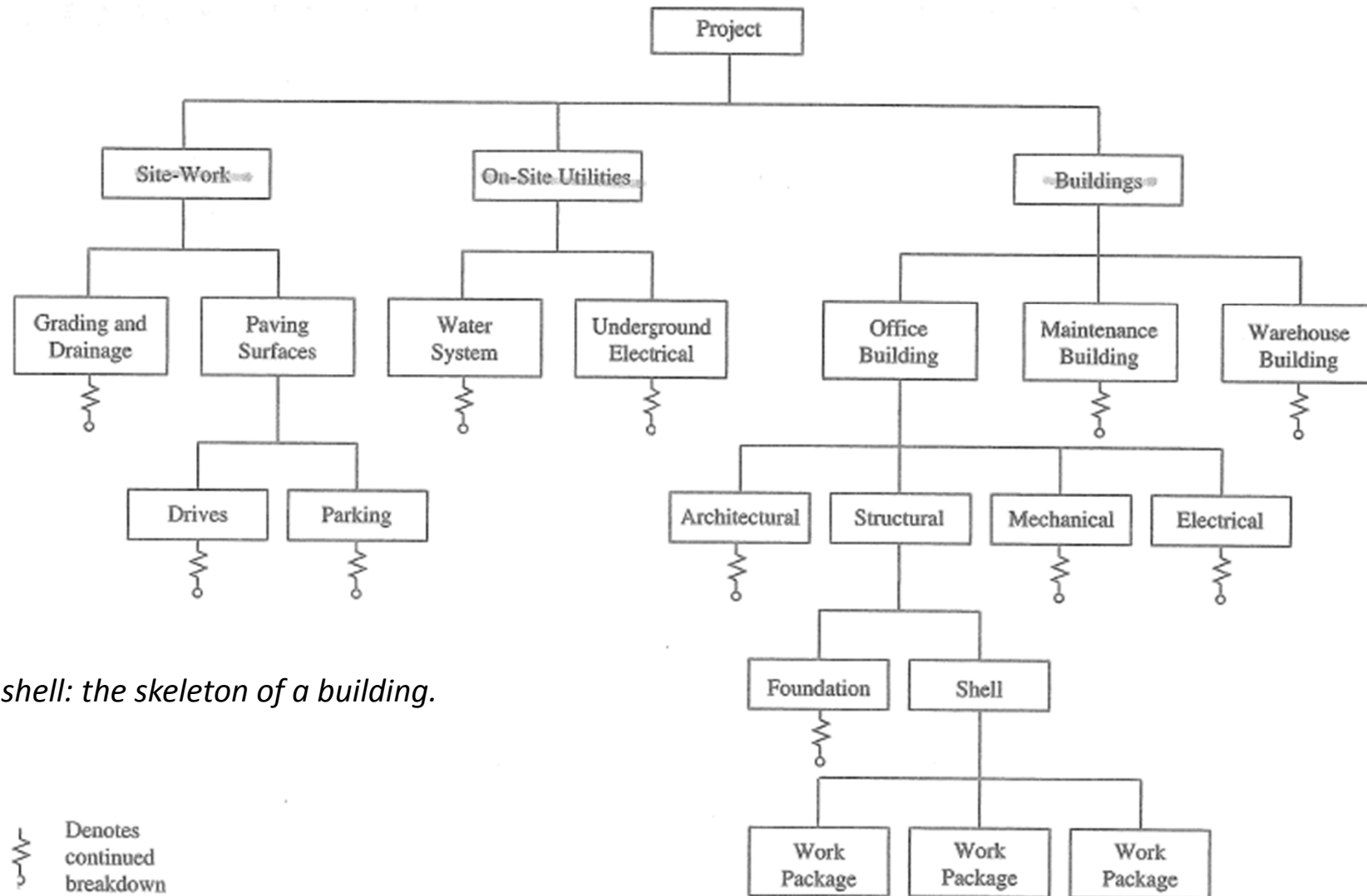
# Work Plan Development

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- 1. PM initial duty is to review sponsoring organization material regarding**
  - Project scope
  - Budget
  - Schedule
- 2. Meet with sponsor to determine requirements and priorities for**
  - Quality
  - Scope
  - Time
  - Cost
  - Determine owner's level of involvement
- 3. Develop work breakdown structure (WBS)**
  - Define work to be performed
  - Identify needed expertise
  - Select project team
  - Establish project schedule and controls

# Work Breakdown Structure (WBS)

- Divides the project into identifiable part that can be managed



# Work Breakdown Structure (WBS)

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- Divides the project into identifiable part that can be managed
- Concept of WBS is simple: to manage the whole project must control each of the parts
- All the work contained within the WBS is to be identified, estimated, scheduled, budgeted, and controlled
  - Identifying work, compiling the budget, and developing an integrated schedule
- Shown in graphical display to organize and subdivide the total scope of work

# Work Breakdown Structure (WBS)

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- **Project work is structured into WBS elements (work packages) must be:**
  - Definable: easily described and understood
  - Manageable: meaningful unit of work where specific responsibility can be assigned
  - Estimateable: duration and costs can be estimated
  - Independent: minimum interface with or dependence on other ongoing elements
  - Integratable: integrates with other project work elements
  - Measureable: has start and completion dates and interim milestones
  - Adaptable: flexible so the addition/elimination of work scope can be accommodated

# Work Breakdown Structure (WBS)

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- **Characteristics of WBS**
  - Most commonly produced in the form of a table or chart
  - Procedure in the associated work flow is used to produce this work product
  - Progresses downward from the general to the specific
  - Provides a framework for turning project objectives into specific deliverables

# Work Breakdown Structure (WBS)

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- **Typical levels of WBS**

- Level 1: Total program
  - Level 2: Project
  - Level 3: Task
  - Level 4: Subtask
  - Level 5: Work package
  - Level 6: Level of effort
- Managerial Levels**
- Technical Levels**
- 
- A diagram showing the typical levels of a Work Breakdown Structure (WBS). The levels are listed on the left, and two red curly braces on the right group them. The first brace groups Level 1 (Total program), Level 2 (Project), and Level 3 (Task), with the label 'Managerial Levels' to its right. The second brace groups Level 4 (Subtask), Level 5 (Work package), and Level 6 (Level of effort), with the label 'Technical Levels' to its right.

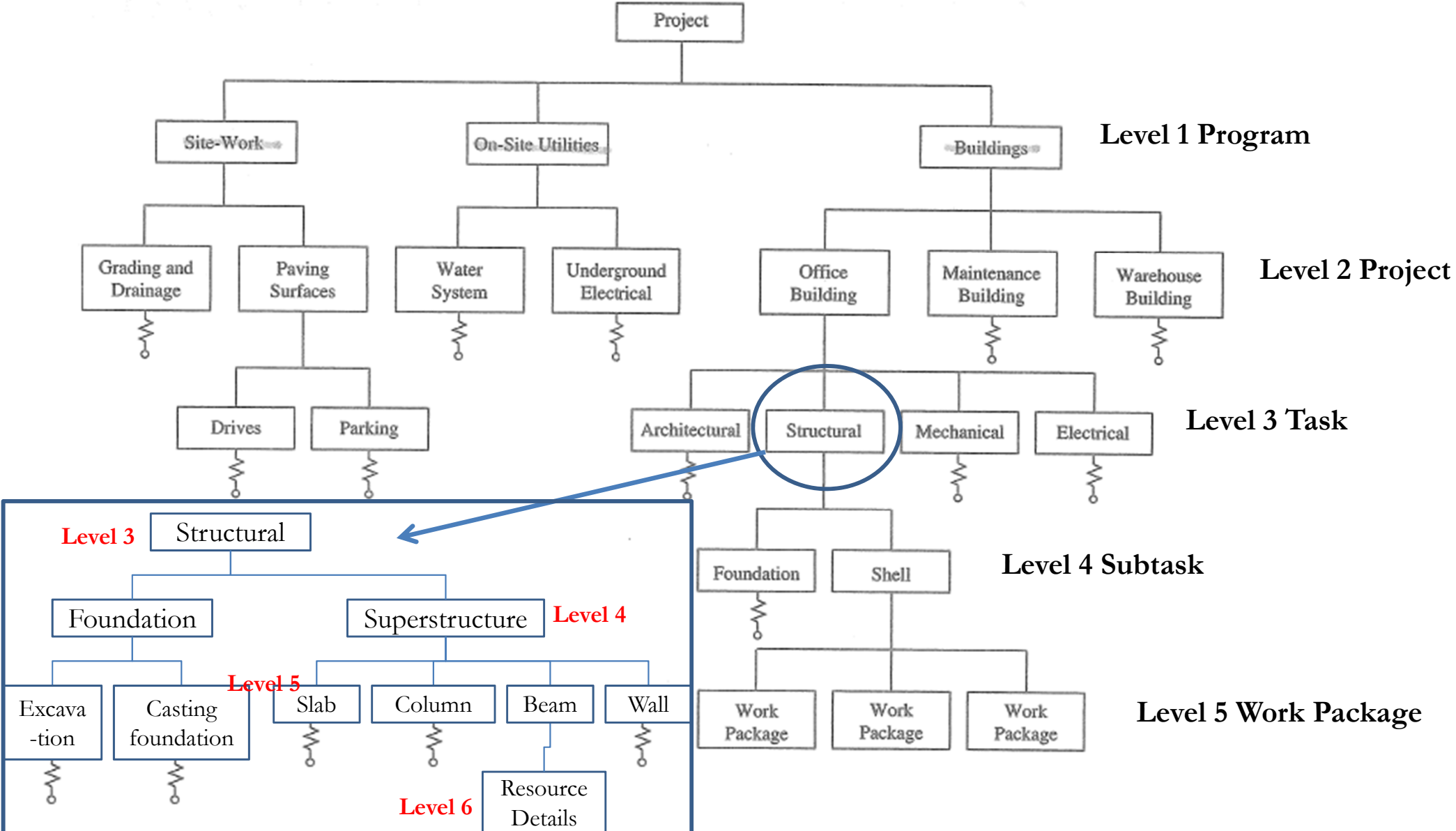
- **Upper 3 levels normally specified by the owner**

- Level 1: authorization and release of work
- Level 2: budgets prepared
- Level 3: schedules prepared

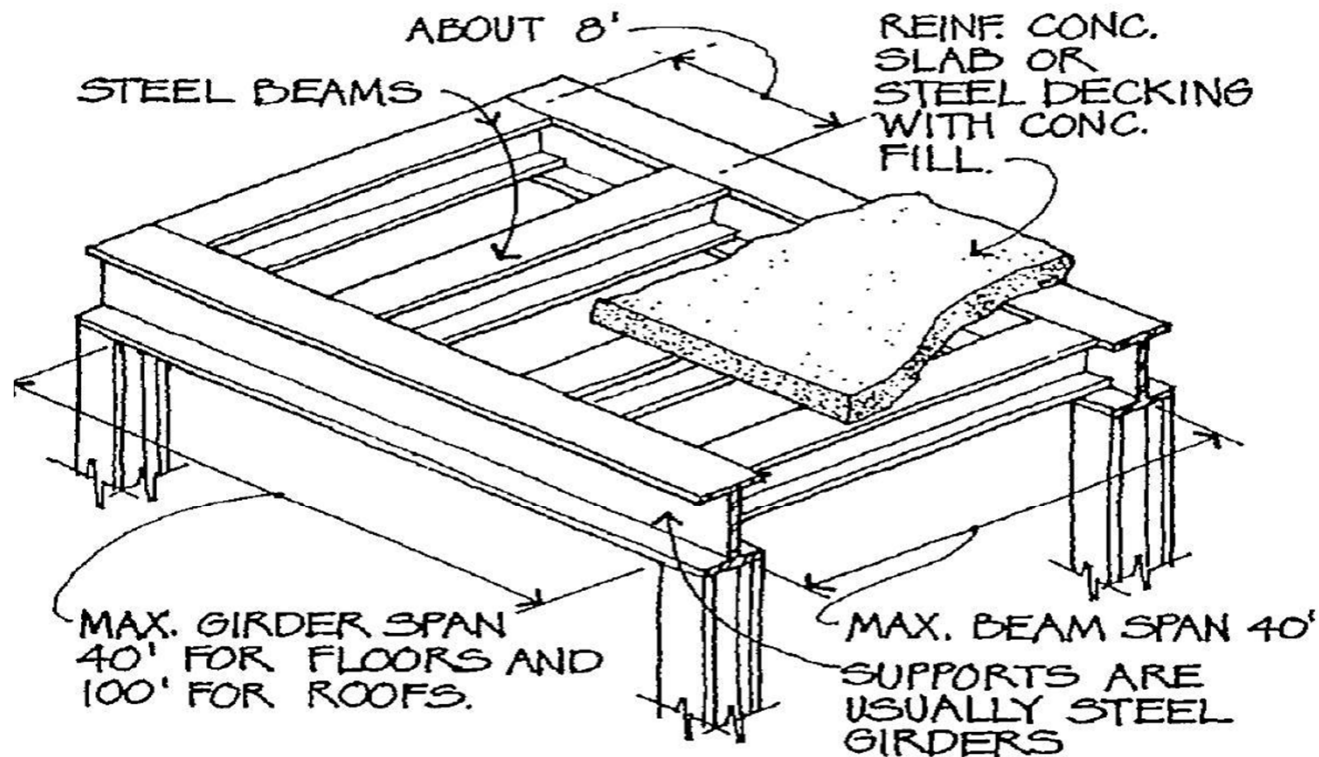
- **Lower 3 levels are generated by the contractor**



# Work Breakdown Structure (WBS)



# Superstructure



## STEEL BEAM AND GIRDER SYSTEM

- BEAMS AND GIRDERS MAY BE PART OF MAIN SKELETON FRAME
- COMPOSITE ACTION BETWEEN BEAM AND SLAB POSSIBLE
- ECONOMICAL FOR MOST BUILDING LOADS

A girder is the primary horizontal member carrying loads from other beams and slabs connected to it. That is a girder has other beams connecting to it on its sides. Typically beams do not have other beams connecting to it but generally have only slabs transferring the loads to it.

# WBS

- **Work Package**
  - Lowest level in the WBS
  - Baseline for scheduling, tracking, cost control

**Work Package**

Title: \_\_\_\_\_  
WBS Code: \_\_\_\_\_

**1. Scope**

Required Scope of Work: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Services to Be Provided: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Services not included in this Work Package, but included in another work package: \_\_\_\_\_  
\_\_\_\_\_

Services not included in this Work Package, but will be performed by: \_\_\_\_\_  
\_\_\_\_\_

**2. Budget**

Personnel Assigned to Job	Work-Hours	-\$-Cost	CBS Code Acct.	Computer Services		
				Type	Hours	-\$-Cost
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
Total Work-Hours = _____			Personnel Costs = \$ _____			
Computer Hours = _____			Computer Costs = \$ _____			
		Travel Expenses	Reproduction Expenses	Other Expenses		
		_____	+ _____	+ _____	= \$ _____	
Total Budget = \$-Labor + \$-Computer + \$-Other = \$ _____						

**3. Schedule**

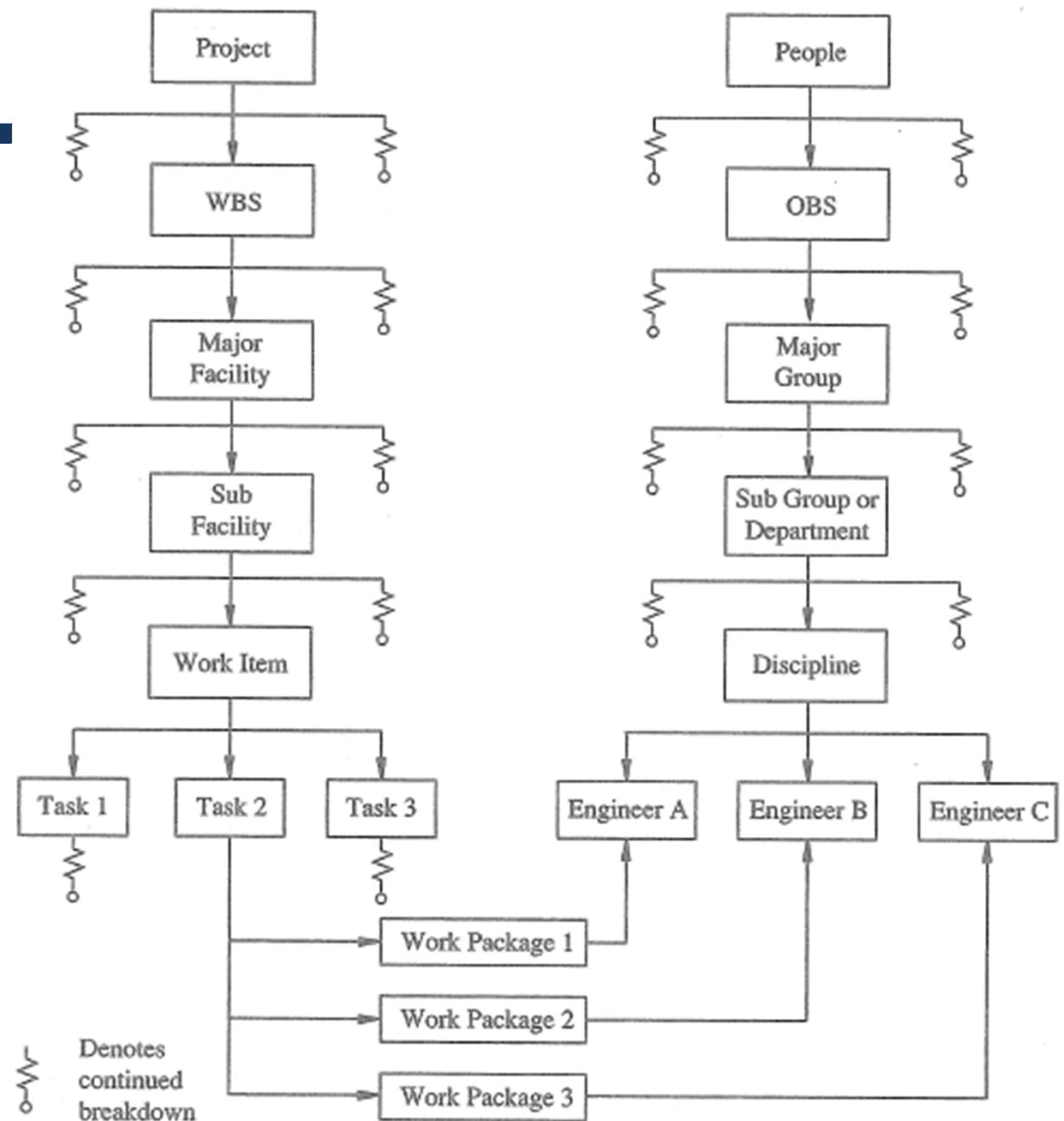
OBS Code	Work Task	Responsible Person	Start Date	End Date
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
Work Package: Start Date: _____			End Date: _____	

Additional Comments: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Prepared by: \_\_\_\_\_ Date: \_\_\_\_\_  
Approved by: \_\_\_\_\_ Date: \_\_\_\_\_

# WBS vs OBS

- WBS: define the work to be accomplished
- OBS (Organizational Breakdown Structure)
  - Define who is responsible for performing the work



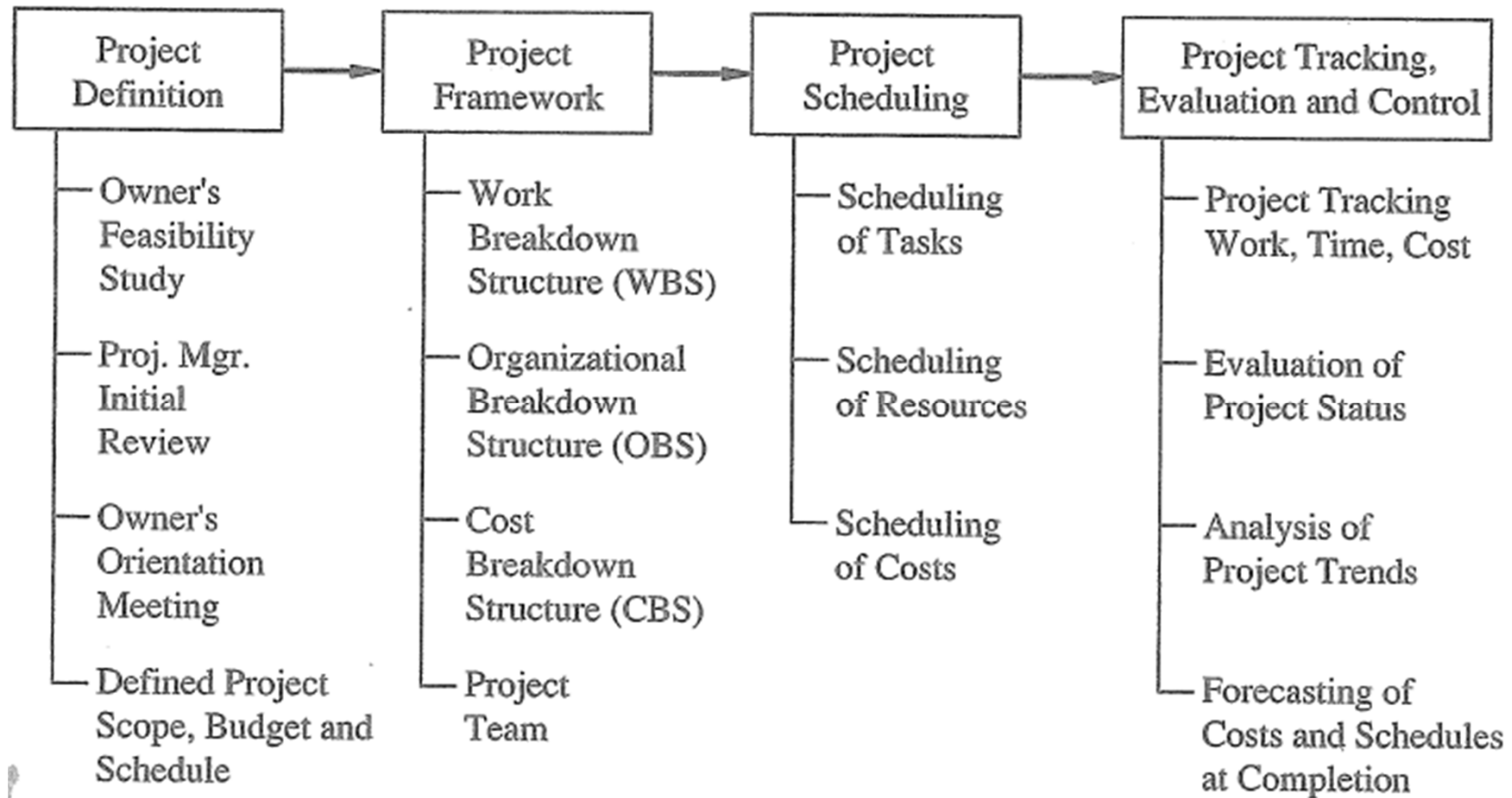
# Good work packages

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- **Connects the abstract (schedules, production analysis) with the physical**
- **To link schedules into production, consider**
  - A complete design
  - A list of materials to be installed
  - A specific area to be worked on
  - A start and end date (handover dates)
  - *A materials handling plan*

# Phases of Development of Work Plan

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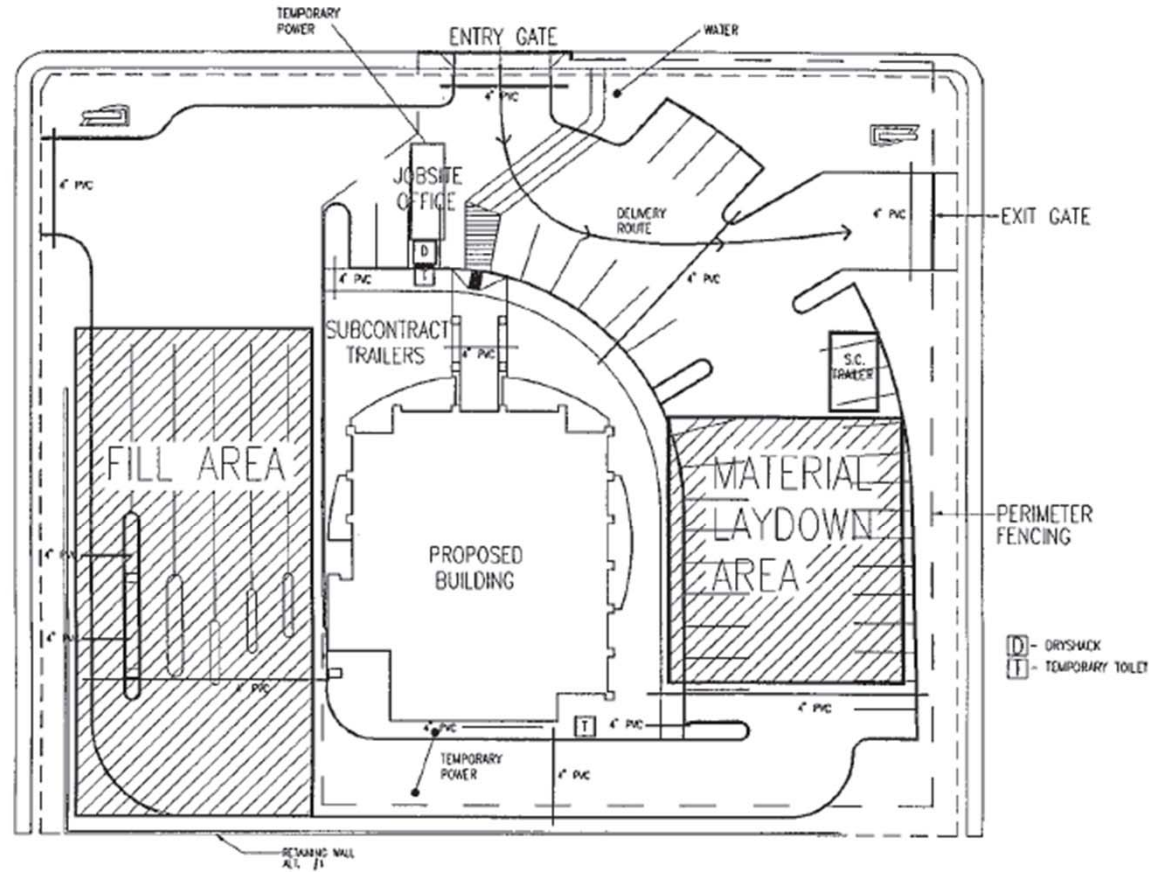


# Site Layout

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- **Definition:**
  - Assigning areas to staging, materials storage, and shared resources (e.g., cranes)
- **Site layout is:**
  - Dynamic; can cause access conflicts
  - Should be considered with work packaging when developing construction plan
  - Site layout (big picture) constraints, then
    - Work packaging <--> Site layout (micro analysis)

# Jobsite Layout



SITE LAYOUT PLAN

SCALE: 1" = 50'-0"



# Jobsite Layout Overview

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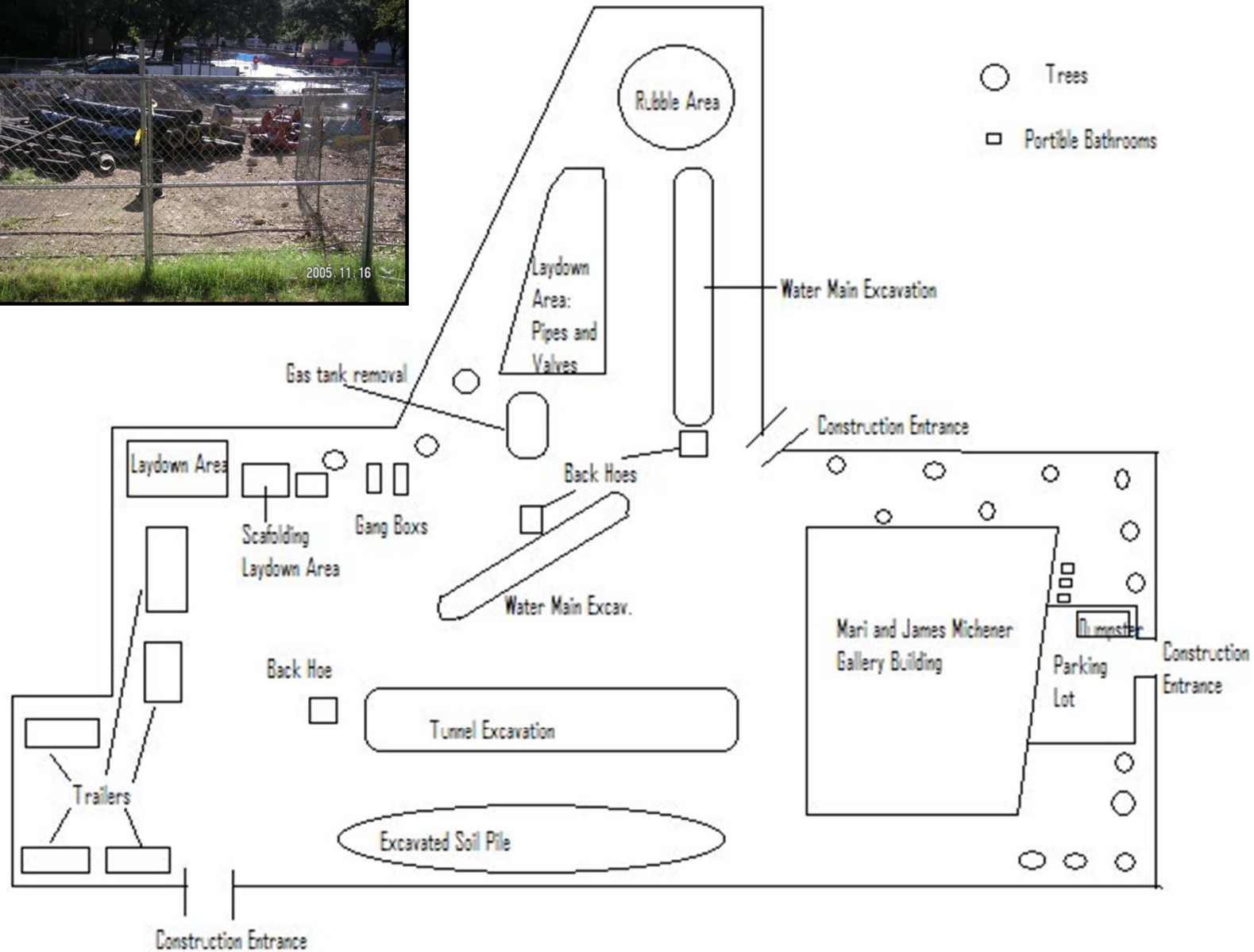
- **Jobsite layout plan**
  - Plan for temporary facilities, material movement, storage, and handling
- **Areas of consideration**
  - Labor productivity
  - Material handling
  - Equipment constraints
  - Site constraints
- **Jobsite layout plan aspects**
  - Jobsite space allocation
  - Jobsite access
  - Material handling
  - Worker transportation
  - Temporary facilities
  - Jobsite security
  - Signage and barricades

# Labor Productivity

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- **Travel time: non-productive time elements**
  - From gate to worksite
  - To sanitary facilities (for toilet, gas, water, etc.)
  - Coffee breaks and lunch
  - Moving material and asking questions
  - *Need to be minimum!*

# Piping Activity: Layout





*Week 5*

# Project Scheduling (1)

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# Project Scheduling (PMBOK Chapter 6)

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- **Project Time Management**
  - Includes the process required to ensure timely completion of the project
- **Major Processes**
  1. Activity definition
  2. Activity sequencing
  3. Activity duration estimation
  4. Schedule development
  5. Schedule control

# Project Scheduling – Activity Definition

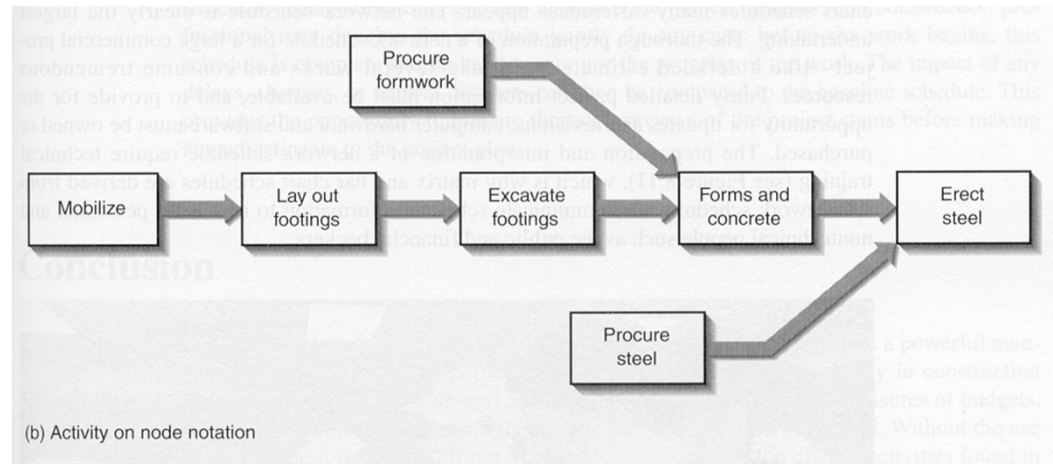
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- **WBS being the basis for development of the final activity list**
- **Tools and Techniques**
  - Decomposition
    - Involves subdividing project elements into smaller, more manageable components in order to provide better management control
  - Templates
    - An activity list, or a portion of an activity list from a previous project, is often usable as a template for a new project
    - Resource skills, required hours of effort, risk identification, expected deliverables, etc.

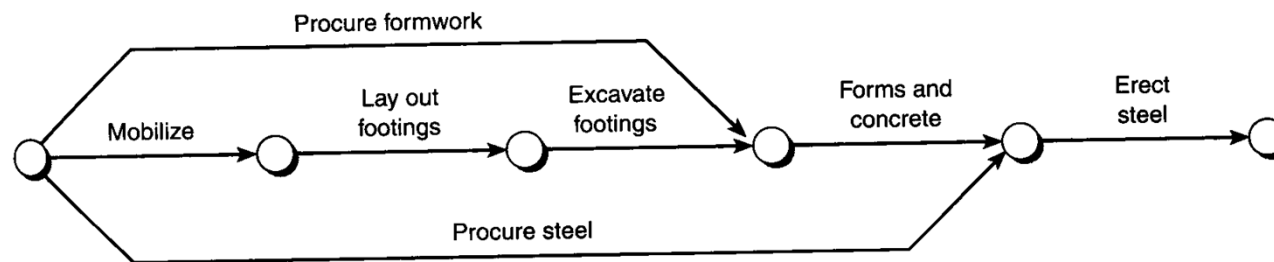
# Project Scheduling – Activity Sequencing

- Identifying interactivity dependencies

- Precedence Diagramming Method (PDM) called Activity-On-Node (AON)



- Arrow Diagramming Method (ADM) called Activity-On-Arrow (AOA), “old school” not much used as more



# Project Scheduling – Activity Sequencing

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- **Precedence Notation**

- Activities or operations are placed on nodes
- Arrows defines relationships between activities
  - Finish to Start
  - Start to Start
  - Finish to Finish
  - Start to Finish
- Apply “leads” and “lags” provide ability to overlap activities, allowing the scheduler to model more accurately the project’s operation



# Project Scheduling – Duration Estimate

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- **Estimating the number of work periods which will be needed to complete individual activities**
- **Tools and Techniques**
  - Expert judgment: historical information may be used
  - Analogous estimating: called top-down estimation, means using the actual duration of a previous, similar activity
  - Simulation: involves calculating multiple durations with different sets of assumptions

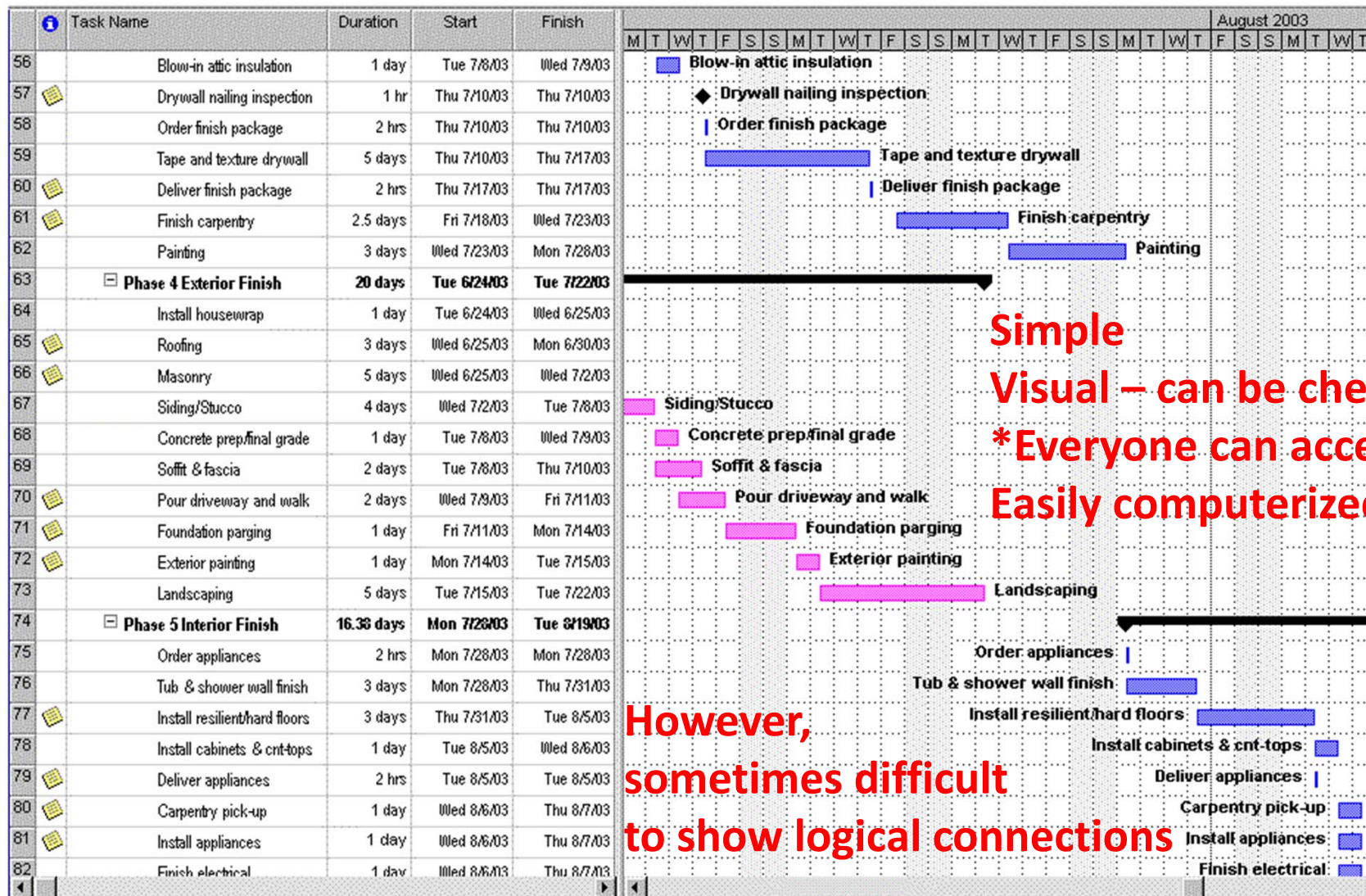
# Project Scheduling – Duration Estimate

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- Duration of an activity varies according to the activity type
  - Production
    - Consult subcontractors
    - Calculate based on quantity and productivity
    - Job conditions, new construction vs. renovation, crew size, work schedule, weather, project calendar, resource calendar
  - Procurement
    - Consult suppliers
    - Review contract documents
  - Administrative
    - Consult agencies
    - Past projects

# Project Scheduling – Schedule Development

- Bar (Gantt) chart

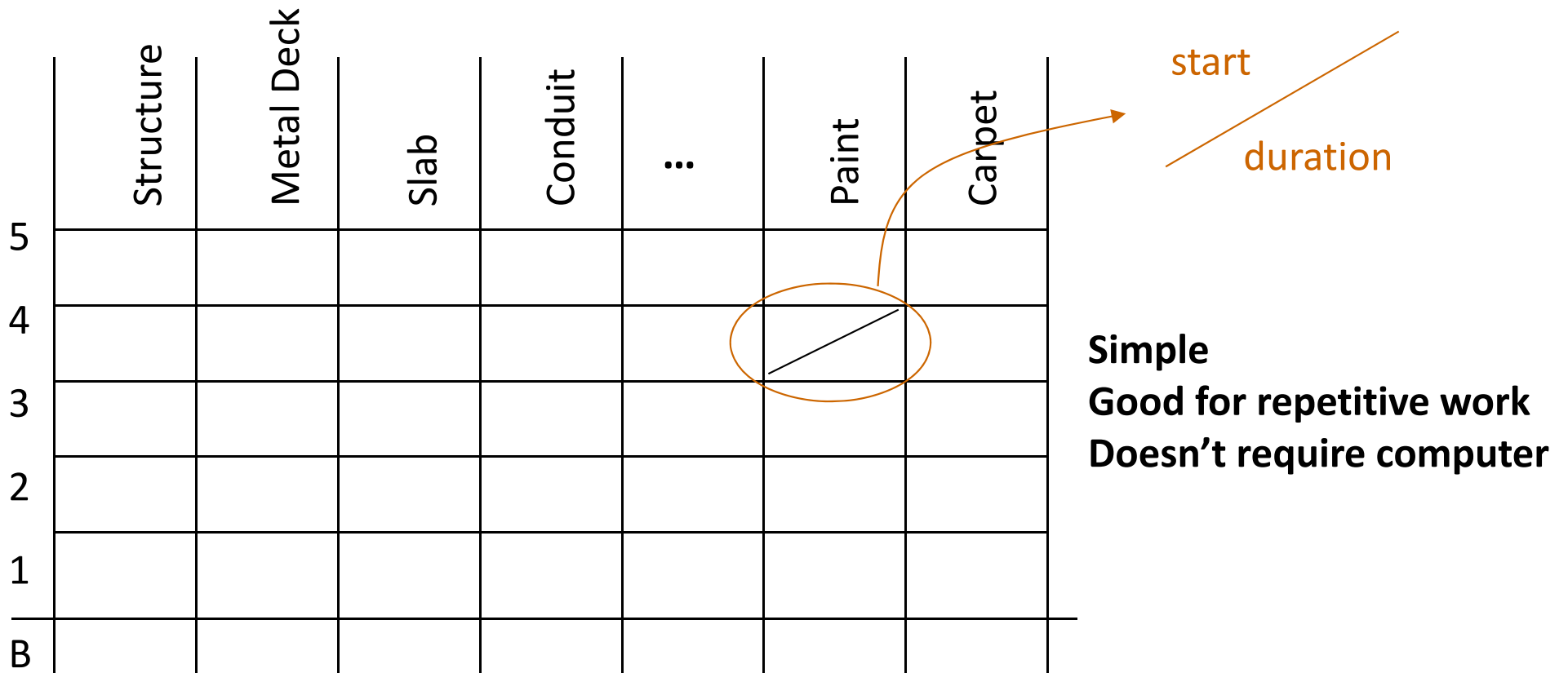


Simple  
 Visual – can be checked  
 \*Everyone can access  
 Easily computerized

However,  
 sometimes difficult  
 to show logical connections

# Project Scheduling – Schedule Development

- Matrix Schedules

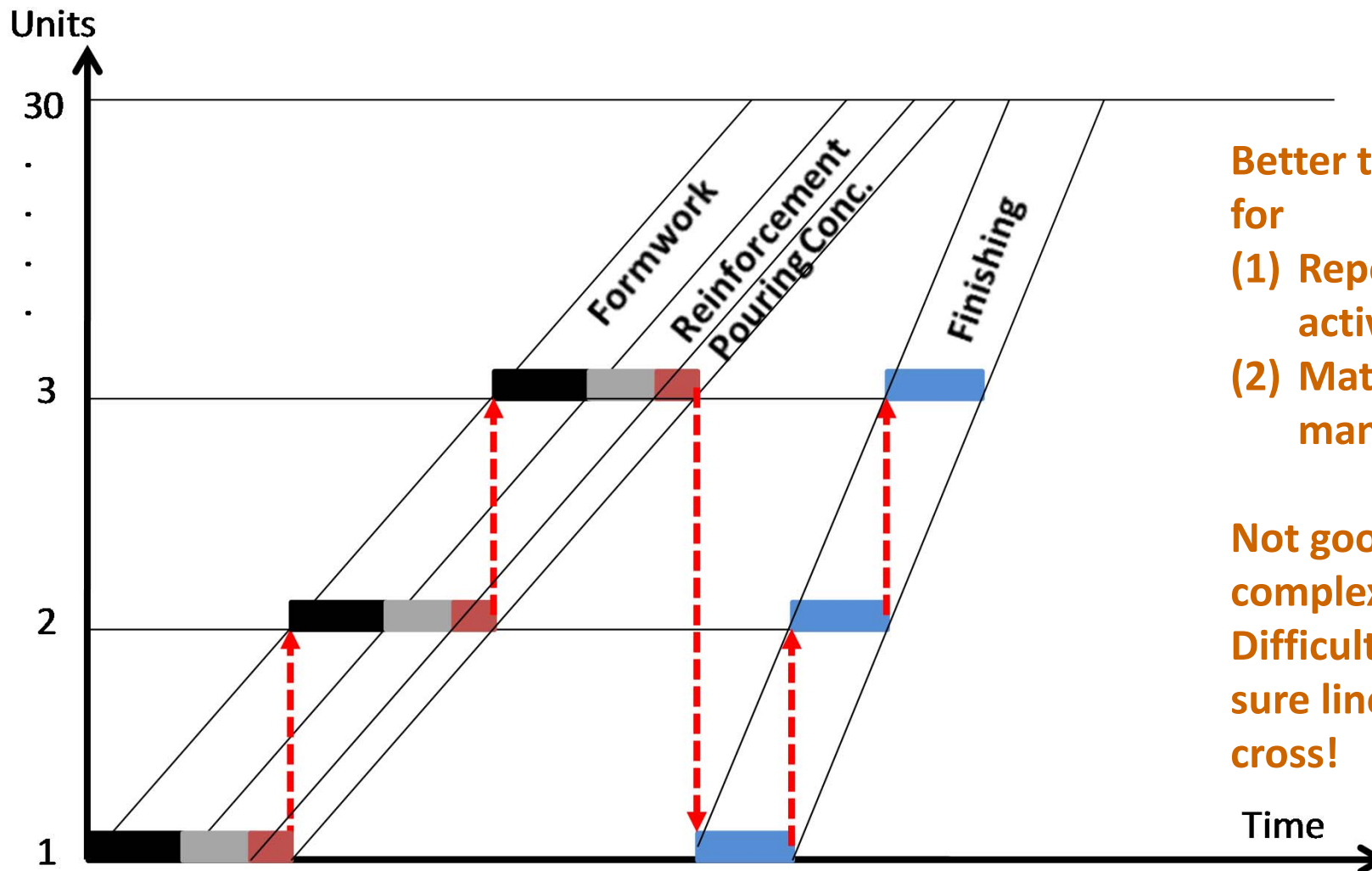


**Simple**  
**Good for repetitive work**  
**Doesn't require computer**

**Hard to use for complex work**  
**Typically useful only for part of project**  
**Difficult to define relationships**

# Project Scheduling – Schedule Development

- **Line of Balance**



Better than matrix for  
(1) Repetitive activities and  
(2) Material management

Not good for complex project:  
Difficult to make sure lines don't cross!

# Project Scheduling – Schedule Development

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- **Terminology**

- Early Start (ES): earliest possible time an activity can start based on the logic and durations identified in the network
- Early Finish (EF): earliest possible time an activity can finish based on the logic and durations identified in the network
  - **$EF = ES + \text{Activity Duration}$**
- Late Finish (LF): latest possible time an activity can finish based on the logic and durations identified in the network without extending the completion date of the project
- Late Start (LS): latest possible time an activity can start based on the logic and durations identified in the network without extending the completion date of the project
  - **$LS = LF - \text{Activity Duration}$**

# Project Scheduling – Schedule Development

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- **Terminology**

- Float: additional time an activity can use beyond its normal duration and not extend the completion date of the project
  - Total Float (TF): maximum time an activity can be delayed without delaying the project completion
  - Free Float (FF): maximum time an activity can be delayed without delaying the start of any succeeding activity
- Critical Path: path from start to finish with no float. Therefore, it is the minimum time to complete the project and highly impacts on the entire project schedule.

*Delay in Critical Path = Project Delay!*

# Project Scheduling – Schedule Development

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- **Development Methods**

- Critical Path Method (CPM): calculates a single, deterministic early and late start and finish date for each activity based on specified, sequential network logic and using duration estimate
- Program Evaluation and Review Technique (PERT): uses sequential network logic and a weighted average duration estimate to calculate project duration



# Project Scheduling – Schedule Development

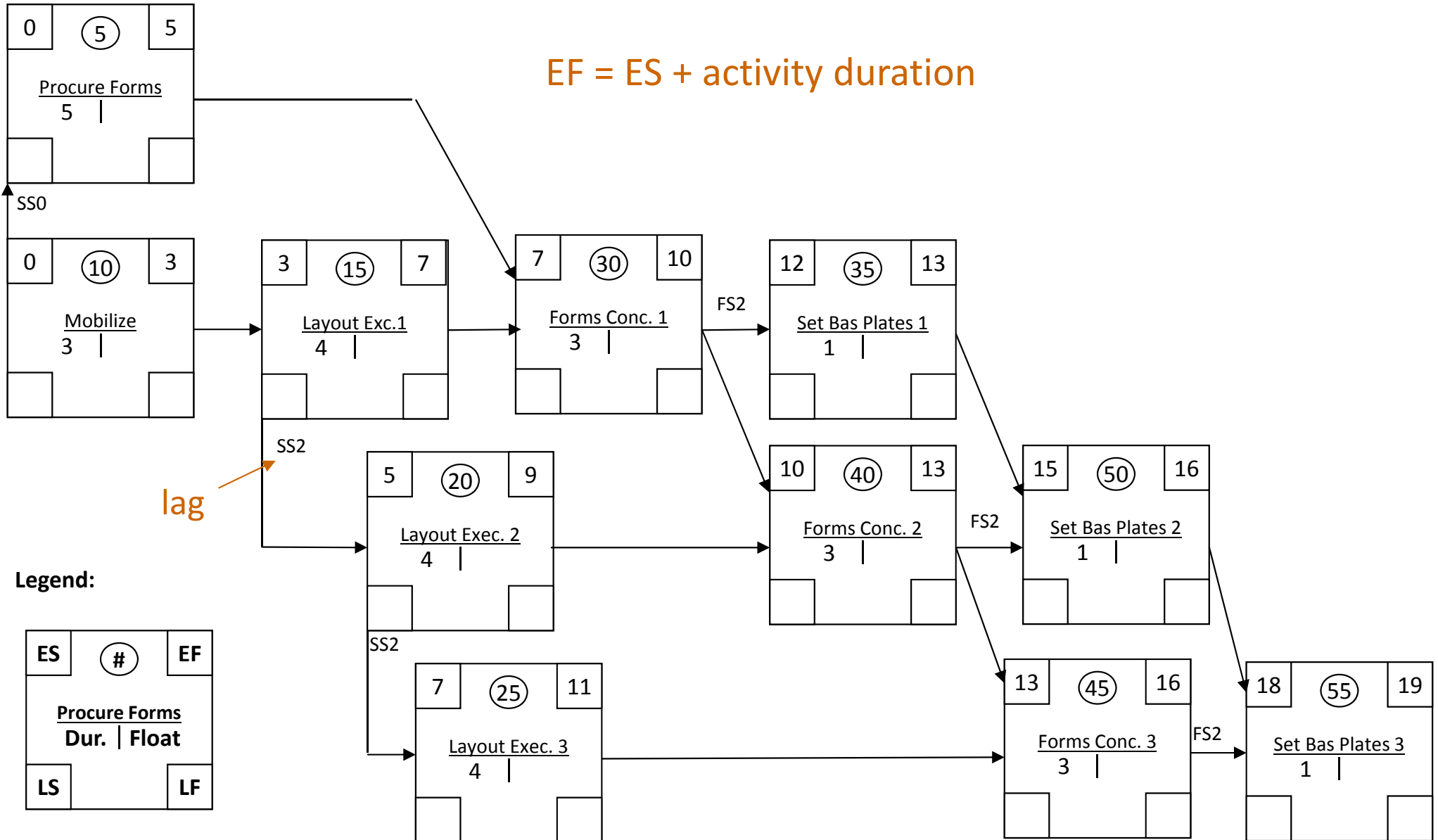
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- **Network Forward Path Calculations – AON**
  - AON (precedence notation) – Finish to Start Links
    - Activities without predecessors
      - Early Start = 0
      - Early Finish = Early Start + Activity Duration
    - Activities with predecessors
      - Early Start = maximum Early Finish among predecessors
      - Early Finish = Early Start + Activity Duration

***IMPORTANT: Pay attention when working with different link types or when there are leads/lags***

Mobilize and procurement of forms → Concrete layout setting  
 → Place concrete in forms → Finalize base concrete plate

# Forward Path Calculation

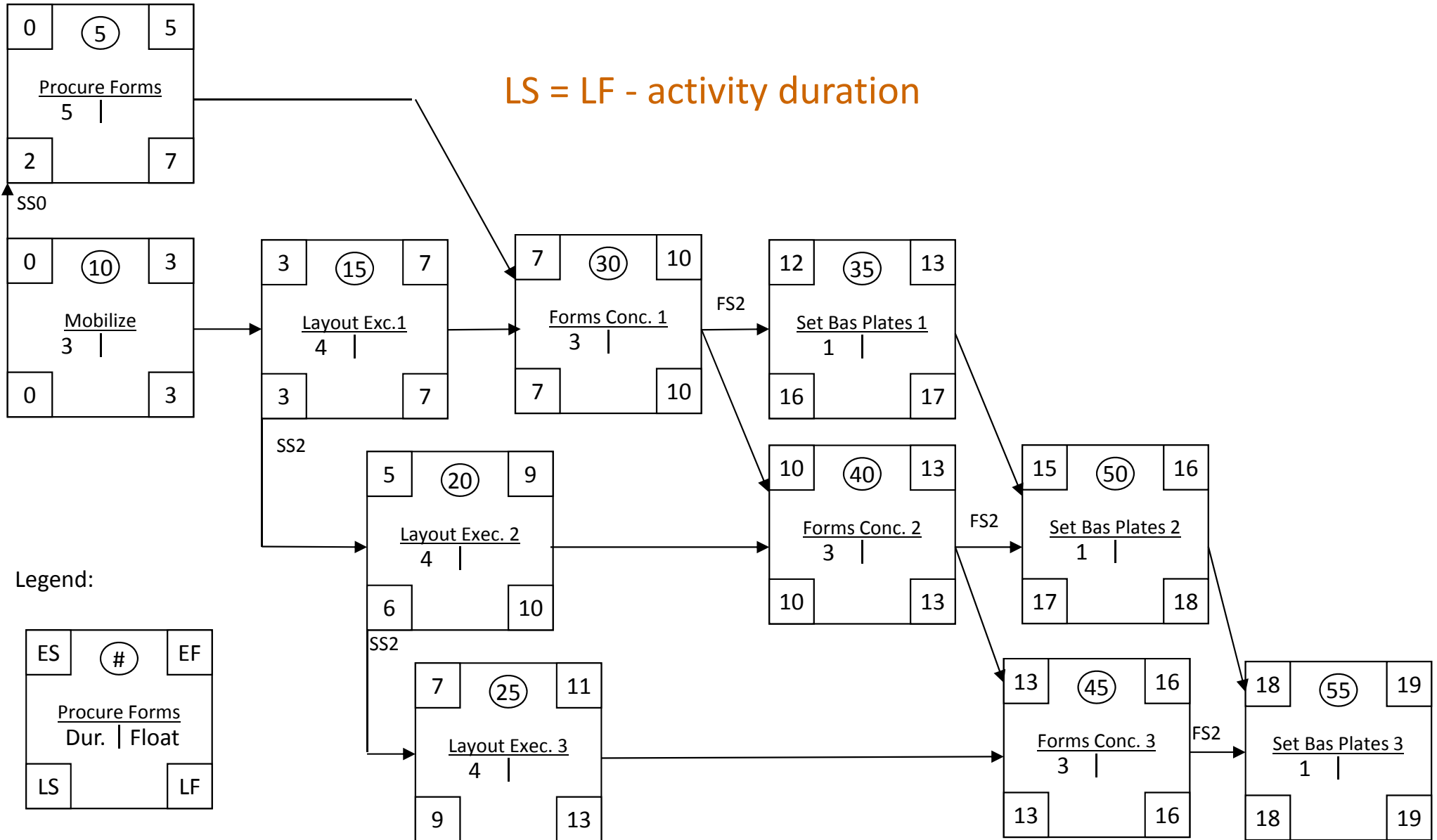


# Project Scheduling – Schedule Development

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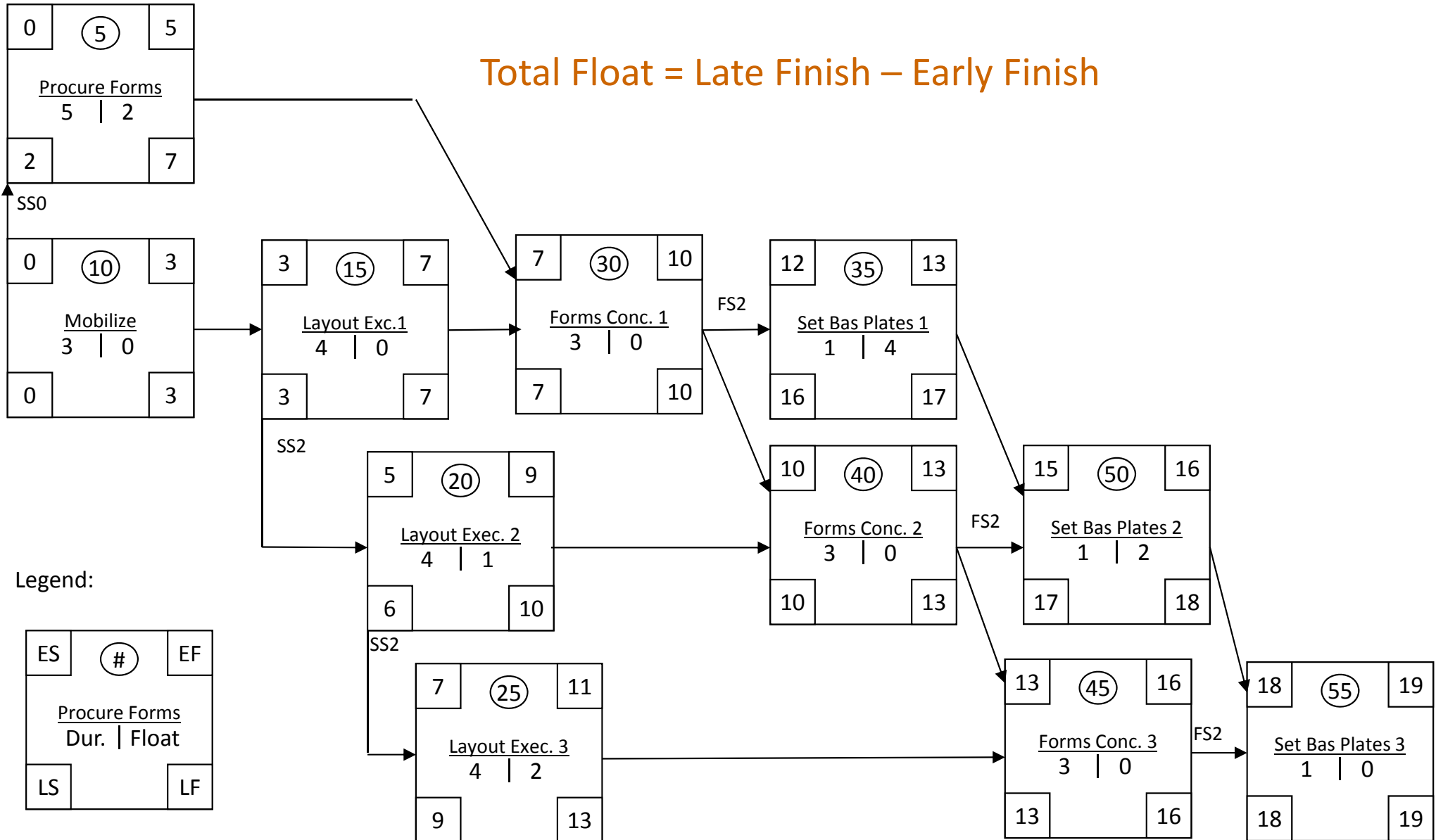
- **Network Backward Path Calculations – AON**
  - AON (precedence notation) – Finish to Start Links
    - Activities without successors
      - Late Finish = Early Finish (or project duration)
      - Late Start = Late Finish – Activity Duration
    - Activities with successors
      - Late Finish = minimum Late Start among successors
      - Late Start = Late Finish – Activity Duration

# Backward Path Calculation

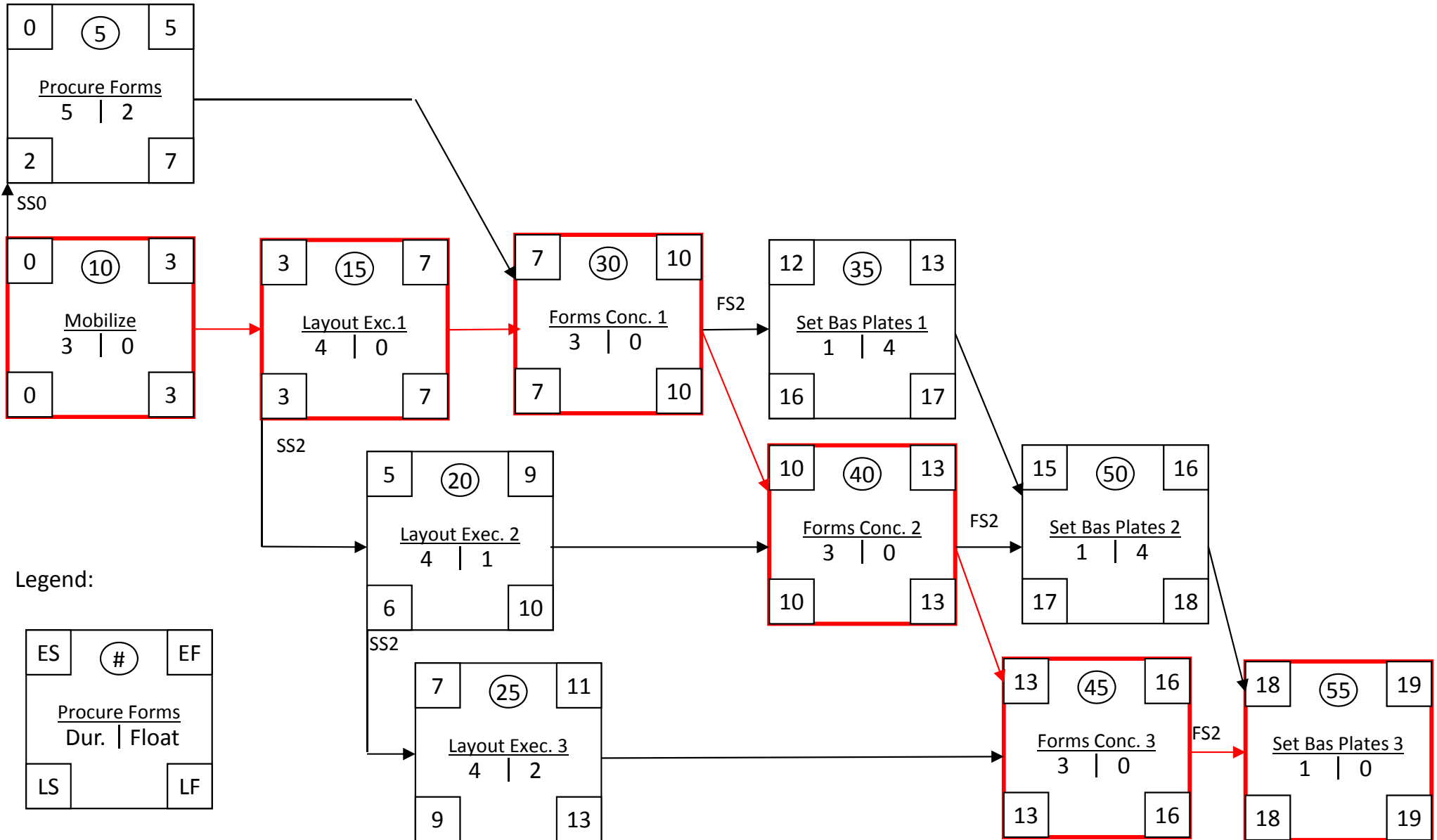


# Total Float Calculation

Total Float = Late Finish – Early Finish



# Critical Path



# Project Scheduling – Schedule Development

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- **Duration Compression**

- Looks for ways to shorten the project schedule without changing the project scope
- Fast Tracking: means you look at activities normally done in sequence and assign them instead partially in parallel. For instance, you would start construction in areas where you felt the design was pretty solid without waiting for the entire design to be completed.
- Crashing: means to throw additional resources with additional costs to the critical path without necessarily getting the highest level of efficiency. For instance, you might add a second worker to the activity usually performed by one worker.

# Project Scheduling – Schedule Control

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- **Controlling changes to the project schedule**
- **Tools and Techniques**
  - Schedule change control system: includes the paperwork, tracking systems, and approval levels
  - Performance measurement: assesses the magnitude of any variations
  - Additional planning: due to prospective changes



# Project Scheduling – Schedule Control

Primavera P6 : Bldg (Office Building Addition)

File Edit View Project Enterprise Tools Admin Help

Layout: Classic Schedule Layout Filter: All Activities

Activity ID	Activity Name	Original Duration	Remaining Duration	Schedule % Complete	Start
<b>Office Building Addition</b>					
		239	134	40.61%	05-Feb-
<b>Design and Engineering</b>					
		45	0	100%	05-Feb-
BA400	Design Building Addition	23	0	100%	05-Feb-
BA000	Start Office Building Addition Project	0	0	100%	05-Feb-
BA-DE	Design & Engineering Summary	45	0	100%	05-Feb-
BA501	Review and Approve Designs	9	0	100%	08-Mar-
BA469	Assemble Technical Data for Heat Pump	3	0	100%	21-Mar-
BA470	Review Technical Data on Heat Pumps	10	0	100%	26-Mar-
<b>Foundation</b>					
		62	0	100%	21-Mar-
BA630	Begin Building Construction	0	0	100%	21-Mar-
BA640	Site Preparation	18	0	100%	21-Mar-
BA-F	Foundation Summary	62	0	100%	21-Mar-
BA650	Excavation	10	0	100%	16-Apr-
BA660	Install Underground Water Lines	5	0	100%	30-Apr-
BA670	Install Underground Electric Conduit	5	0	100%	30-Apr-
BA680	Form/Pour Concrete Footings	10	0	100%	07-May-
BA681	Concrete Foundation Walls	10	0	100%	21-May-
BA690	Form and Pour Slab	5	0	100%	06-Jun-
BA700	Backfill and Compact Walls	2	0	100%	13-Jun-
BA701	Foundation Phase Complete	0	0	100%	
<b>Structure</b>					
		67	56	10.28%	15-Jun-
BA710	Erect Structural Frame	20	12	55%	15-Jun-
BA-S	Structure Summary	67	56	16.42%	15-Jun-
BA702	Begin Structural Phase	0	0	0%	18-Jul-0
BA712	Floor Decking	14	14	0%	18-Jul-0

2007

03-Jan-08, Office Building A

06-Apr-07 A, Design and Engineering

14-Jun-07 A, Foundation

17-Sep-07, Structure

If your P6 installation looks like this, you should choose the P6 Professional training class option.

Display: Current Project's Resources

Resource ID	Resource Name	Resource Type	Unit of Measure
OR	Oliver Rock	Labor	
CRANE	Truck Crane	Material	Each
PK	Paul Kim	Labor	
AC	Ace Corp	Labor	

Display: Open Projects Only

400h

320h

240h

160h

80h

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr

2007

Actual Units

Remaining Early Units

Overallocated Early Units

Limit

Portfolio: All Projects User: admin Data Date: 01-Jul-07 Access Mode: Shared Baseline: Current Project

# Project Scheduling – Schedule Control

Primavera P6 Professional R8.3.2 : LEVELING EXAMPLE (Leveling Example Project Schedule)

File Edit View Project Enterprise Tools Admin Help

**Activities**  
Projects Activities Resources

Layout: Classic WBS Layout Filter: All Activities

Activity ID	Activity Name	Original Duration	Activity Leveling Priority	Total Float	Resources
LEVELING EXAMPLE		30		0	
A1000	Activity #1	10	1 - Top	20	Brand Scaffolding
A1010	Activity #2	10	2 - High	20	Brand Scaffolding
A1020	Activity #3	10	3 - Normal	20	Brand Scaffolding

Jun 22  
Sun Mon Tue Wed Thu Fri Sat  
25-Jun-14 17:00: LEVELING EXAM

Display: Open Projects Only

30h  
24h  
18h  
12h  
6h  
Sun Mon Tue Wed Thu Fri Sat  
Jun 22

Line: Current Project User: admin DB: Training (Professional)

Primavera P6 Professional R8.3.2 : LEVELING EXAMPLE (Leveling Example Project Schedule)

File Edit View Project Enterprise Tools Admin Help

**Activities**  
Projects Activities Resources

Layout: Classic WBS Layout Filter: All Activities

Activity ID	Activity Name	Original Duration	Activity Leveling Priority	Total Float	Resources
LEVELING EXAMPLE		30		0	
A1000	Activity #1	10	1 - Top	20	Brand Scaffolding
A1010	Activity #2	10	2 - High	20	Brand Scaffolding
A1020	Activity #3	10	3 - Normal	20	Brand Scaffolding
AT030	FINISH MILESTONE	0	3 - Normal	0	

Jun 22  
Sun Mon Tue Wed Thu Fri Sat  
25-Jun-14 17:00: LEVELING EXAM

Display: Current Project's Resources

Resource ID	Resource Name	Resource Type	Max Units/Time
TEP.SCAF.BRAND	Brand Scaffolding	Labor	1/h

Display: Open Projects Only

10h  
8h  
6h  
4h  
2h  
Sun Mon Tue Wed Thu Fri Sat  
Jun 22

Display Activities for selected...  
 Time Period  Resource

Portfolio: All Projects Access Mode: Shared Data Date: 23-Jun-14 07:00 Baseline: Current Project User: admin DB: Training (Professional)

# In-Class Scheduling Exercise

- **Project Start Date:**  
**5/1/2018**

Code Value	Code Title
GC	General Contractor
PC	Plumbing Contractor
EC	Electrical Contractor
RC	Roofing Contractor

Activity	Description	Duration	Predecessor	Code
10	Mobilization	1		GC
20	Excavation	2	10	GC
30	Place gravel	2	20	GC
40	Place slab forms	3	20	GC
50	Place rebar	2	30	GC
60	Rough in plumbing	2	50	PC
70	Pour & cure concrete	9	40, 60	GC
80	Remove forms	2	70	GC
90	Erect frame & sheath walls	4	70	GC
100	Sheath roof	3	80, 90	RC
110	Electrical	3	100	EC
120	Install siding	4	100	GC
130	Finish carpentry	3	100	GC
140	Finish roof & flashing	3	100	RC
150	Paint	5	110, 120, 130	GC
160	Clean-up	2	140, 150	GC

# In-Class Scheduling Exercise

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1. Draw the precedence diagram network
2. Use CPM calculations to determine the project duration
3. Develop a Gantt chart