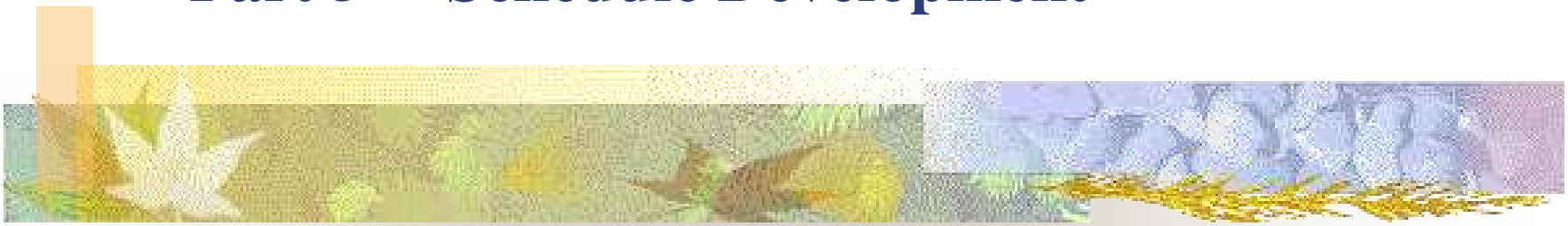
Time Management

Part 5 – Schedule Development



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6.5 Schedule Development

Inputs	Tools &Techniques	Outputs
■ Organizational Process Assets ■ Scope Statement ■ Activity List ■ Activity Attributes ■ Network Diagrams ■ Resource Req'ms ■ Resource Calendars ■ Activity Duration Est. ■ PM Plan (Risk Reg.)	■ Network Analysis ■ Critical Path Method (CPM) ■ Schedule Compression ■ What if Simulation? ■ Resource Leveling ■ Critical Chain ■ PM Software ■ Applying Calendars ■ Adjust Lead & Lag ■ Schedule Model	■ Project Schedule ■ Schedule Model Data ■ Baseline ■ Resource Req'm Up ■ Activity Attributes Up ■ Project Calendar Up ■ Requested Changes ■ PM Plan Schedule Mgmt Plan

Purposes of Scheduling

Primary

- Best Time
- Least Cost
- Least Risk

Secondary

- Study alternatives
- Optimize schedule
- Effective resource utilization
- Communication
- Refine Estimate
- Project control
- Manage time/cost changes

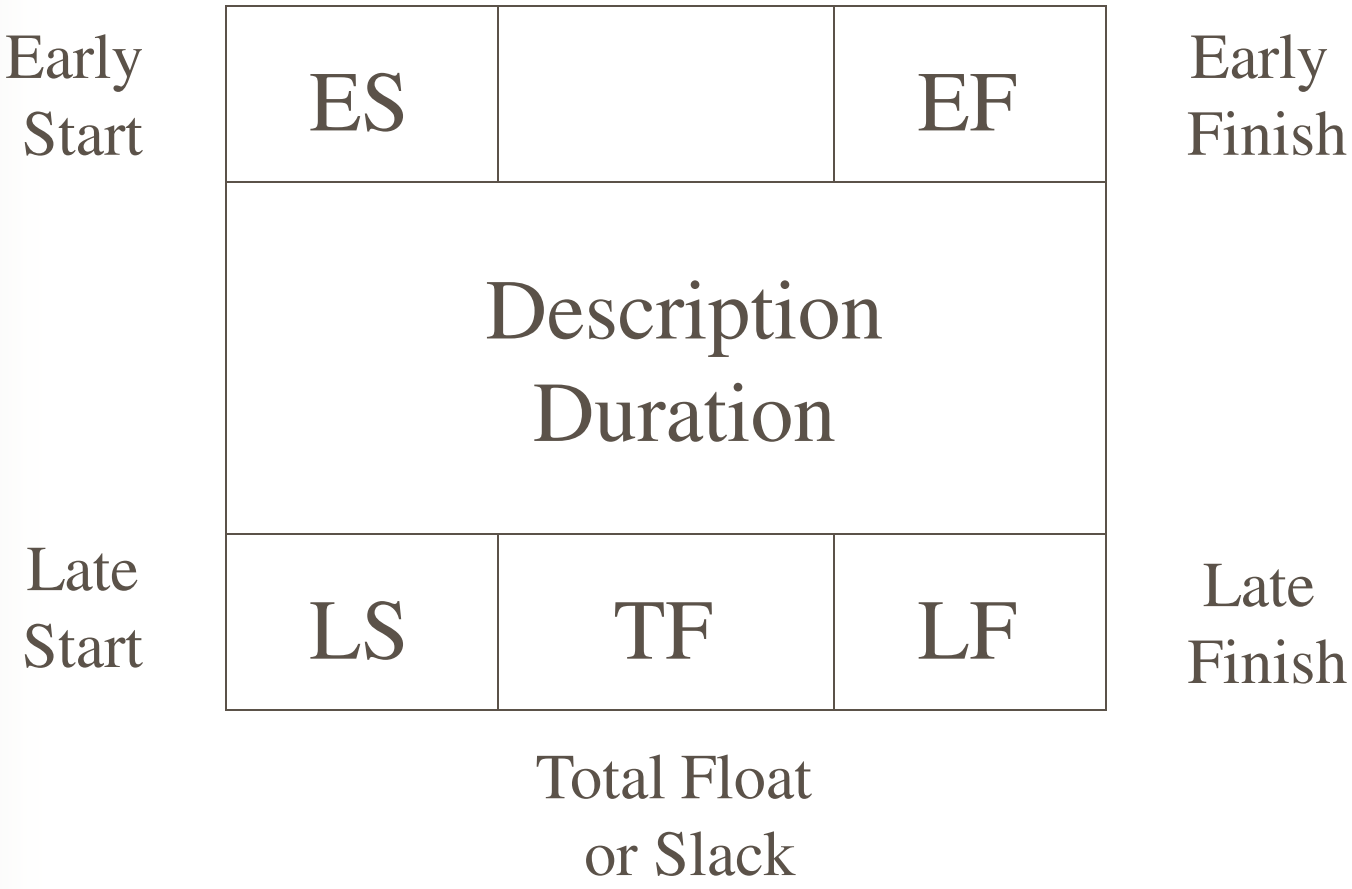
Scheduling Terms

- Early Start
- Early Finish
- Late Start
- Late Finish
- Total Float
- Free Float
- Slack
- Forward Pass
- Backward Pass
- Lead
- Lag
- Critical Path
- Almost Critical?

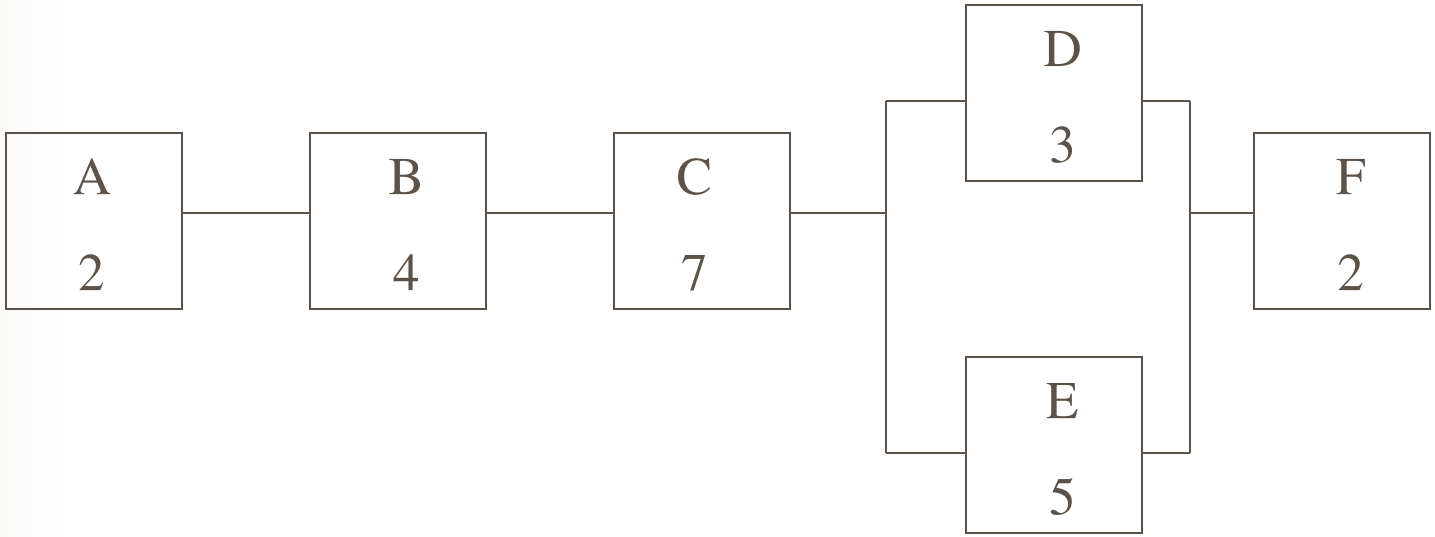
Description of Scheduling Techniques

- For a narrative description of scheduling technique basics (forward pass, backward pass, float/slack, and critical path) see *A Guide to Network Analysis*, by Michael C. Glen at: http://project.mvps.org/networkanalysis.htm

Activity On Node (AON) Notation

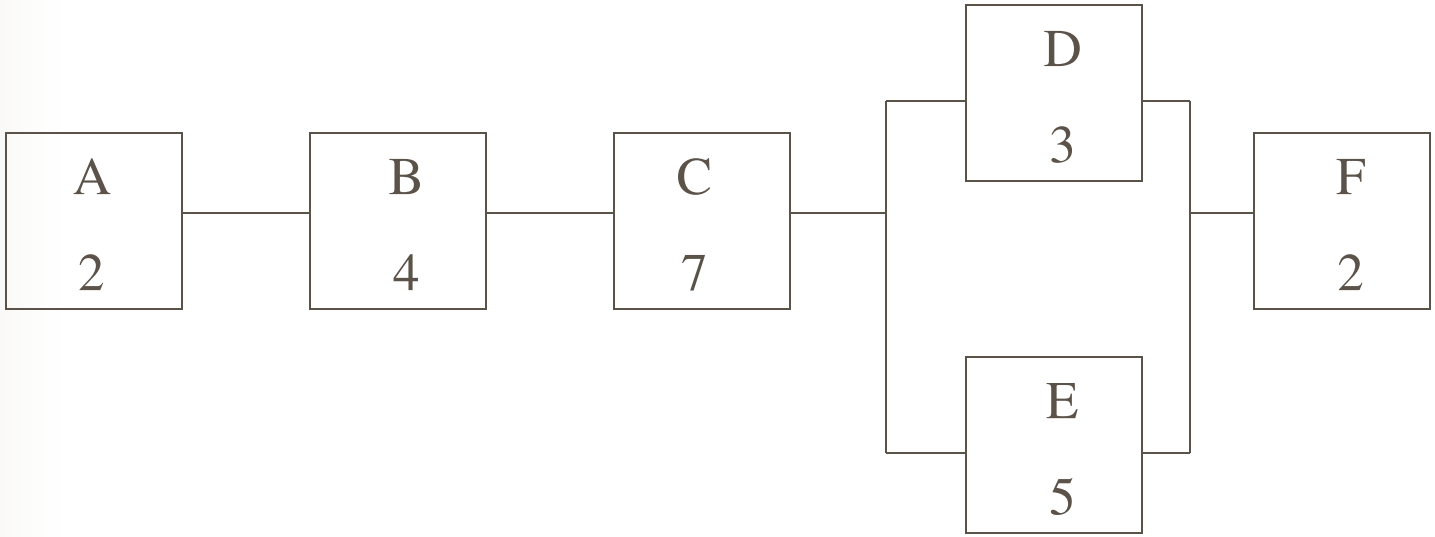


Forward Pass



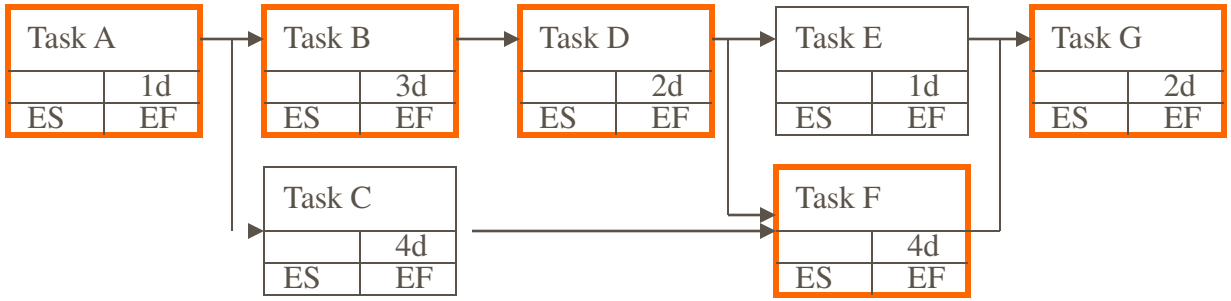
Determine duration of project

Backward Pass



Determine slack and critical path of project

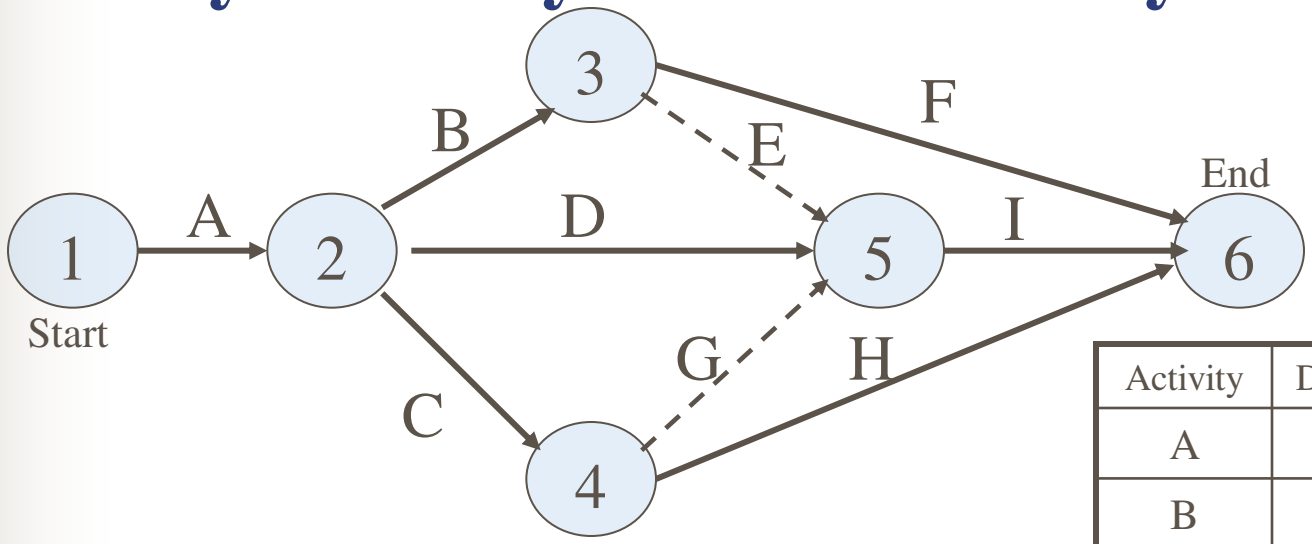
Example Critical Path (CPM)



Critical Path

- Calculated by forward & backward passes
- Longest path of dependent activities
- Activities with zero float/slack
- Any activity delay will impact the project in terms of time and money
- Activities on critical may be compressed to shorten project duration

Activity: Activity on Arrow Analysis



Activity	Duration	Float
A	2	
B	4	
C	3	
D	4	
E	0	
F	6	
G	0	
H	5	
I	2	

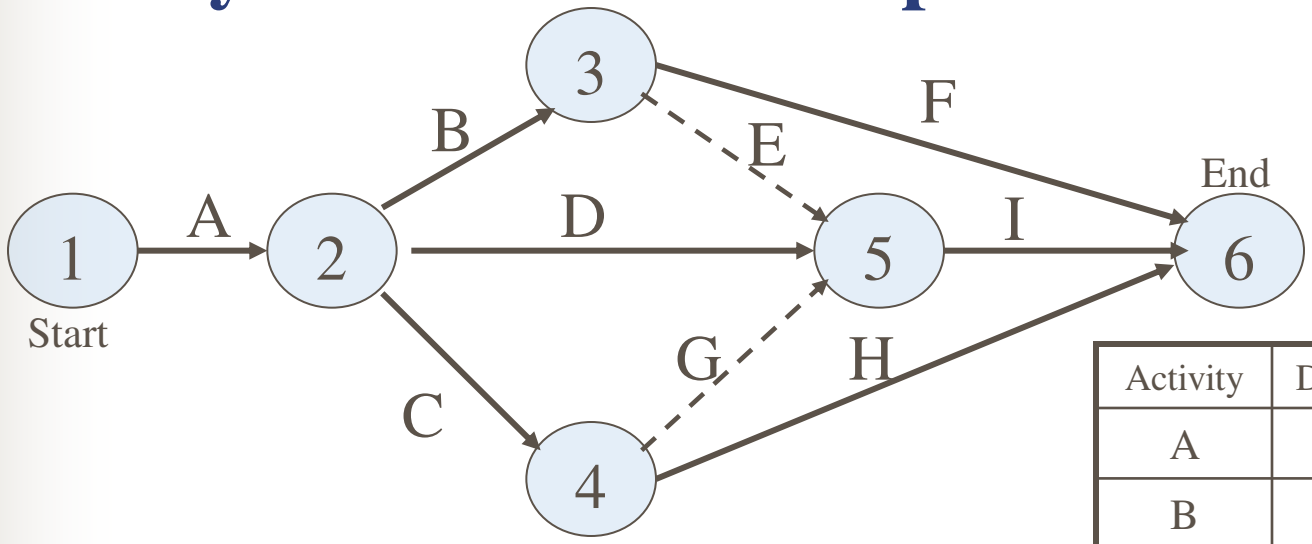
How many paths? ____

Critical Path = _____

Critical Path Duration = _____

Challenge: Enter in MS Project

Activity #4A: AOA with Specified Deadline



Activity	Duration	Float
A	2	
B	4	
C	3	
D	4	
E	0	
F	6	
G	0	
H	5	
I	2	

1. What happens to float if the specified project deadline is 18 days?
2. Are any of the activities critical?

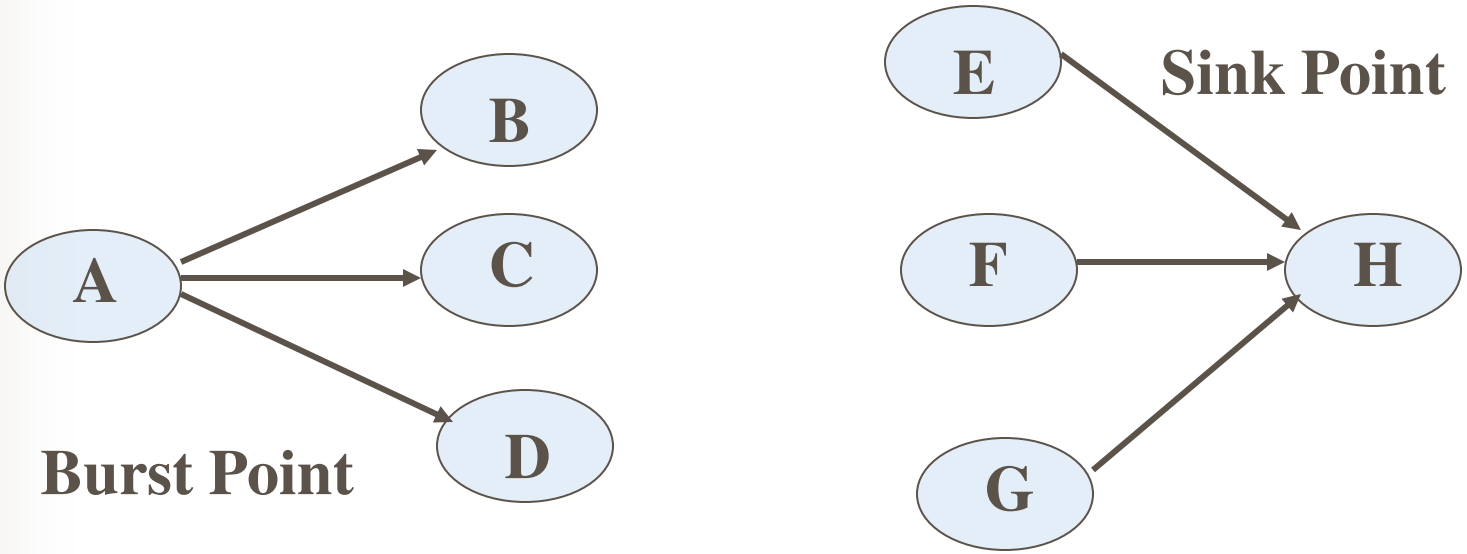
Float or Slack

- **Total Float**: Range of dates an activity can finish without delaying project
  - Total Float = LS – ES
  - Float can be positive or negative!
    - If negative – Finish date will slip!
- **Free Float** (Activity Float): Maximum delay in early dates w/o delaying immediate successors
  - Free Float = ES successor – EF activity
  - Can be = but not > than Total Float
  - Value –
    - Delay non-critical activities to level resources

Analysis of CPM

- Display relationships
  - What are consequences of delays?
- Identify bottlenecks & problems before they occur.
  - Where are difficult tasks & tight deadlines combined?
- Can workflow be redesigned?
  - e.g. more parallel activities. What are the risks?
- Focus attention on key tasks
  - ” Management by Exception”

Critical Schedule Nodes



Easy to generate on schedule, but what is practical significance?

Reduce Project Duration

- Reduce Scope / Quality
  - Eliminate some parts or activities in the project
  - Substitute less time consuming parts or activities
- Add more resources / Increase the number of work hours in a day
- Fast-Track – Parallel activities
- Crash Critical Path activities
- Shorten least-cost critical activities

Gantt Chart Example

						Planning Gantt Chart					
						Project: Home Foundation					
Date:	11/9/2001										
		Day									
ID #	Activity	1	2	3	4	5	6	7	8	9	10
1	Call Julie										
2	Mark utilities										
3	Establish building lines										
4	Excavate foundation										
5	Re-establish building lines										
6	Form footings										
7	Place reinforcing										
8	Order concrete										
9	Place concrete										
10	Strip and clean forms										
11											

Named after Henry Gantt who developed procedure on Navy ship construction in the early 1900s. Visualize duration & sequence.

Value of Planning Gantt

- Visualize activities & sequence
- Communication & Delegation
  - Easy to understand and interpret
- Check plan against time constraints
- Measure progress
- Motivate/buy-in with agreed upon schedule
- Determine & allocate resources

Quiz #5: Schedule Development

1. What is the difference between “work hours” and duration?
2. What is the value of a Gantt Chart?
3. How is the critical path determined?
4. How is float calculated?
5. How can the schedule be compressed?
6. How can the CPM be used as a management tool?

Test Yourself

Which of the following is the BEST PM tool to determine the longest time a project will take?

a. WBS
b. Network diagram
c. Bar or Gantt chart
d. Project charter

Test Yourself

Which of the following is the BEST PM tool to determine the longest time a project will take?

a. WBS
b. **Network diagram**
c. Bar or Gantt chart
d. Project charter

B: Dependencies are needed to determine the critical path.

Activity #5

Project Management
AON/CPM

A project is specified by the following activities:

Activity	Immediate Predecessor(s)	Duration
A		11
B	A	9
C	A, B	11
D	A	19
E	B	7
F	C, D, E	15
G	E, F	4

To Do:

1. Construct an Activity On Node (AON) network to represent the above project.

2. Calculate the earliest start, latest start, earliest finish and latest finish times for each activity. Also calculate the minimum project completion time and identify the critical path.

3. Identify the total float associated with each of the non-critical activities?

4. What effect, if any, will each of the following changes have on the completion time of the project :

   - Activity D is delayed by 3 days?
   - Activity C is finished 1 day early?

5. Ignoring the changes to activities D and C given above, suppose now that activity F cannot start until at least 2 days after activity D is finished. How is the project duration and critical path affected as a result of including this dependency in the project?

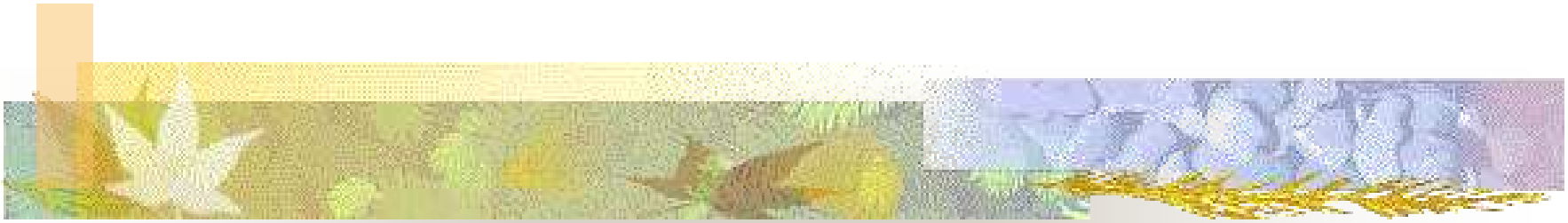
MS Project Activity

- See learning module

Questions/Notes

Time Management

Part 6 – Schedule Control



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6.6 Schedule Control

Inputs	Tools &Techniques	Outputs
■ Sched Mgmt Plan ■ Schedule Baseline ■ Performance Rpts ■ Approved Change Requests	■ Progress Rpts ■ Schedule Change Control System ■ Performance Measurements ■ PM Software ■ Variance Anal. ■ Sched Compress Bar Chart	■ Sched Model Data UP ■ Sched Baseline UP ■ Performance Measurements ■ Req Changes ■ Recommended Corrective Actions ■ Org Process Assets ■ Activity List UP ■ Activity Attributes UP ■ PM Plan UP

Shortening the Schedule

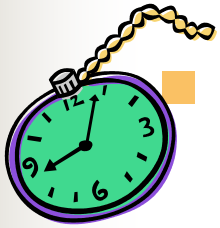
- Re-sequence workflow - add more parallel tasks – May increases risk & resources
- Apply additional resources to critical path
  - Transfer resources from non-critical tasks to speed up completion at little or no cost
  - Use float
  - Redo CPM to make sure you have not created a new critical path

Compressing the Schedule

- Crash Time: Fastest a task can be completed given additional resources
- Crash Cost: Total cost in resources or money to achieve crash time
- Only crash activities on critical path
- Start with least-cost activities

Crash Example

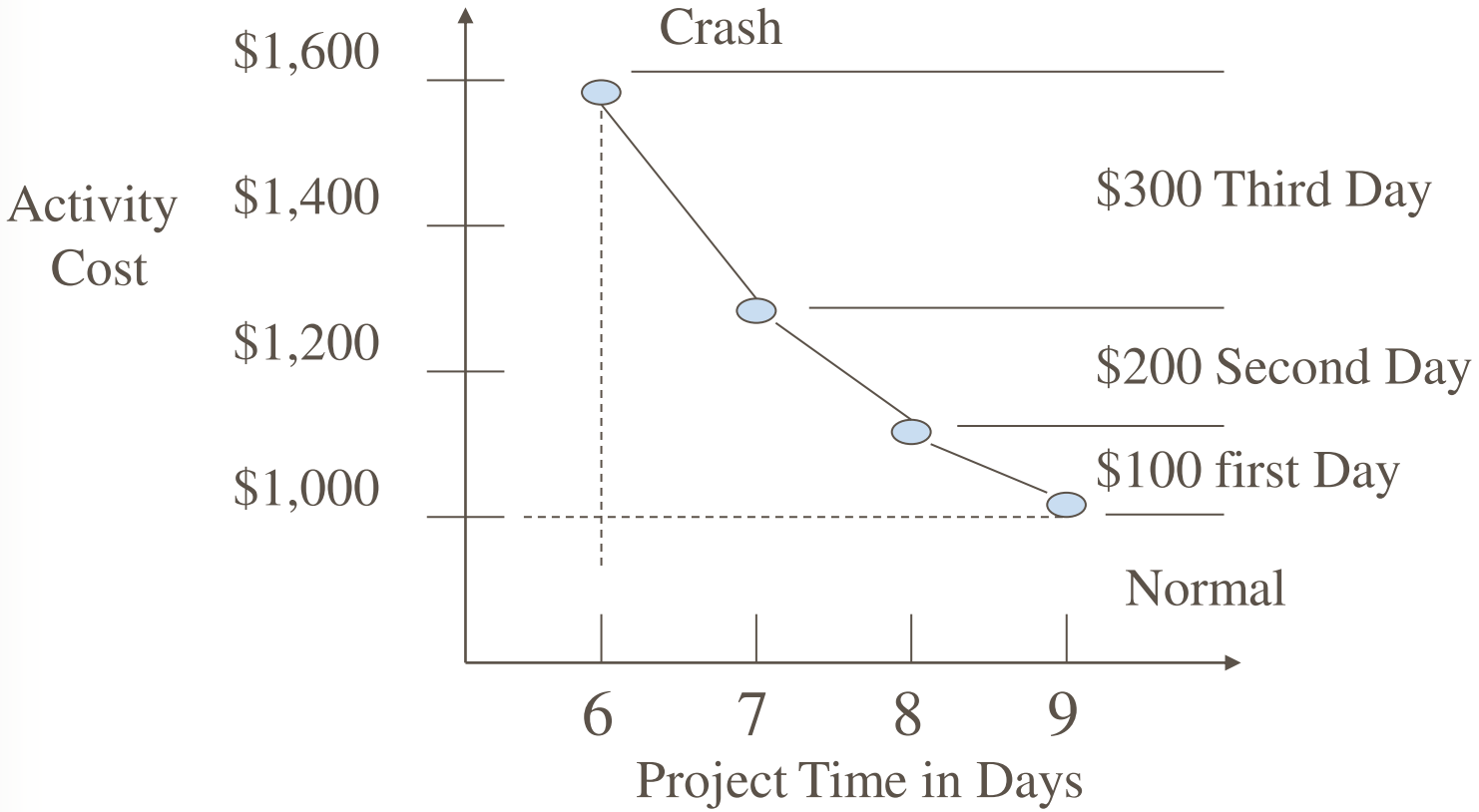
Assume salary is $1,000 per week per person.

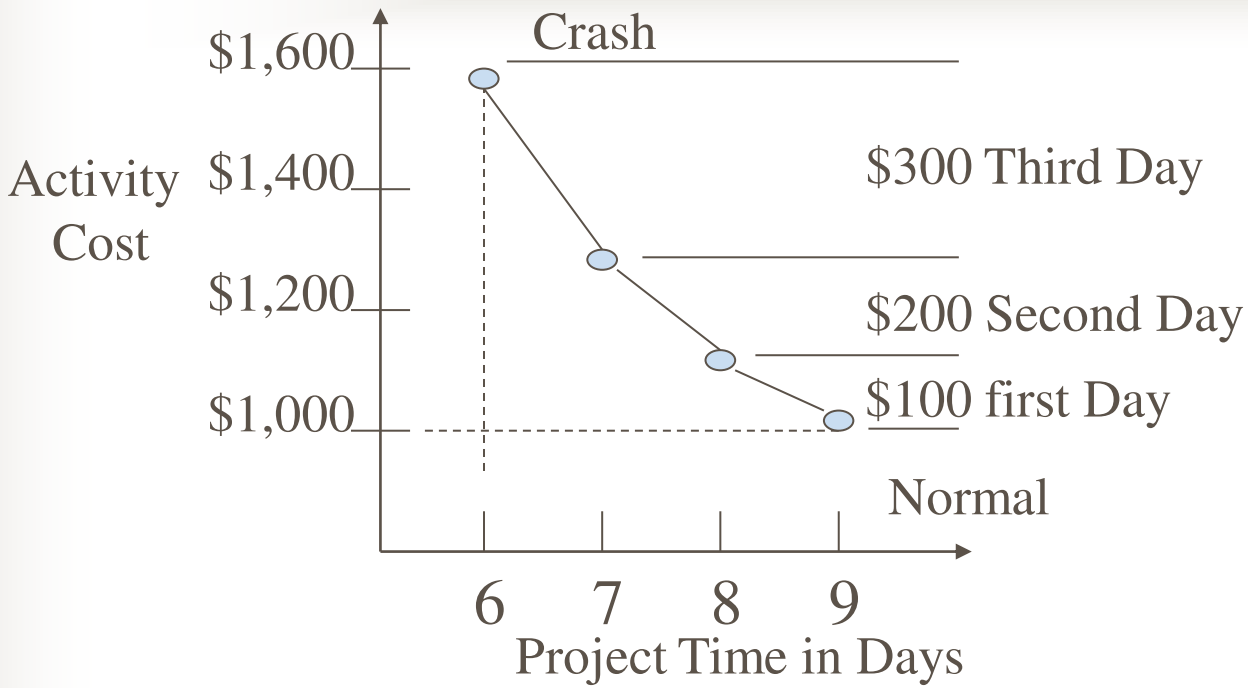


- If ONE person can develop software specs in 5 weeks, the regular cost is $_____
- If two people can develop software specs in 3 weeks, the crash time is _____

- If two people can develop software specs in 3 weeks, the crash cost is $_____
- Is it worth it?

Crashing -- Continuous Step-Wise Buying Time Along the Critical Path!





$$\textbf{Cost Slope} = \frac{\text{Crash Cost} - \text{Normal Cost}}{\text{Crash Duration} - \text{Normal Duration}}$$

$$\textbf{Cost Slope} = \frac{\$1{,}100 - \$1{,}000}{8 - 9} = -\ 100 \text{ First Day}$$

Crash Issues

- In rank order, which activities **on the critical path** have lowest daily crash cost?
- Logical Limit: How far to crash before other activities become critical?
- Note: Crash slope is negative
  - Negative relationship between cost and time:
  - i.e. Shorter the duration the greater the cost

Test Yourself

Rearranging resources so that a constant number of resources are used each month is:

a. Crashing
b. Floating
c. Leveling
d. Fast tracking

Test Yourself

Rearranging resources so that a constant number of resources are used each month is:

a. Crashing
b. Floating
c. **Leveling**
d. Fast tracking

C: Resource leveling strives for consistent staffing

Activity #7

Project Management
AON/CPM & Crashing the Schedule

The table below defines the activities within a small project.

Activity	Immediate Predecessor(s)	Normal Time	Normal Cost ($1,000s)	Crash Time	Crash Cost ($1,000s)	Crash Slope (Daily $)
A		6	24	4	34	
B		4	12	3	22	
C	A	5	20	3	28	
D	A	7	29	4	47	
E	B	6	26	5	34	
F	B	8	34	5	52	
G	C, E	10	27	6	47	
H	D, F	9	34	7	48	

Crash Slope (Daily $) = (Crash Cost – Normal Cost)/(Crash Time – Normal Time)

To Do:

1. Draw an activity on node network to represent the above project.
2. Using normal duration times, calculate the earliest start, latest start, earliest finish and latest finish activity times. Also calculate the minimum project completion time and identify which activities are critical.
3. Identify the total float associated with each of the non-critical activities?
4. Suppose that activity H cannot start until at least 2 days after activity F is finished. Using normal durations, what effect (if any) will this have on the project duration and critical path?
5. Ignoring the possible need for lag between H and F, is it possible to reduce the total project time to 21 days? If so, what is the cost?
6. Do any other activities become critical if the schedule is reduced to 21 days?

From Time Estimate to Schedule

- As PM you need to develop a credible schedule for the sake of the project and your reputation. In order, what do you need to move from the estimating data to a finalized schedule?
- Discuss and list the steps.

Test Yourself

From Time Estimate to Schedule

- Work with stakeholders priorities
- Look for alternate ways to do the work
- Assess impacts on other projects
- Negotiate resource availability
- Team approval of final schedule
- Compress, fast-track, & re-estimate
- Revise in response to risk response plan
- Level resources
- Gain formal approval from stakeholders & mgmt.

Schedule Control Option Matrix

Strategy	Action	Explanation and/or Assumptions
1.		
2.		
3.		
4.		
5.		
6.		

Summary of Key Concepts

Activity Definition
- Activity List
- Templates
- WBS Dictionary

Activity Duration Estimating
- Activity Attributes
- Analogous Estimating
- Assumptions
- Calendars
- Constraints
- Lead & Lag
- Project Review and Evaluation Technique (PERT)
- Quantitatively Based Estimating

Activity Sequencing
- Mandatory Dependencies
- Discretionary Dependencies
- External Dependencies
- Activity on Arrow (AOA)
- Gantt Charts
- Network Diagrams
- Precedence Diagramming Method (PDM)

Schedule Development
- Forward Pass
- Backward Pass
- Early Start
- Early Finish
- Late Start
- Late Finish

Schedule Development (cont…)
- Total Float
- Free Float
- Critical Path (CPM)
- Milestones
- Coding Structure

Schedule Control

Crashing
Fast Tracking
Reserve Time (Contingency)
Resource Leveling
Schedule Baseline
Simulation
Variance Analysis

And then a miracle happens!

Major Inputs to Budget

- Project Charter
- Scope Statement
- WBS
- Activity List
- Network Diagram
- Activity Duration Estimates
- Schedule

End of Scheduling Section!
Questions/Notes