Program Evaluation and Review Technique (PERT)

CpE 190 and EEE 193A

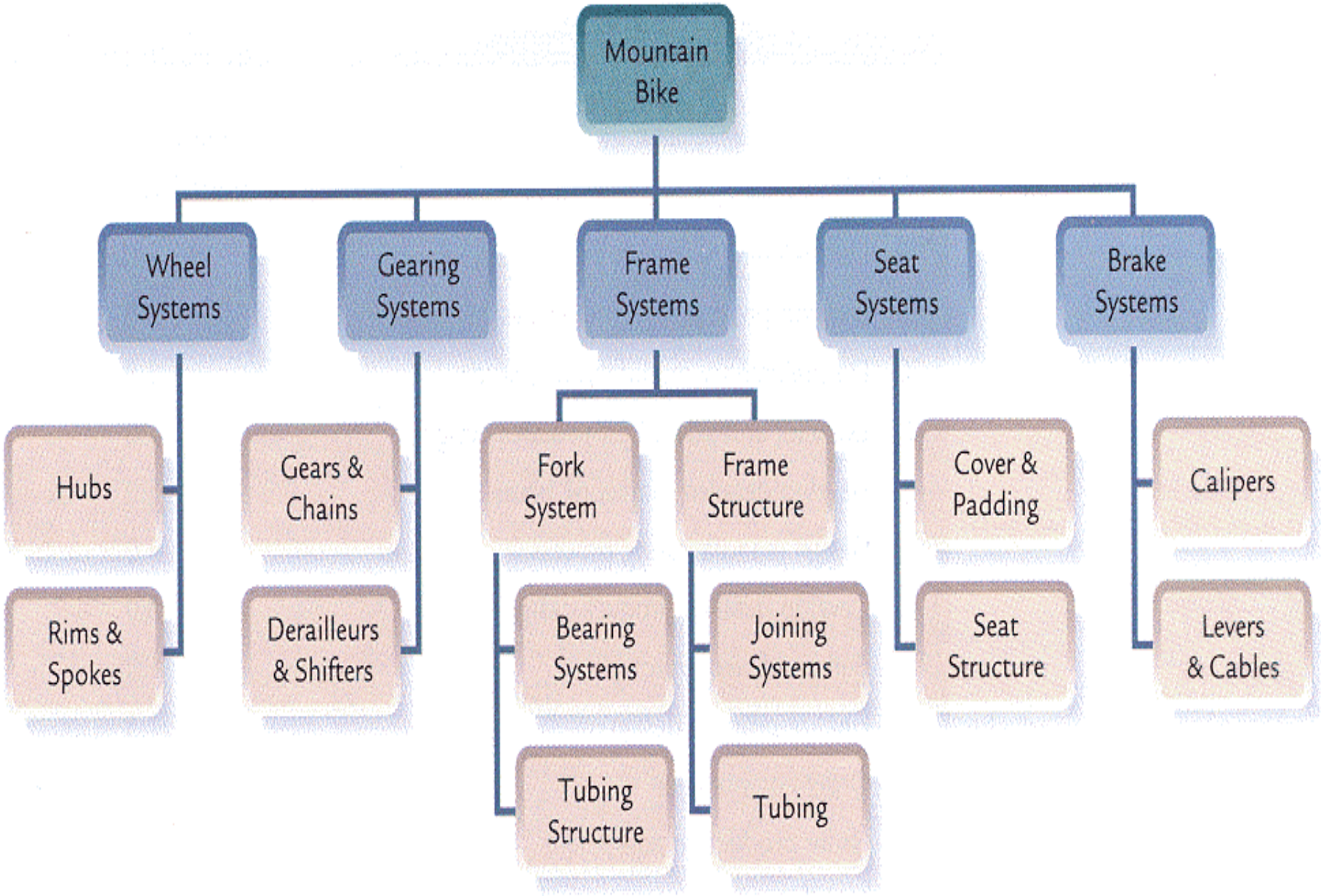
Week 4

So far ...

- Societal problem
- Design idea
- Work breakdown structure

Work Breakdown Structure (WBS) and Program Evaluation and Review Technique (PERT)

Work Breakdown Structure (WBS): divide and conquer.


Mountain Bike
Wheel Systems
Gearing Systems
Frame Systems
Seat Systems
Brake Systems
Hubs
Rims & Spokes
Gears & Chains
Derailleurs & Shifters
Fork System
Frame Structure
Bearing Systems
Tubing Structure
Joining Systems
Tubing
Cover & Padding
Seat Structure
Calipers
Levers & Cables

Timeline

Project timeline – graphic coordination of the project's tasks.

Prepare a timeline graph that covers the entire Senior Design course:
September through May.

This graph will show:

1. The task or element.
2. Duration of the task.
3. Personnel assigned to the task.
4. Status of the task.

Timeline

The project timeline should be in a form that can be easily updated as the project status changes, and as tasks require modification.

Microsoft Project is loaded onto each of the lab computers as one method to complete this ongoing assignment.

Use of Microsoft Project is not required but some form of computer assistance in keeping your timeline updated is highly suggested.

Timeline

Submit an initial timeline for the team and the individual team members for the entire course to the instructor by uploading an electronic copy to the ECS Hive.

Post a readable copy of this timeline on the team's bulletin board next to your work station.

Submit a task list by team member for the entire course to the instructor by uploading an electronic copy to the ECS Hive.

Post a copy of these tasks on your team's bulletin board.

The importance of project scheduling

You are a manager in a company and
your company just made the winning bid of $5 million to *deliver something* within *six months*.

Contract includes:

- No bonus if you deliver before the deadline.
- A penalty of $100,000 for every week of delay.

PERT is valuable for large and complex projects.

PERT uses graphs and networks to represent activities and milestones.

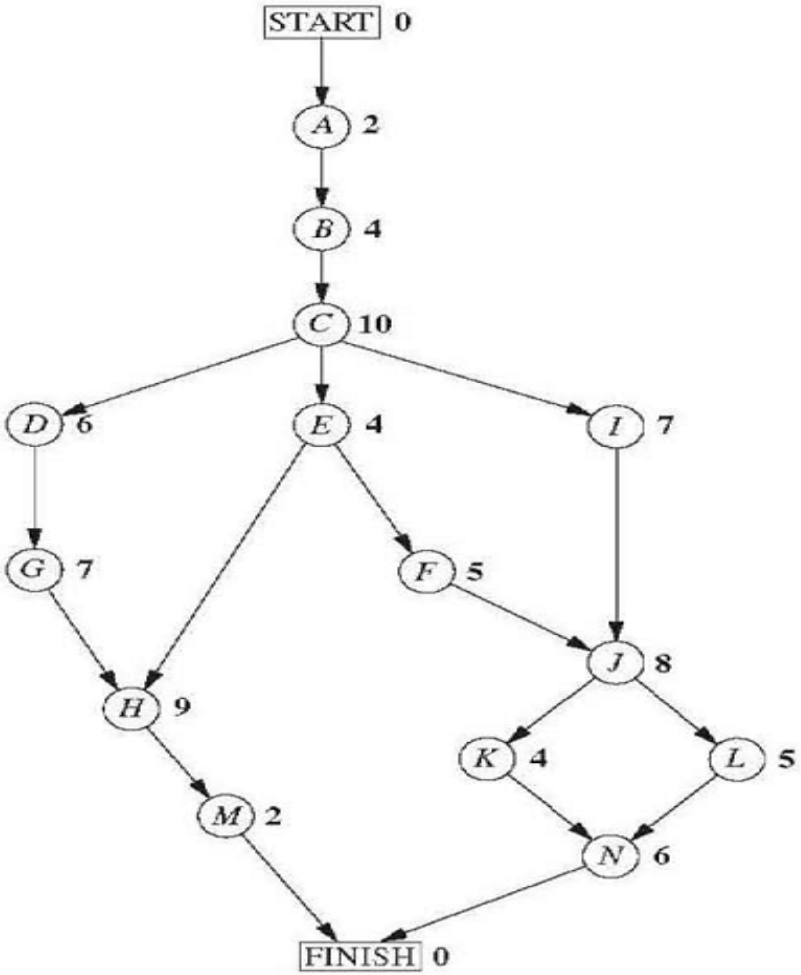
Three things you need to know to describe a project timeline.

- Activity information: individual activities at the desired level of details
- Relationship between activities: identify relationship between activities including predecessor and successor relationships
- Time information: estimate the duration of each activity.

Network representation:

- Activity: Stands for the time consuming part of a project, represented by branches
- Event: denotes the start or end of an activity.

An event does not consume time. It is represented by a node (or circle).


START 0
A 2
B 4
C 10
D 6
E 4
I 7
G 7
F 5
J 8
H 9
K 4
L 5
M 2
N 6
FINISH 0

PERT (Project evaluation and review technique) and CPM (Critical path method)

- PERT was developed by the US navy for the Polaris missile project.
- CPM was developed by DuPont and the Remington Rand Corporation for the management of large chemical plants

Scheduling a project

- What is the **total time** required to complete the project if no delay occurs?
- What is the **duration and order** of the individual activities?
- Which are the **critical bottleneck activities** where any delays must be avoided?
- For the **other activities**, how much delay can be tolerated without delaying project completion?

- Summing the durations of all activities will give us 79 hours. This is not the answer.

- A path is one of the routes from start to finish.

The length of the path is the sum of the durations of the individual activities on the path. How many paths we have?

- Critical path: The longest path.

What is the estimated project duration? The length of the longest path through the project network.

- What are the bottleneck activities?

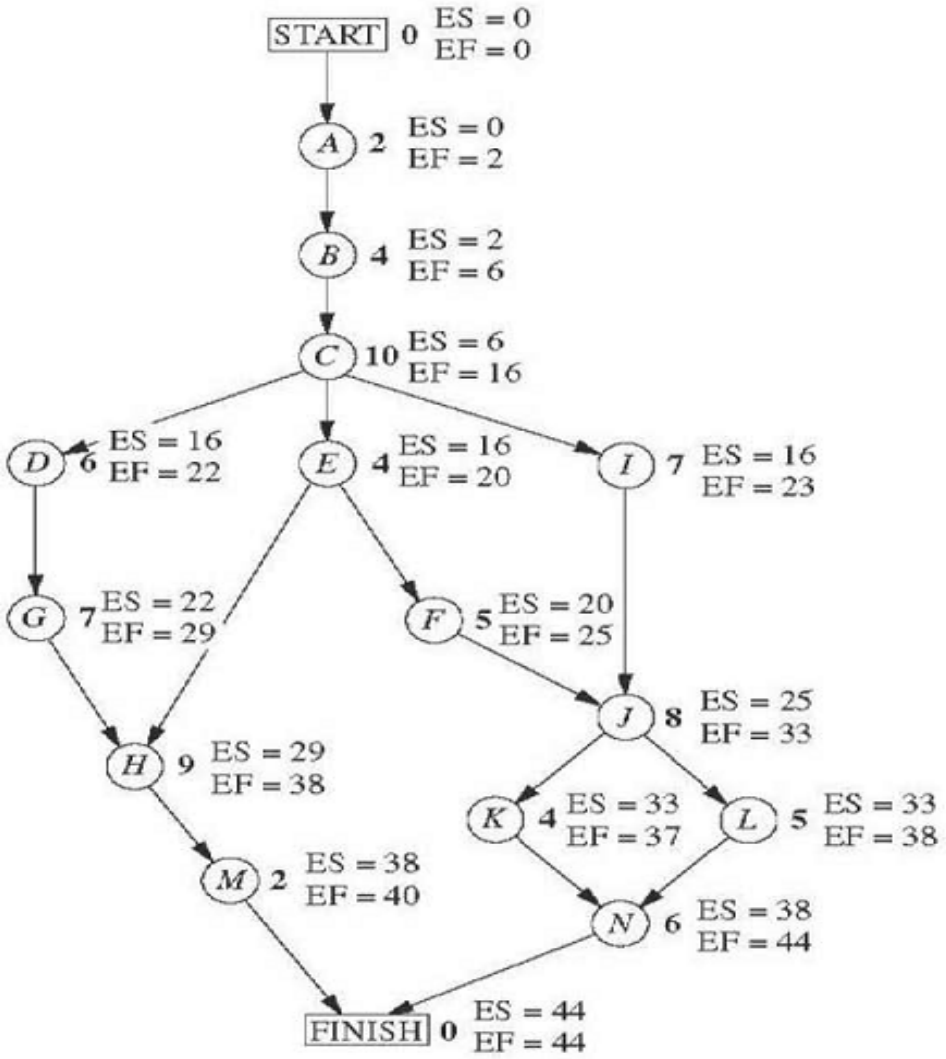
Scheduling individual activities

Duration is translated to start and finish times.

ES: Earliest start time for a particular activity
EF: Earliest finish time for a particular activity.

How to find ES for a given activity?
Rule: ES = largest EF of the immediate predecessors.

What happens if a given activity depends on more than one activity?
Example: Activity G has EF=29. Activity E has EF=20. Larger EF=29.
ES for activity H is 29.


START 0 ES = 0 EF = 0
A 2 ES = 0 EF = 2
B 4 ES = 2 EF = 6
C 10 ES = 6 EF = 16
D 6 ES = 16 EF = 22
E 4 ES = 16 EF = 20
I 7 ES = 16 EF = 23
G 7 ES = 22 EF = 29
F 5 ES = 20 EF = 25
J 8 ES = 25 EF = 33
H 9 ES = 29 EF = 38
K 4 ES = 33 EF = 37
L 5 ES = 33 EF = 38
M 2 ES = 38 EF = 40
N 6 ES = 38 EF = 44
FINISH 0 ES = 44 EF = 44

Scheduling individual activities

Duration is translated to start and finish times. The latest start time for an activity is the latest possible time that it can start without delaying the completion of the project

- LS: latest start time for a particular activity
- LF: latest finish time for a particular activity

Rule: LF= smallest LS of the immediate successors

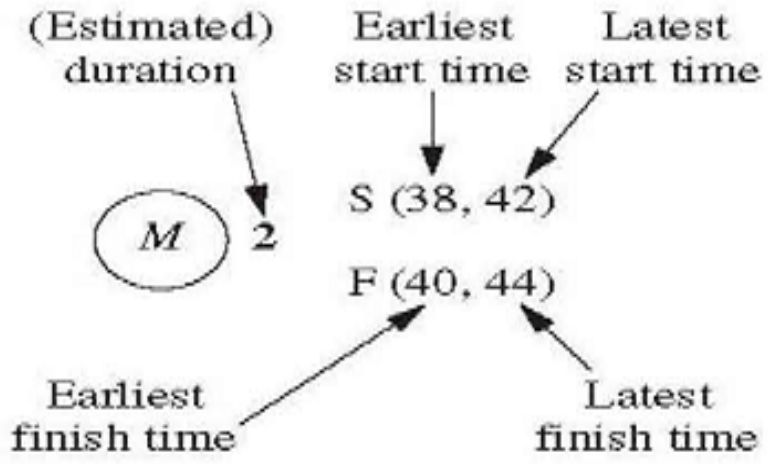
Identifying slack in schedule

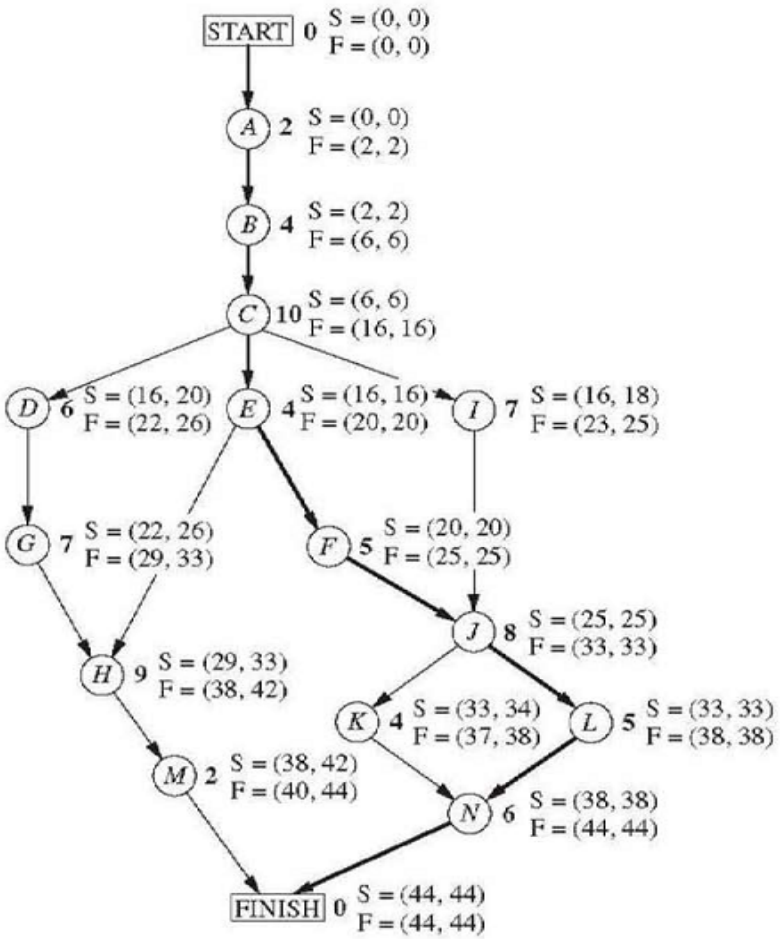
The slack for an activity is the difference between its latest finish time and its earliest finish time

$$Slack = LF - EF$$

Example: Find the slack of activity M

Slack of activity M: 44-40=4.



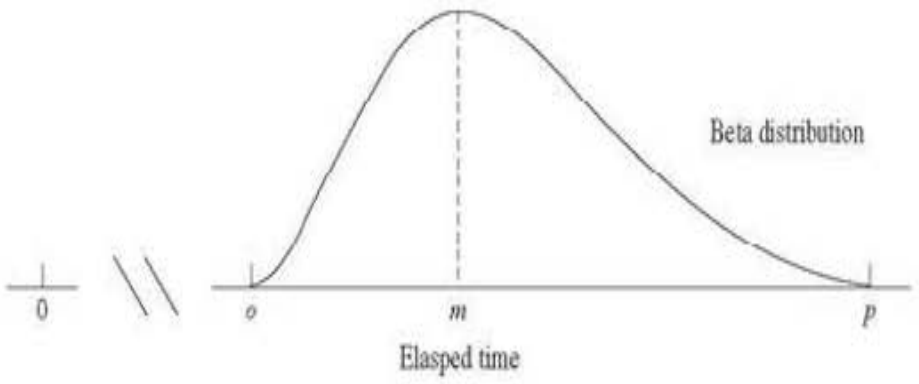

START 0 S = (0, 0) F = (0, 0)
A 2 S = (0, 0) F = (2, 2)
B 4 S = (2, 2) F = (6, 6)
C 10 S = (6, 6) F = (16, 16)
D 6 S = (16, 20) F = (22, 26)
E 4 S = (16, 16) F = (20, 20)
I 7 S = (16, 18) F = (23, 25)
G 7 S = (22, 26) F = (29, 33)
F 5 S = (20, 20) F = (25, 25)
J 8 S = (25, 25) F = (33, 33)
H 9 S = (29, 33) F = (38, 42)
K 4 S = (33, 34) F = (37, 38)
L 5 S = (33, 33) F = (38, 38)
M 2 S = (38, 42) F = (40, 44)
N 6 S = (38, 38) F = (44, 44)
FINISH 0 S = (44, 44) F = (44, 44)

Important result: Each activity with **zero slack** is on the **critical path** through the project network such that any delay along this path will delay project completion.

Dealing with uncertainties

Original PERT took uncertainties into account by using three different types of estimates of the duration of an activity. These estimates are defined for each activity as follows

- Optimistic time (*o*): estimation of the shortest time an activity may take
- Pessimistic time (*p*): estimation of the longest time an activity may take
- Most likely time (*m*): the completion time with the highest probability.
- *o*, *m* and *p* follow a ? distribution



Model of the probability of an activity for the PERT three estimate approach

m: most likely estimate
o: optimistic estimate
p: pessimistic estimate

Does the previous graph give you an idea why a distribution is used? Because it is a probability distribution, it is characterized by two things:

Mean value:

$$M = \frac{p + 4m + o}{6}$$

Variance:

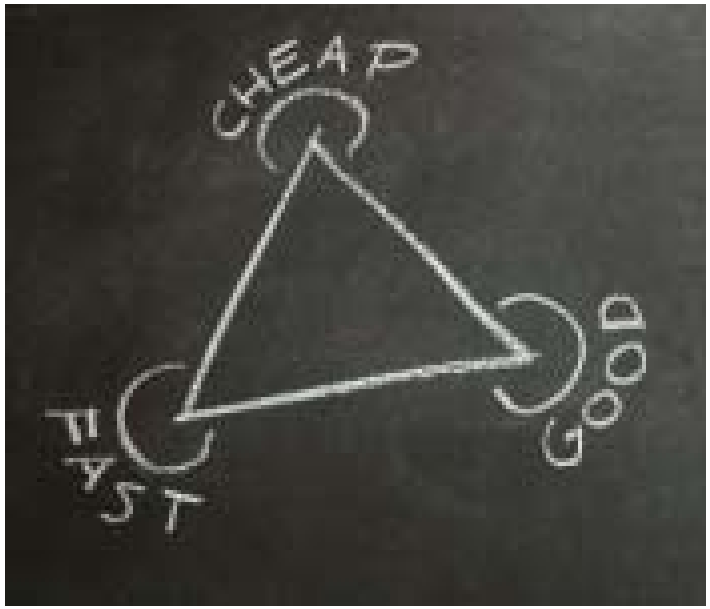
$$\sigma^2 = \frac{(p - o)^2}{6}$$

Estimating time

- Guesstimating:
- Comparative estimation: You look at the time it took to do similar tasks, on other projects.
- Parametric estimation: You estimate the time required for one deliverable; and then multiply it by the number of deliverables required.
- Three-point estimation:

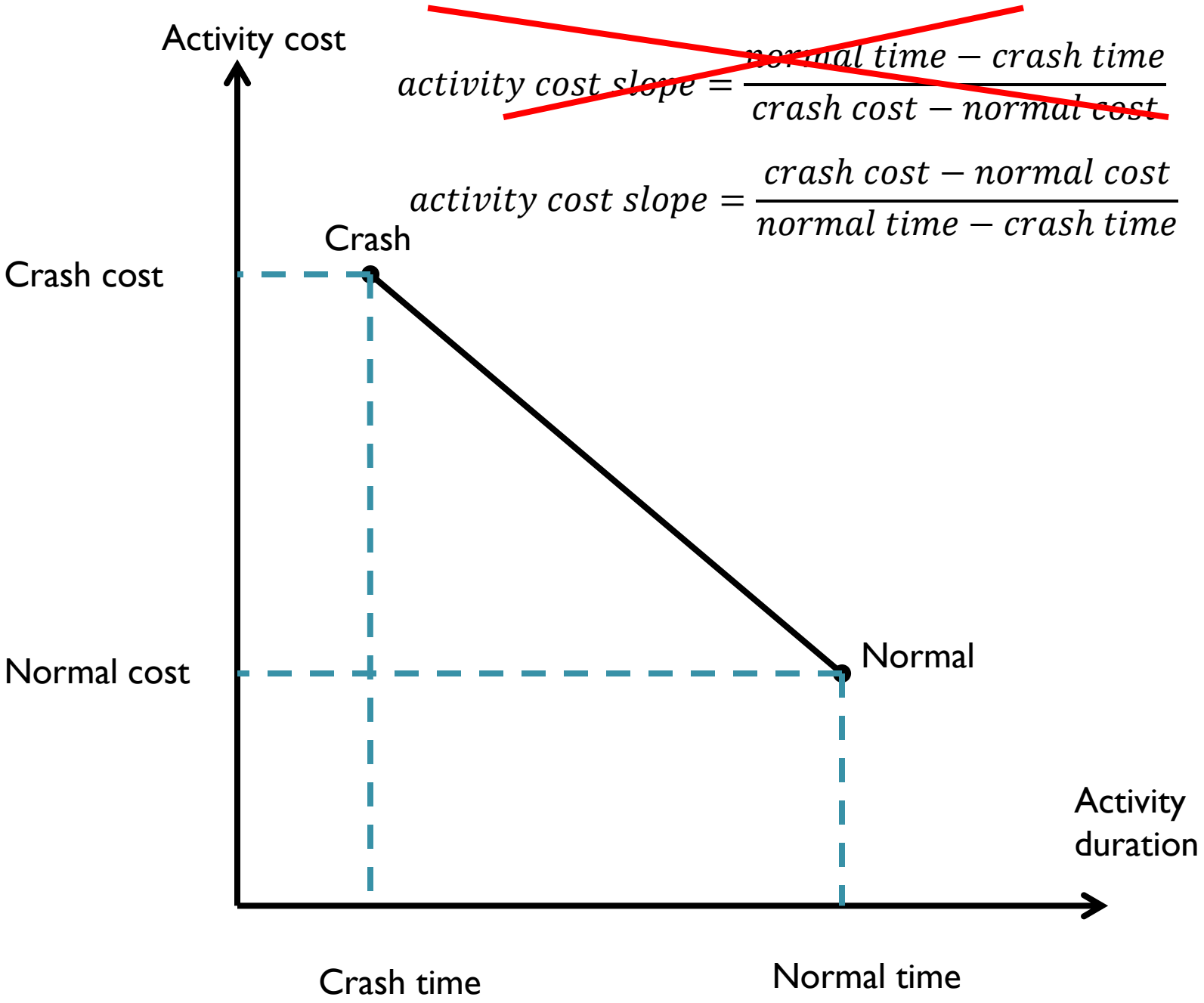
The time-cost trade-offs

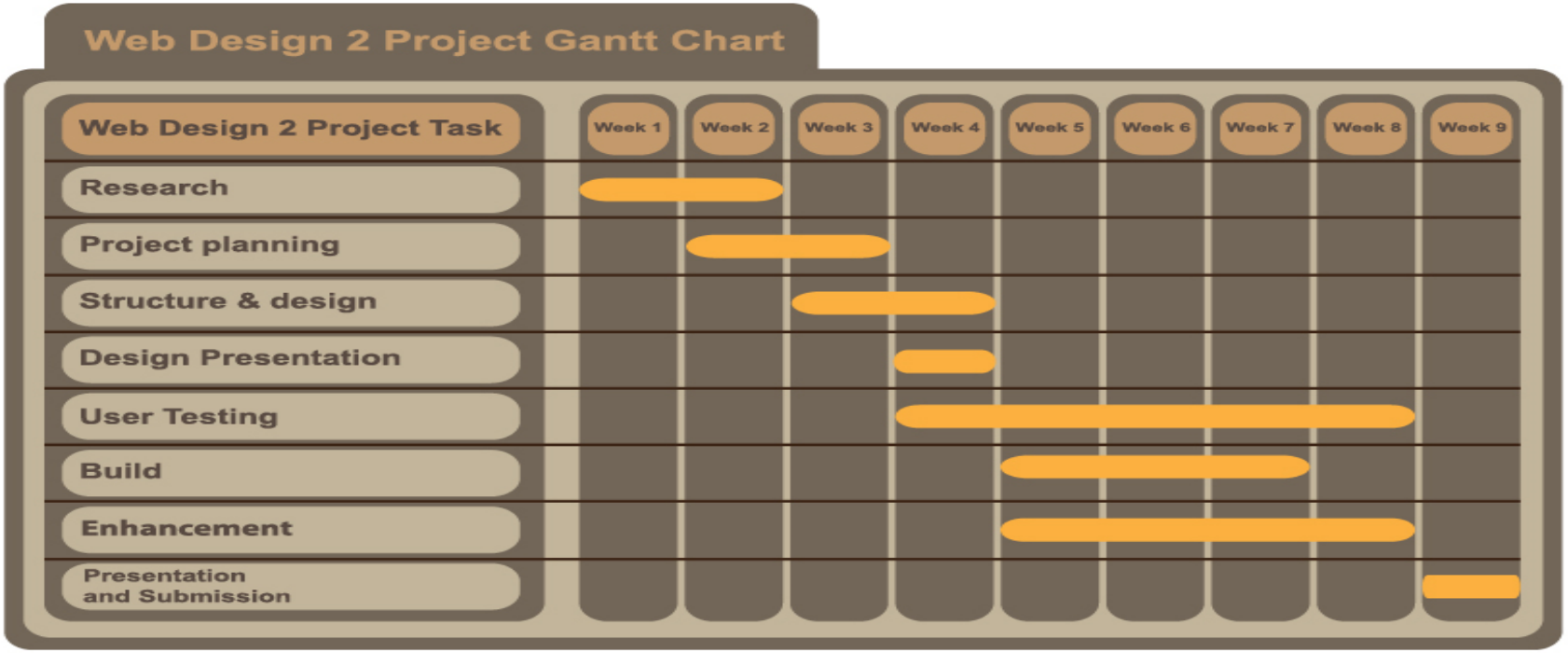
Crashing an activity: refers to taking special costly measures to reduce the duration of an activity below its normal value.



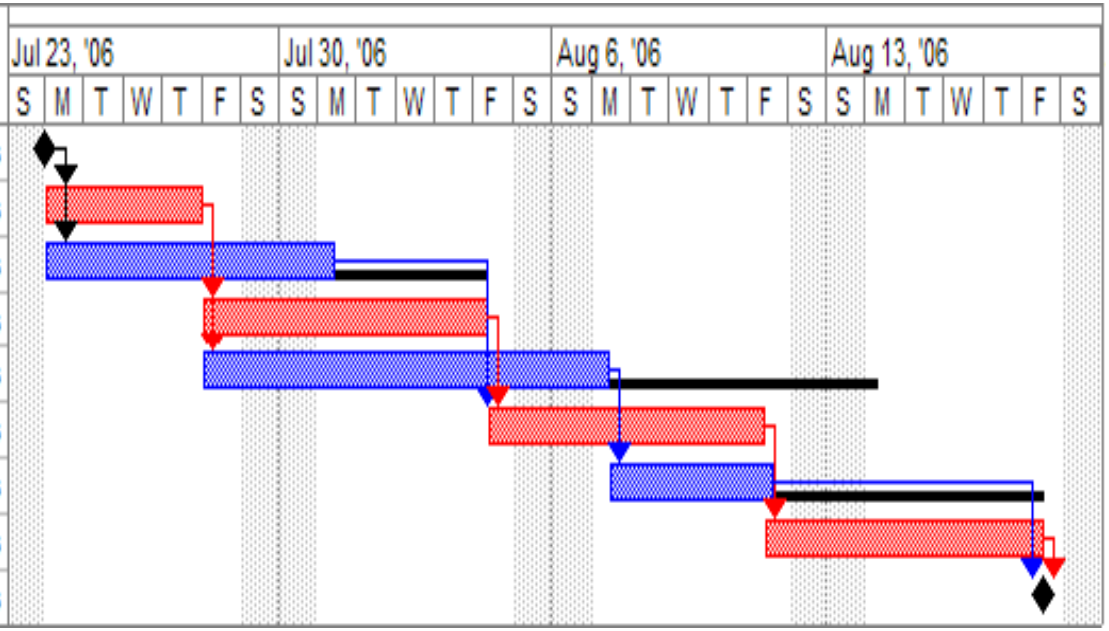
Measures to crash an activity:

- using additional temporary help
- obtaining special equipment
- **working overtime (night, weekend, holidays, etc.)**


Activity cost
$activity\ cost\ slope = \frac{normal\ time - crash\ time}{crash\ cost - normal\ cost}$
$activity\ cost\ slope = \frac{crash\ cost - normal\ cost}{normal\ time - crash\ time}$
Crash
Crash cost
Normal cost
Normal
Activity duration
Crash time
Normal time



ID	Task Name	Predecessors	Duration
1	Start		0 days
2	a	1	4 days
3	b	1	5.33 days
4	c	2	5.17 days
5	d	2	6.33 days
6	e	3,4	5.17 days
7	f	5	4.5 days
8	g	6	5.17 days
9	Finish	7,8	0 days



Conclusion


I'LL NEED A PROJECT PLAN TO JUSTIFY THE RESOURCES WE NEED TO CHANGE OUR SOFTWARE.
www.dilbert.com scottadams@aol.com
I CAN MAKE THOSE SOFTWARE CHANGES IN TEN SECONDS.
DONE.
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GOOD WORK.
NOW ALL WE NEED IS THAT PLAN.