Research Methods
Project Management

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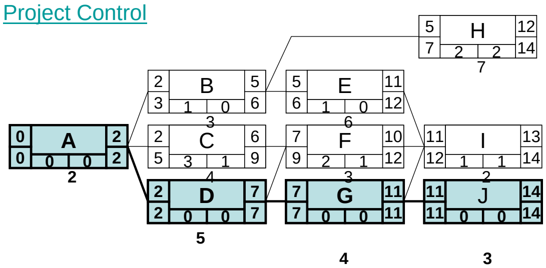
Outline

- **Network Analysis**
- Gantt Charts
- Risk Management
- Project Control


0 A 2
0 0 0 2
2
2 B 5
3 1 0 6
3
2 C 6
5 3 1 9
4
2 D 7
2 0 0 7
5
5 E 11
6 1 0 12
6
7 F 10
9 2 1 12
3
7 G 11
7 0 0 11
4
5 H 12
7 2 2 14
7
11 I 13
12 1 1 14
2
11 J 14
11 0 0 14
3

What is Network Analysis?

- Project tasks (activities):
  - Are often interdependent
  - But need to be done in parallel for teamwork to be effective
- Task networks are graphical depictions of task dependence
- Network analysis is a project planning method that:
  - Determines the critical path
  - Establishes “most likely” time estimates
  - Calculates boundaries to stop project slippage

History of Network Analysis

1958 PERT (Program Evaluation and Review Technique) used in U.S. Navy Polaris Missile Program

1959 CPM (Critical Path Method) devised

1960’s Massive U.S. Government Projects

- Vietnam, Nuclear Power Plants, NASA Apollo
- Required extensive Computer Aided planning and control

Terminology

Earliest Start/Finish

- Earliest a task can begin/end if all preceeding tasks are completed in the shortest time

Latest Start/Finish

- Latest a task can begin/end without delaying the minimum project completion time

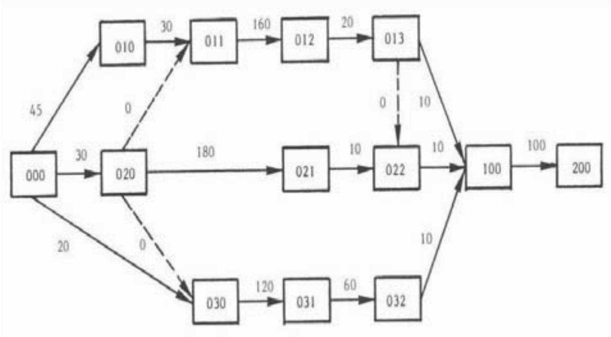
Critical Path

- Chain that determines overall project duration

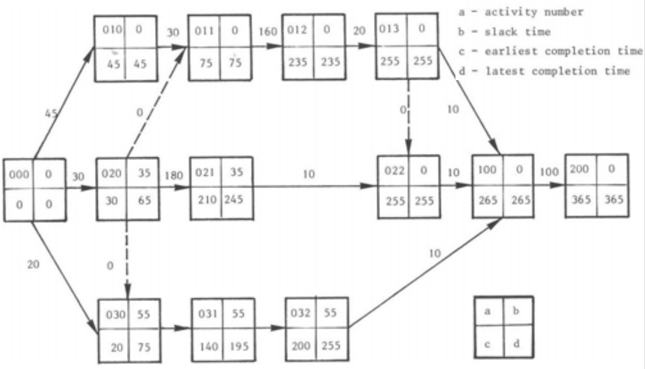
Slack (Float)

- The amount of surplus time or leeway allowed while still maintaining the critical path

Example: Task Network


000
010
011
012
013
020
021
022
030
031
032
100
200
45
30
20
30
160
20
0
180
10
0
10
10
0
10
120
60
100

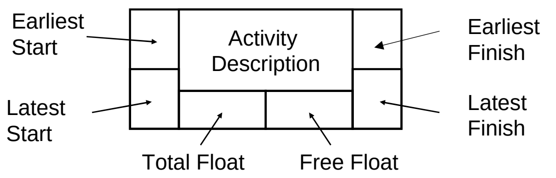
Example: Network Analysis


a - activity number
b - slack time
c - earliest completion time
d - latest completion time
000 0 0 0
010 0 45 45
011 0 75 75
012 0 235 235
013 0 255 255
020 35 30 65
021 35 210 245
022 0 255 255
100 0 265 265
200 0 365 365
030 55 20 75
031 55 140 195
032 55 200 255
45
30
20
0
160
180
10
100
a b c d

Network Analysis

Tasks are shown as boxes

Sequence constraints are lines connecting the boxes



Earliest Start

Activity Description

Earliest Finish

Latest Start

Latest Finish

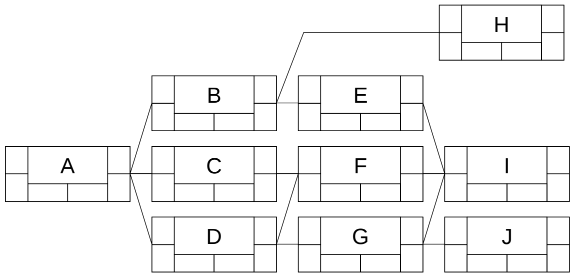
Total Float

Free Float

Analysis: Step #1

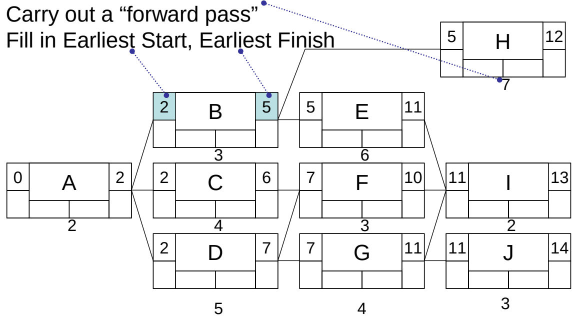
Draw network

- Labelling tasks in order (left to right, top to bottom)


H
B
E
A
C
F
I
D
G
J

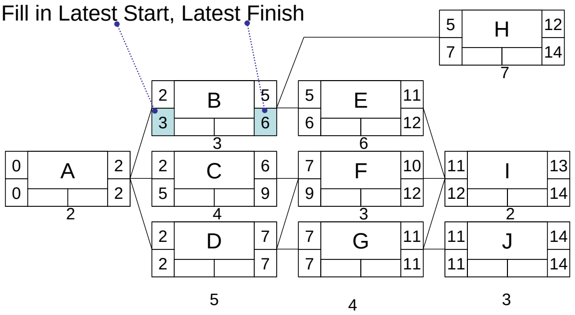
Analysis: Step #2

- Write the estimated time for each activity
- Carry out a "forward pass"
- Fill in Earliest Start, Earliest Finish


5 H 12
7
2 B 5
3
5 E 11
6
0 A 2
2
2 C 6
4
7 F 10
3
11 I 13
2
2 D 7
7 G 11
11 J 14
5
4
3

Analysis: Step #3

- Carry out a "backward pass"
- Fill in Latest Start, Latest Finish


5 H 12
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2 B 5
3 6
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5 E 11
6 12
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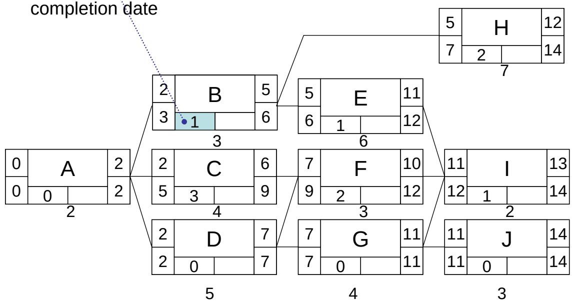
0 2
2
2 C 6
5 9
4
7 F 10
9 12
3
11 I 13
12 14
2
2 D 7
2 7
7 G 11
7 11
11 J 14
11 14
5
4
3

Analysis: Step #4

- Fill in Total Float
  - Time by which an activity may be delayed without affecting the final completion date


5 H 12
7 2 14
7
2 B 5
3 1 6
3
5 E 11
6 1 12
6
0 A 2
0 0 2
2
2 C 6
5 3 9
4
7 F 10
9 2 12
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11 I 13
12 1 14
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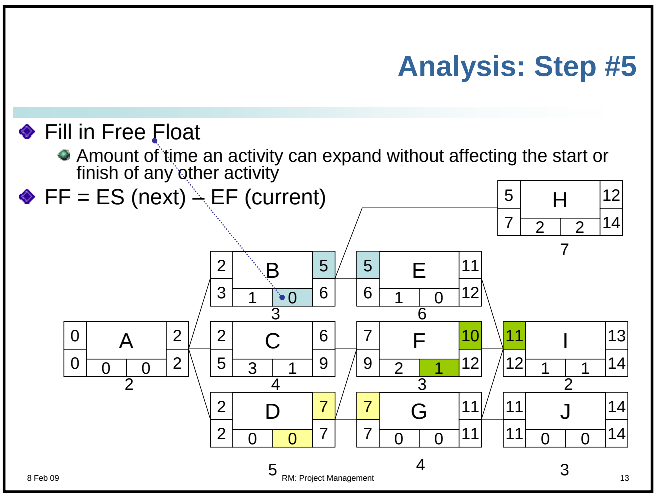
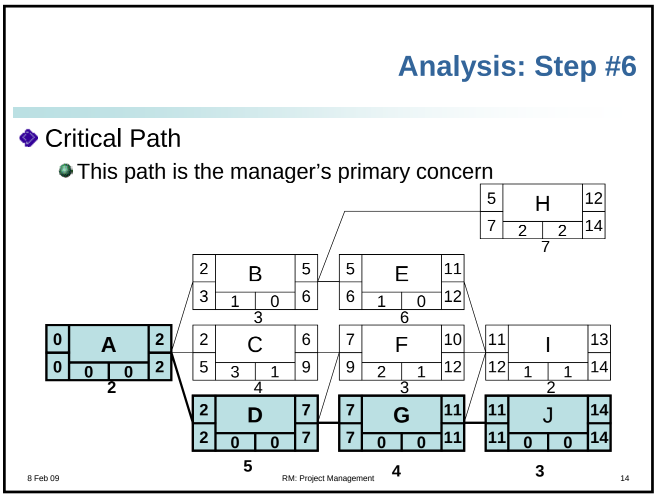
2 D 7
2 0 7
7 G 11
7 0 11
11 J 14
11 0 14
5
4
3



Analysis: Step #5

- Fill in Free Float
  - Amount of time an activity can expand without affecting the start or finish of any other activity
- FF = ES (next) – EF (current)

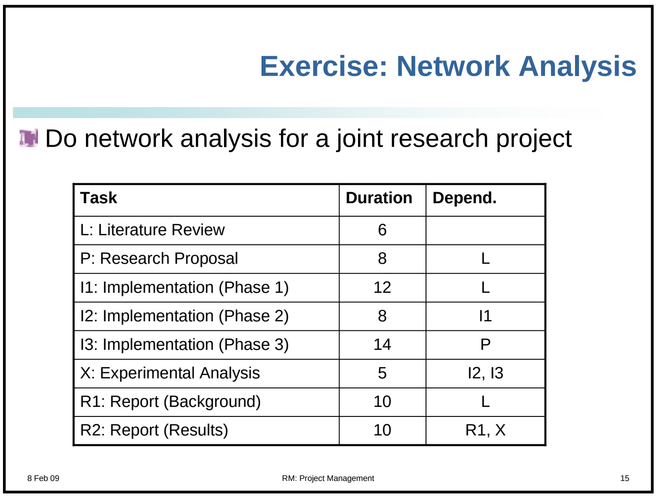
5 | H | 12
7 | 2 | 2 | 14
7
2 | B | 5
3 | 1 | 0 | 6
3
5 | E | 11
6 | 1 | 0 | 12
6
0 | A | 2
0 | 0 | 0 | 2
2
2 | C | 6
5 | 3 | 1 | 9
4
7 | F | 10
9 | 2 | 1 | 12
3
11 | I | 13
12 | 1 | 1 | 14
2
2 | D | 7
2 | 0 | 0 | 7
5
7 | G | 11
7 | 0 | 0 | 11
4
11 | J | 14
11 | 0 | 0 | 14
3



Analysis: Step #6

- Critical Path
  - This path is the manager's primary concern

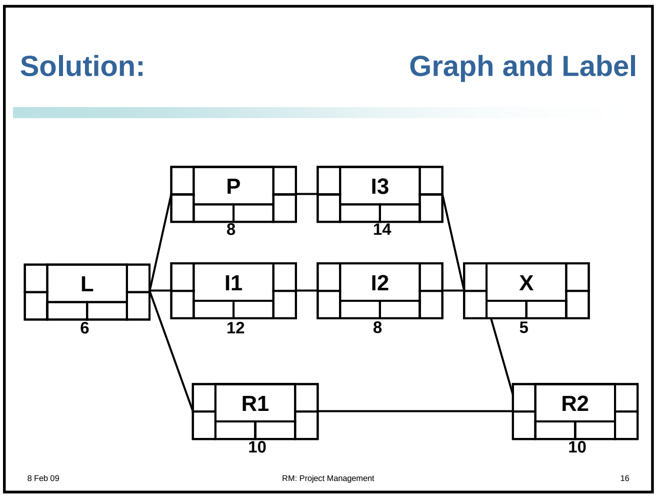
5 | H | 12
7 | 2 | 2 | 14
7
2 | B | 5
3 | 1 | 0 | 6
3
5 | E | 11
6 | 1 | 0 | 12
6
0 | A | 2
0 | 0 | 0 | 2
2
2 | C | 6
5 | 3 | 1 | 9
4
7 | F | 10
9 | 2 | 1 | 12
3
11 | I | 13
12 | 1 | 1 | 14
2
2 | D | 7
2 | 0 | 0 | 7
5
7 | G | 11
7 | 0 | 0 | 11
4
11 | J | 14
11 | 0 | 0 | 14
3



Exercise: Network Analysis

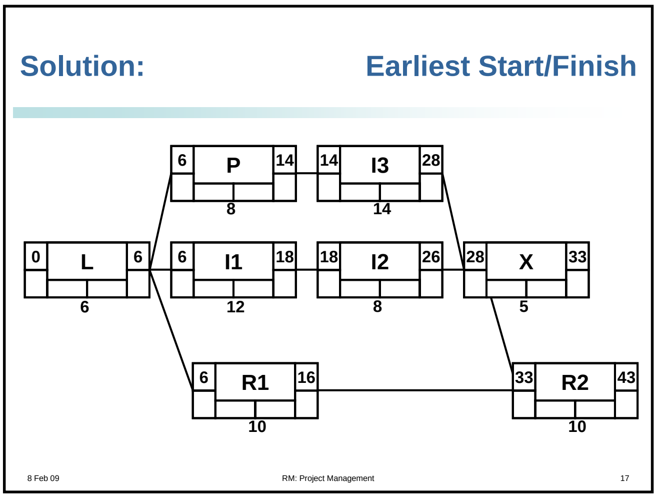
- Do network analysis for a joint research project

Task	Duration	Depend.
L: Literature Review	6	
P: Research Proposal	8	L
I1: Implementation (Phase 1)	12	L
I2: Implementation (Phase 2)	8	I1
I3: Implementation (Phase 3)	14	P
X: Experimental Analysis	5	I2, I3
R1: Report (Background)	10	L
R2: Report (Results)	10	R1, X



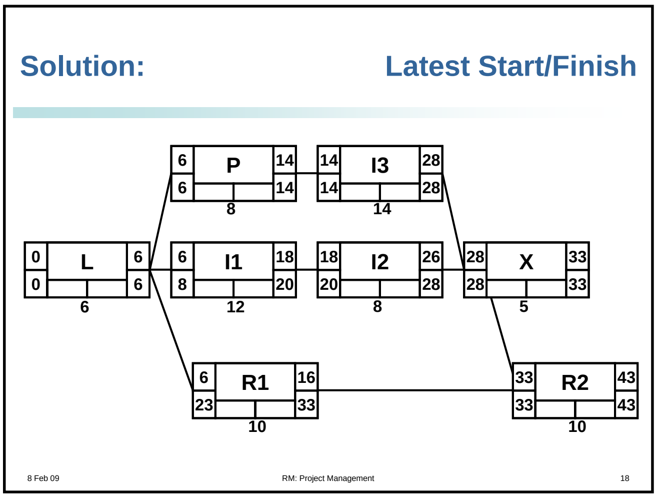
Solution: Graph and Label

P
8
I3
14
L
6
I1
12
I2
8
X
5
R1
10
R2
10



Solution: Earliest Start/Finish

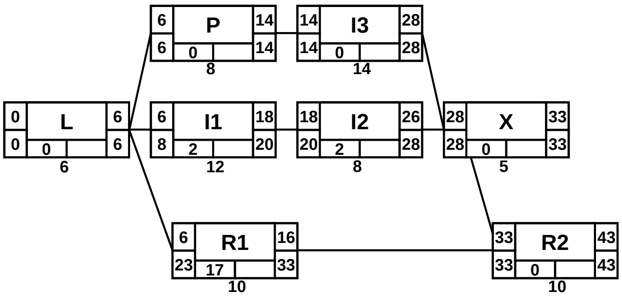
6 | P | 14
8
14 | I3 | 28
14
0 | L | 6
6
6 | I1 | 18
12
18 | I2 | 26
8
28 | X | 33
5
6 | R1 | 16
10
33 | R2 | 43
10



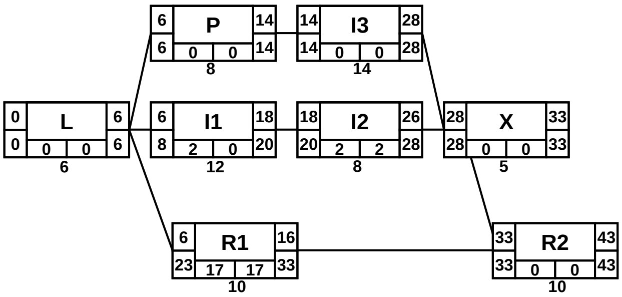
Solution: Latest Start/Finish

6 | P | 14
6 | 14
8
14 | I3 | 28
14 | 28
14
0 | L | 6
0 | 6
6
6 | I1 | 18
8 | 20
12
18 | I2 | 26
20 | 28
8
28 | X | 33
28 | 33
5
6 | R1 | 16
23 | 33
10
33 | R2 | 43
33 | 43
10

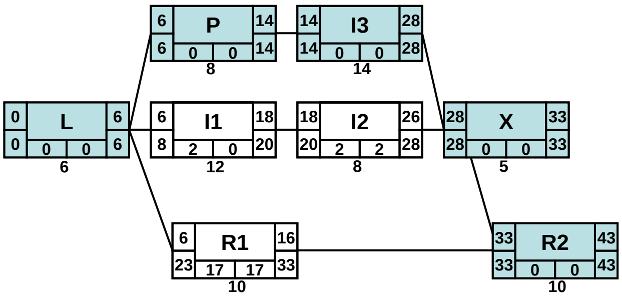
Solution: Total Float


6 P 14
6 0 14
8
14 I3 28
14 0 28
14
0 L 6
0 0 6
6
6 I1 18
8 2 20
12
18 I2 26
20 2 28
8
28 X 33
28 0 33
5
6 R1 16
23 17 33
10
33 R2 43
33 0 43
10

Solution: Free Float


6 P 14
6 0 0 14
8
14 I3 28
14 0 0 28
14
0 L 6
0 0 0 6
6
6 I1 18
8 2 0 20
12
18 I2 26
20 2 2 28
8
28 X 33
28 0 0 33
5
6 R1 16
23 17 17 33
10
33 R2 43
33 0 0 43
10

Solution: Critical Path


6 P 14
6 0 0 14
8
14 I3 28
14 0 0 28
14
0 L 6
0 0 0 6
6
6 I1 18
8 2 0 20
12
18 I2 26
20 2 2 28
8
28 X 33
28 0 0 33
5
6 R1 16
23 17 17 33
10
33 R2 43
33 0 0 43
10

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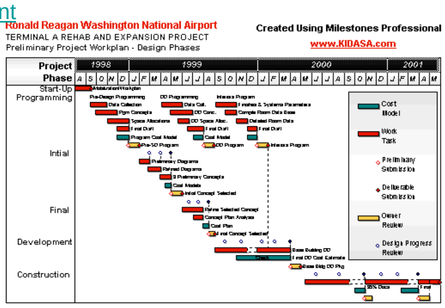
- **Gantt Charts**
- Risk Management
- Project Control



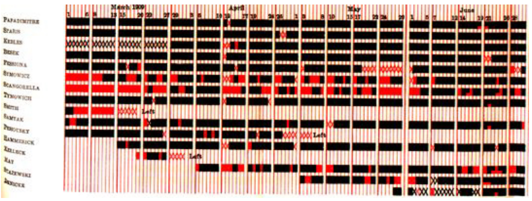
History of Gantt Charts

Developed by Henry L. Gantt in 1917

Widely used for WW1 ship building

Below: an early precursor (1910) showing productivity of workers in a sewing factory

- Red = idle, black = productive



Gantt Charts

Horizontal Bar Charts:

- Horizontal axis represents project time span
- Vertical axis represent project tasks

Capture:

- Task completion
- Simple dependencies
- Milestones and Deliverables

Don’t handle complex task dependencies

Extensively supported by automated scheduling tools

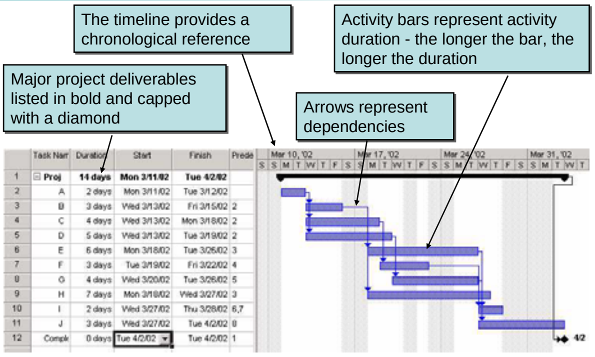
- E.g., Microsoft Project

Milestones and Deliverables

Milestone:
- Recognisable end-product of a task
- Requires a formal, measurable output
- “Coding 80% complete” is not adequate

Deliverable:
- A project result that is delivered to the customer (supervisor)
- Milestones are not always deliverables. Can be internal

Before Project



The timeline provides a chronological reference

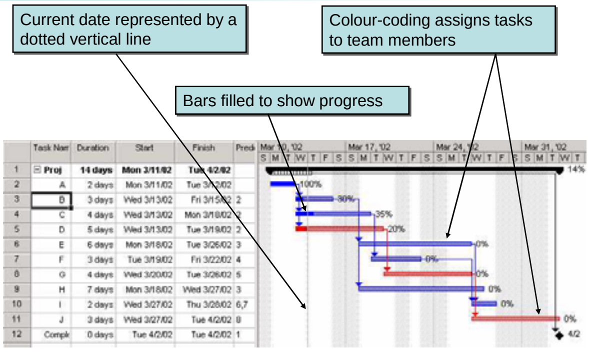
Activity bars represent activity duration - the longer the bar, the longer the duration

Major project deliverables listed in bold and capped with a diamond

Arrows represent dependencies

	Task Nam	Duration	Start	Finish	Prede
1	**Proj**	**14 days**	**Mon 3/11/02**	**Tue 4/2/02**	
2	A	2 days	Mon 3/11/02	Tue 3/12/02	
3	B	3 days	Wed 3/13/02	Fri 3/15/02	2
4	C	4 days	Wed 3/13/02	Mon 3/18/02	2
5	D	5 days	Wed 3/13/02	Tue 3/19/02	2
6	E	6 days	Mon 3/18/02	Tue 3/26/02	3
7	F	3 days	Tue 3/19/02	Fri 3/22/02	4
8	G	4 days	Wed 3/20/02	Tue 3/26/02	5
9	H	7 days	Mon 3/18/02	Wed 3/27/02	3
10	I	2 days	Wed 3/27/02	Thu 3/28/02	6,7
11	J	3 days	Wed 3/27/02	Tue 4/2/02	8
12	Comple	0 days	Tue 4/2/02	Tue 4/2/02	1

During Project



Current date represented by a dotted vertical line

Colour-coding assigns tasks to team members

Bars filled to show progress

	Task Nam	Duration	Start	Finish	Predi
1	**Proj**	**14 days**	**Mon 3/11/02**	**Tue 4/2/02**	
2	A	2 days	Mon 3/11/02	Tue 3/12/02	
3	B	3 days	Wed 3/13/02	Fri 3/15/02	2
4	C	4 days	Wed 3/13/02	Mon 3/18/02	2
5	D	5 days	Wed 3/13/02	Tue 3/19/02	2
6	E	6 days	Mon 3/18/02	Tue 3/26/02	3
7	F	3 days	Tue 3/19/02	Fri 3/22/02	4
8	G	4 days	Wed 3/20/02	Tue 3/26/02	5
9	H	7 days	Mon 3/18/02	Wed 3/27/02	3
10	I	2 days	Wed 3/27/02	Thu 3/28/02	6,7
11	J	3 days	Wed 3/27/02	Tue 4/2/02	8
12	Compl	0 days	Tue 4/2/02	Tue 4/2/02	1

Outline

- Network Analysis
- Gantt Charts
- **Risk Management**
- Project Control

AN EXPERIMENTAL BURGER AND FRIES HAS BROKEN OUT OF THE CONTAINMENT FACILITY!! IT'S ACCOMPANIED BY A MEDIUM COKE AND/OR PEPSI!!
GOD HELP US ALL...

1964, the height of the cold war. In an average community surrounding a little-known biological warfare institute, the obesity epidemic is quietly unleashed.

Managing Research Risks

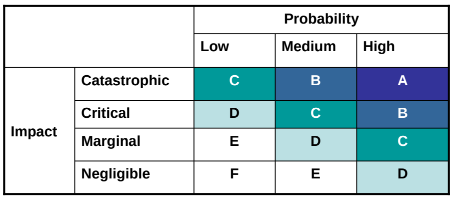
- Why?
  - Research projects have a high level of uncertainty
  - Better to anticipate problems in advance
- How?
  - Identify specific risks to the project
  - Analyze the risks
  - Rank them in a particular order
  - Plan for monitoring, mitigation, management
  - Revisit during project

Some Typical Research Risks

- Solving the wrong problem
- Trying to hit a moving target
- Difficulties with data collection
- Overlooking previous work
- Being blindsided by the competition
- Misinterpreting results
- Contravening research conventions
- Outside interruptions (e.g., ill-health)

Risk Matrix

- Sort risk by a combination of:
  - Probability (high, medium, low)
  - Impact - catastrophic (project failure), critical (massive delay), marginal, negligible



		Probability		
		Low	Medium	High
Impact	Catastrophic	C	B	A
	Critical	D	C	B
	Marginal	E	D	C
	Negligible	F	E	D

3M’s

- Mitigation:
  - How can we avoid or reduce the risk?
- Monitoring:
  - What factors can we track that will enable us to determine if the risk is becoming more or less likely?
- Management:
  - What contingency plans do we have if the risk becomes a reality

Risk Examples I

- Turnover in research programmers

Risk Condition	Consequence	Mitigation	Monitoring	Management	Up-date
High turnover in programmers	Costs and delays in replacing, loss of knowledge capital	Performance incentives, SE procedures to distribute knowledge	Six monthly employee reviews	Recruit replacement, transfer skills once notice given	…

Risk Examples II

- Postgraduate students fail to meet research objectives

Risk Condition	Consequence	Mitigation	Monitoring	Management	Up-date
Students fail to complete research	Delays while alternative research is undertaken	Memorandum of understanding, research proposal	Regular supervision& monthly presentations	Reallocate research to post-docs or staff	…

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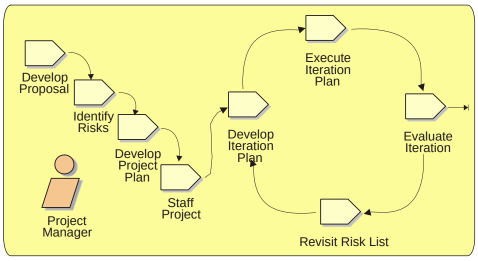
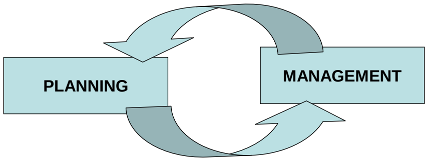
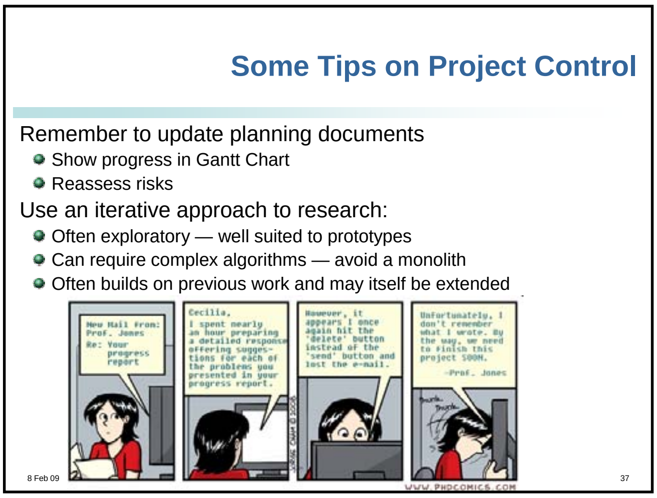

Develop Proposal
Identify Risks
Develop Project Plan
Staff Project
Project Manager
Develop Iteration Plan
Execute Iteration Plan
Evaluate Iteration
Revisit Risk List

Planning vs. Management

- Planning
  - Pre- and post-
  - Network analysis, resourcing, risks, schedule
- Management
  - During
  - Controlling resources and timescales


PLANNING
MANAGEMENT



Some Tips on Project Control

Remember to update planning documents

- Show progress in Gantt Chart
- Reassess risks

Use an iterative approach to research:

- Often exploratory — well suited to prototypes
- Can require complex algorithms — avoid a monolith
- Often builds on previous work and may itself be extended

New Mail From: Prof. Jones
Re: Your progress report
Cecilia, I spent nearly an hour preparing a detailed response offering suggestions for each of the problems you presented in your progress report.
However, it appears I once again hit the 'delete' button instead of the 'send' button and lost the e-mail.
Unfortunately, I don't remember what I wrote. By the way, we need to finish this project SOON. -Prof. Jones
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