SGS 4613 REMOTE SENSING PROJECT MANAGEMENT

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Topic 6

Allocating Resources to the Project

Introduction

- **Projects Compete With One Another for Resources**
  - resources that are not consumed
  - resources that are consumed
- **Goal of Resource Allocation is to Optimize Use of Limited Supply**
- **Requires making trade-offs**
  - time constrained
  - resource constrained

EXPEDITING A PROJECT

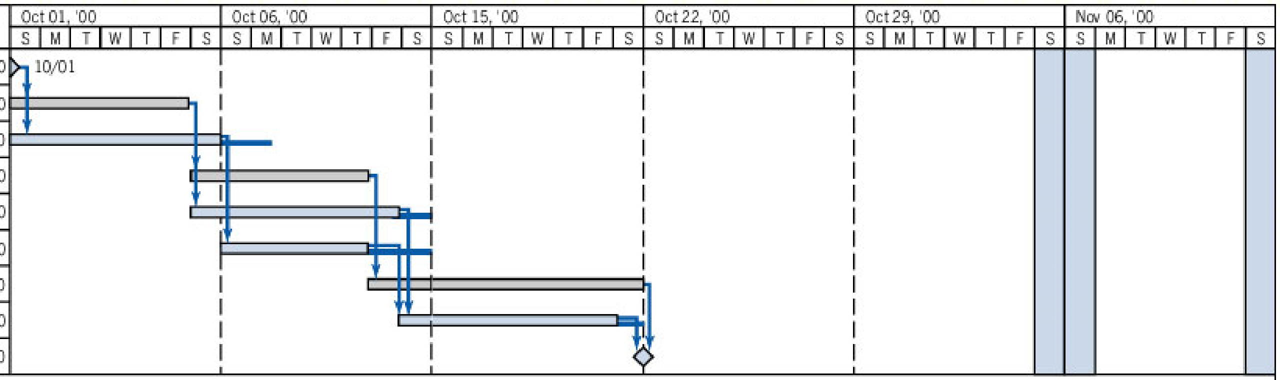
The Critical Path Method (CPM)

- **Normal Duration Estimates**
- **Normal Costs**
- **Crash Duration Estimates**
- **Crash Costs**
- **Crash Cost Per Day**

$$\frac{\text{Normal Duration - Crash Duration}}{\text{Crash Cost - Normal Cost}}$$

Gantt Chart Crash Problem -- 21-Day Project

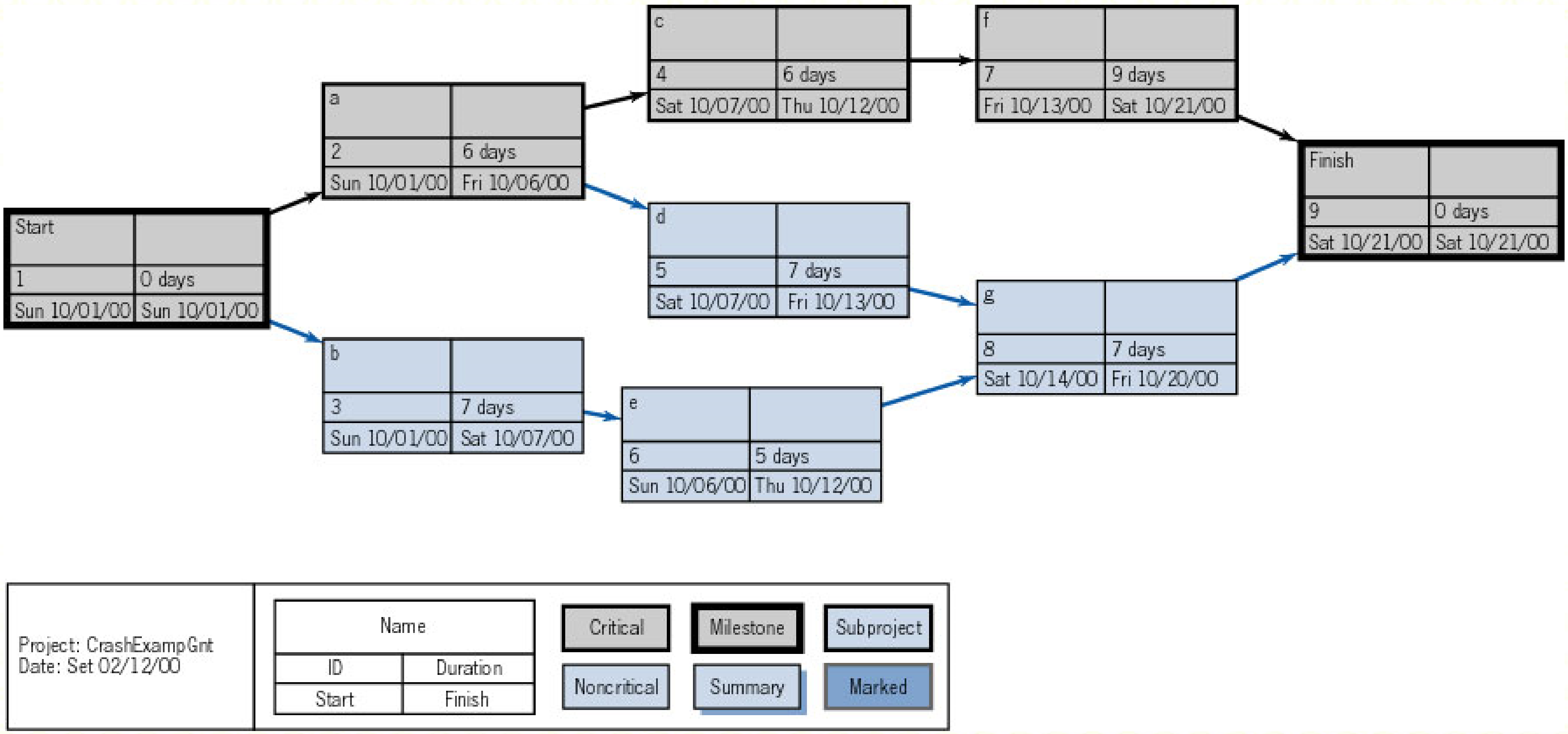
ID	Task Name	Duration	Prede	Start	Finish
1	Start	0 days		Sun 10/01/00	Sun 10/01/00
2	a	6 days	1	Sun 10/01/00	Fri 10/06/00
3	b	7 days	1	Sun 10/01/00	Sat 10/07/00
4	c	6 days	2	Sat 10/07/00	Thu 10/12/00
5	d	7 days	2	Sat 10/07/00	Fri 10/13/00
6	e	5 days	3	Sun 10/06/00	Thu 10/12/00
7	f	9 days	4	Fri 10/13/00	Sat 10/21/00
8	g	7 days	5, 6	Sat 10/14/00	Fri 10/20/00
9	Finish	0 days	7, 8	Sat 10/21/00	Sat 10/21/00



Project: CrashExampGnt
Date: Sat 02/12/00

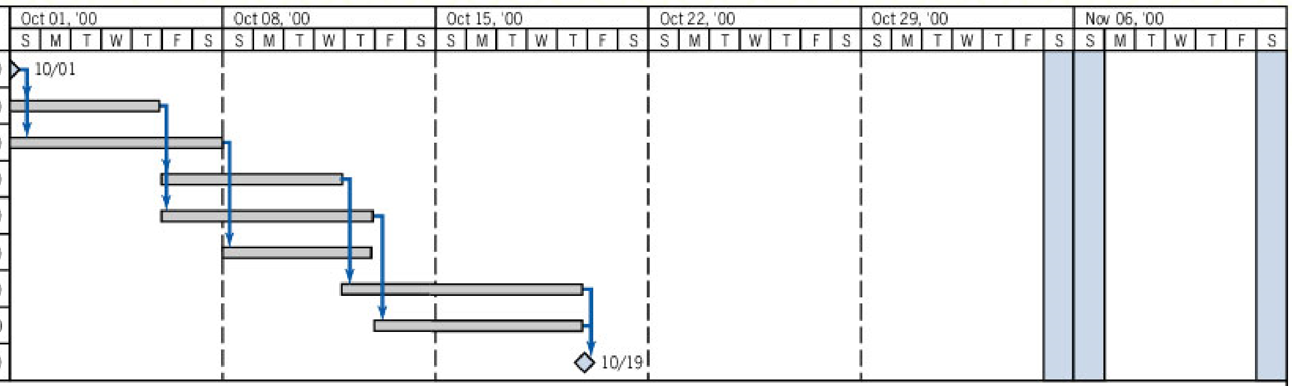
Task
Critical task
Stack
Milestone

AON Network for Sample Crash Problem -- 21-Day Project



Gantt Chart for 20-Day Solution to Crash Problem

ID	Task Name	Duration	Prede	Start	Finish
1	Start	0 days		Sun 10/01/00	Sun 10/01/00
2	a	5 days	1	Sun 10/01/00	Thu 10/05/00
3	b	7 days	1	Sun 10/01/00	Sat 10/07/00
4	c	6 days	2	Fri 10/06/00	Wed 10/11/00
5	d	7 days	2	Fri 10/06/00	Thu 10/12/00
6	e	5 days	3	Sun 10/06/00	Thu 10/12/00
7	f	8 days	4	Thu 10/12/00	Thu 10/19/00
8	g	7 days	5, 6	Fri 10/13/00	Thu 10/19/00
9	Finish	0 days	7, 8	Fri 10/19/00	Thu 10/19/00

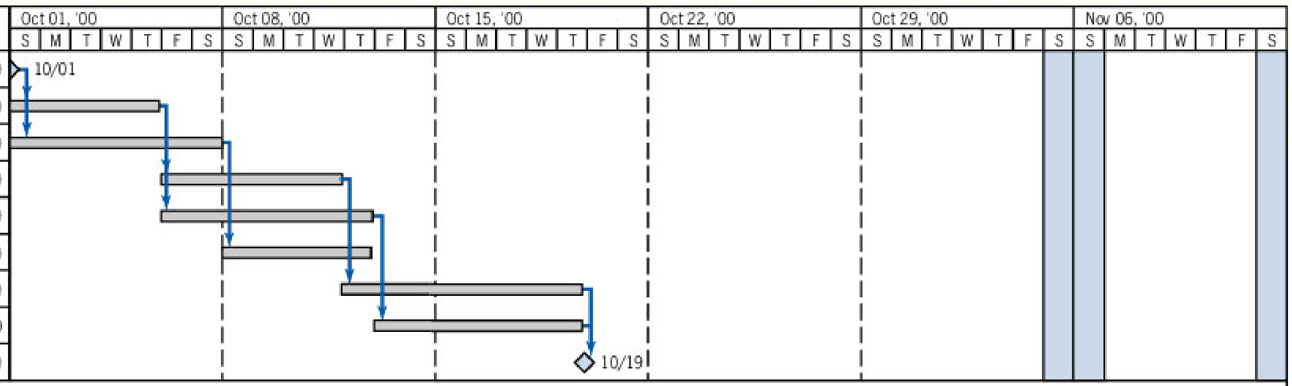


Project: CrashExampGnt
Date: Sat 02/12/00

Task
Critical task
Stack
Milestone

Gantt Chart for 19-Day Solution to Crash Problem

ID	Task Name	Duration	Prede	Start	Finish
1	Start	0 days		Sun 10/01/00	Sun 10/01/00
2	a	5 days	1	Sun 10/01/00	Thu 10/05/00
3	b	7 days	1	Sun 10/01/00	Sat 10/07/00
4	c	6 days	2	Fri 10/06/00	Wed 10/11/00
5	d	7 days	2	Fri 10/06/00	Thu 10/12/00
6	e	5 days	3	Sun 10/06/00	Thu 10/12/00
7	f	8 days	4	Thu 10/12/00	Thu 10/19/00
8	g	7 days	5, 6	Fri 10/13/00	Thu 10/19/00
9	Finish	0 days	7, 8	Fri 10/19/00	Thu 10/19/00

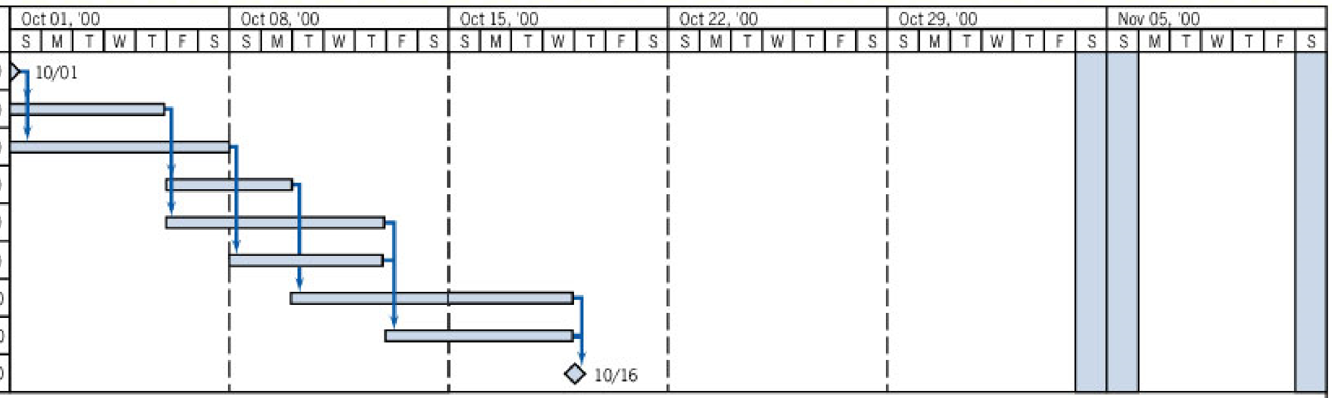


Project: CrashExampGnt
Date: Sat 02/12/00

Task
Critical task
Stack
Milestone

Gantt Chart for 18-Day Solution to Crash Problem

ID	Task Name	Duration	Prede	Start	Finish
1	Start	0 days		Sun 10/01/00	Sun 10/01/00
2	a	5 days	1	Sun 10/01/00	Thu 10/05/00
3	b	7 days	1	Sun 10/01/00	Sat 10/07/00
4	c	4 days	2	Fri 10/06/00	Mon 10/09/00
5	d	7 days	2	Fri 10/06/00	Thu 10/12/00
6	e	5 days	3	Sun 10/06/00	Thu 10/12/00
7	f	9 days	4	Thu 10/10/00	Wed 10/18/00
8	g	6 days	5, 6	Fri 10/13/00	Wed 10/18/00
9	Finish	0 days	7, 8	Wed 10/18/00	Wed 10/18/00

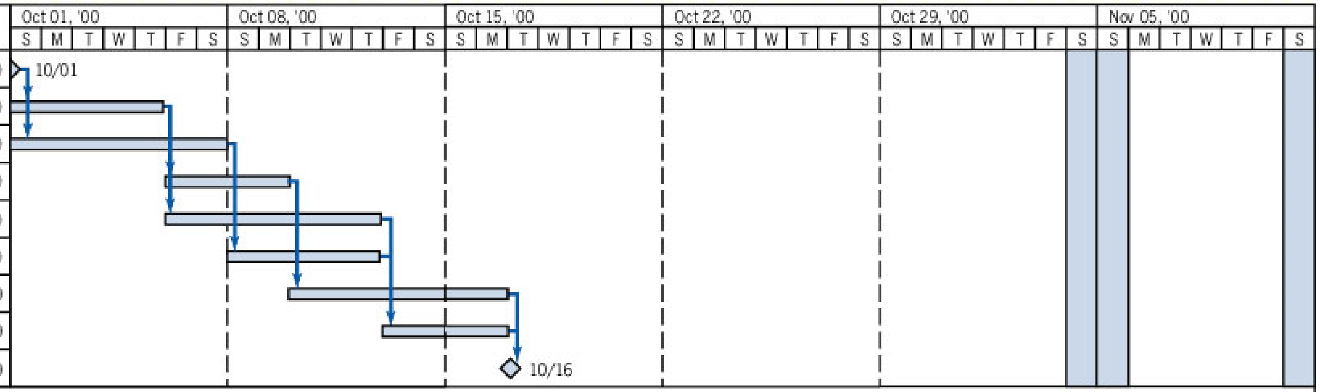


Project: CrashExampGnt
Date: Sat 02/12/00

Task | Critical task | Stack | Milestone

Gantt Chart for 16-Day Solution to Crash Problem

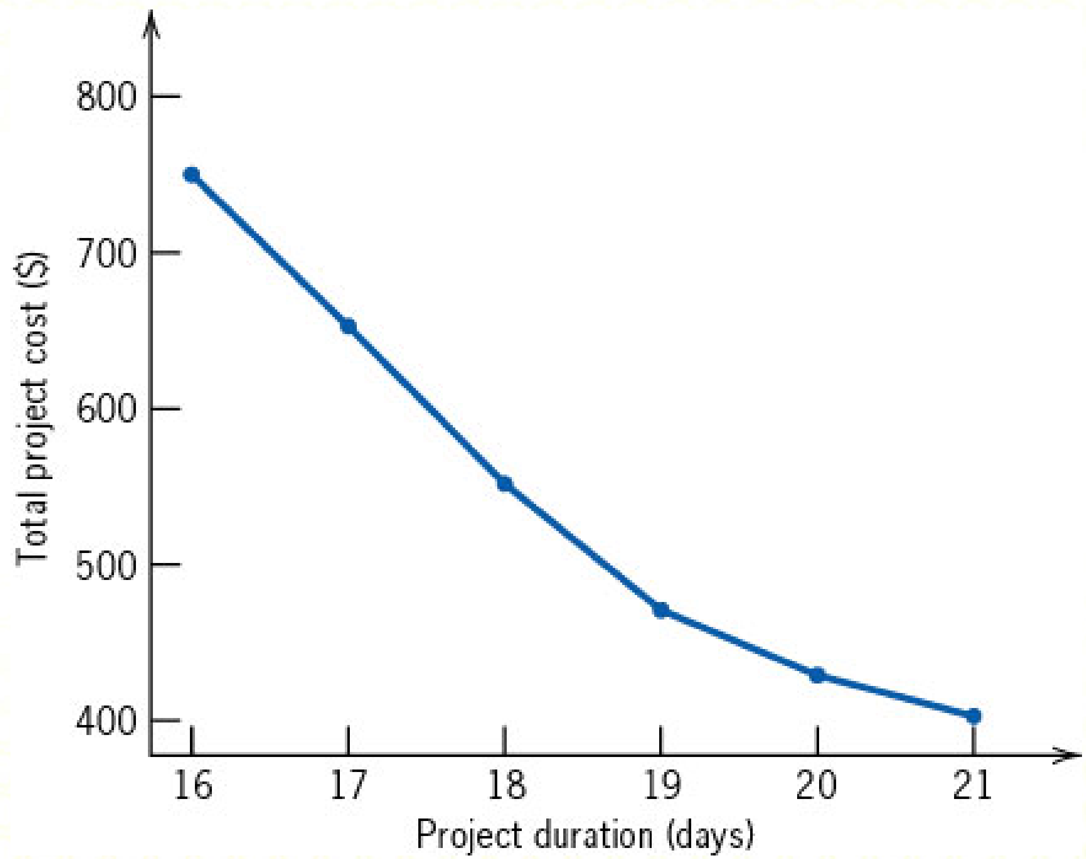
ID	Task Name	Duration	Prede	Start	Finish
1	Start	0 days		Sun 10/01/00	Sun 10/01/00
2	a	5 days	1	Sun 10/01/00	Thu 10/05/00
3	b	7 days	1	Sun 10/01/00	Sat 10/07/00
4	c	4 days	2	Fri 10/06/00	Mon 10/09/00
5	d	7 days	2	Fri 10/06/00	Thu 10/12/00
6	e	5 days	3	Sun 10/06/00	Thu 10/12/00
7	f	7 days	4	Thu 10/10/00	Mon 10/16/00
8	g	4 days	5, 6	Fri 10/13/00	Mon 10/16/00
9	Finish	0 days	7, 8	Mon 10/16/00	Mon 10/16/00



Project: CrashExampGnt
Date: Sat 02/12/00

Task
Critical task
Stack
Milestone

Project Cost Versus Project Duration for Sample Crash Problem



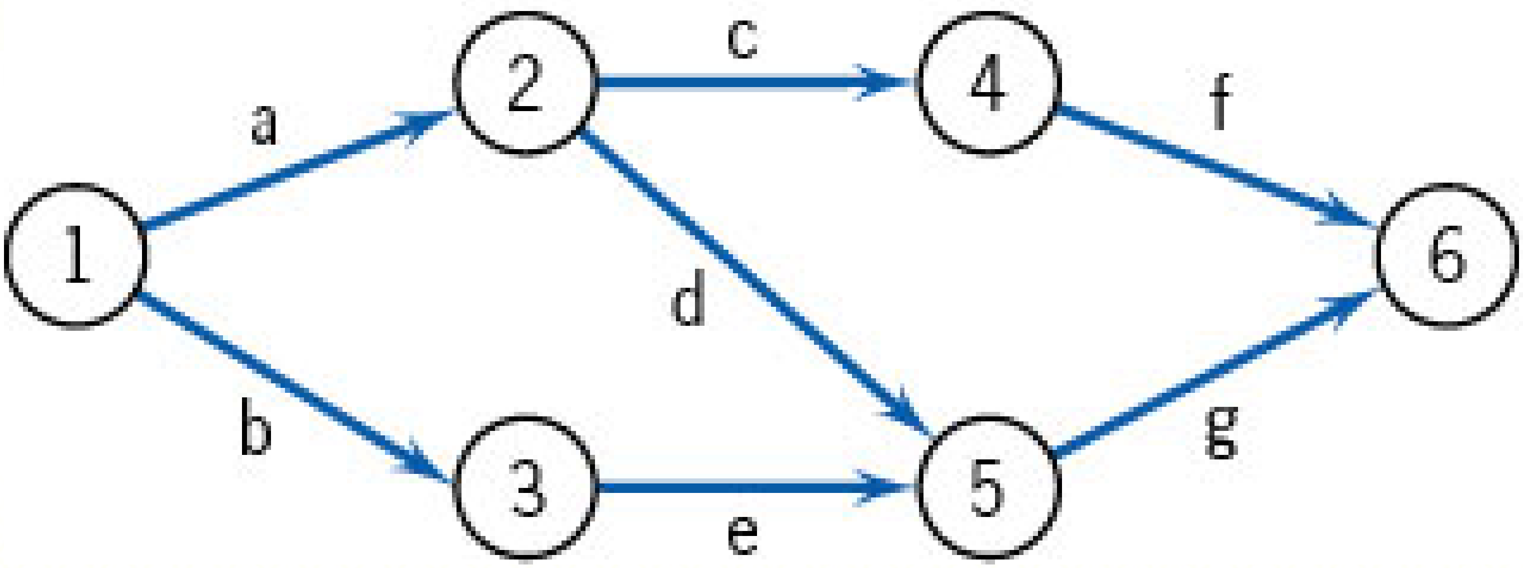
Probabilistic Activity Durations

- Three time estimates made for both normal resource loading and crash resource loading
- Variance of normal activity may be different than variance of crash time

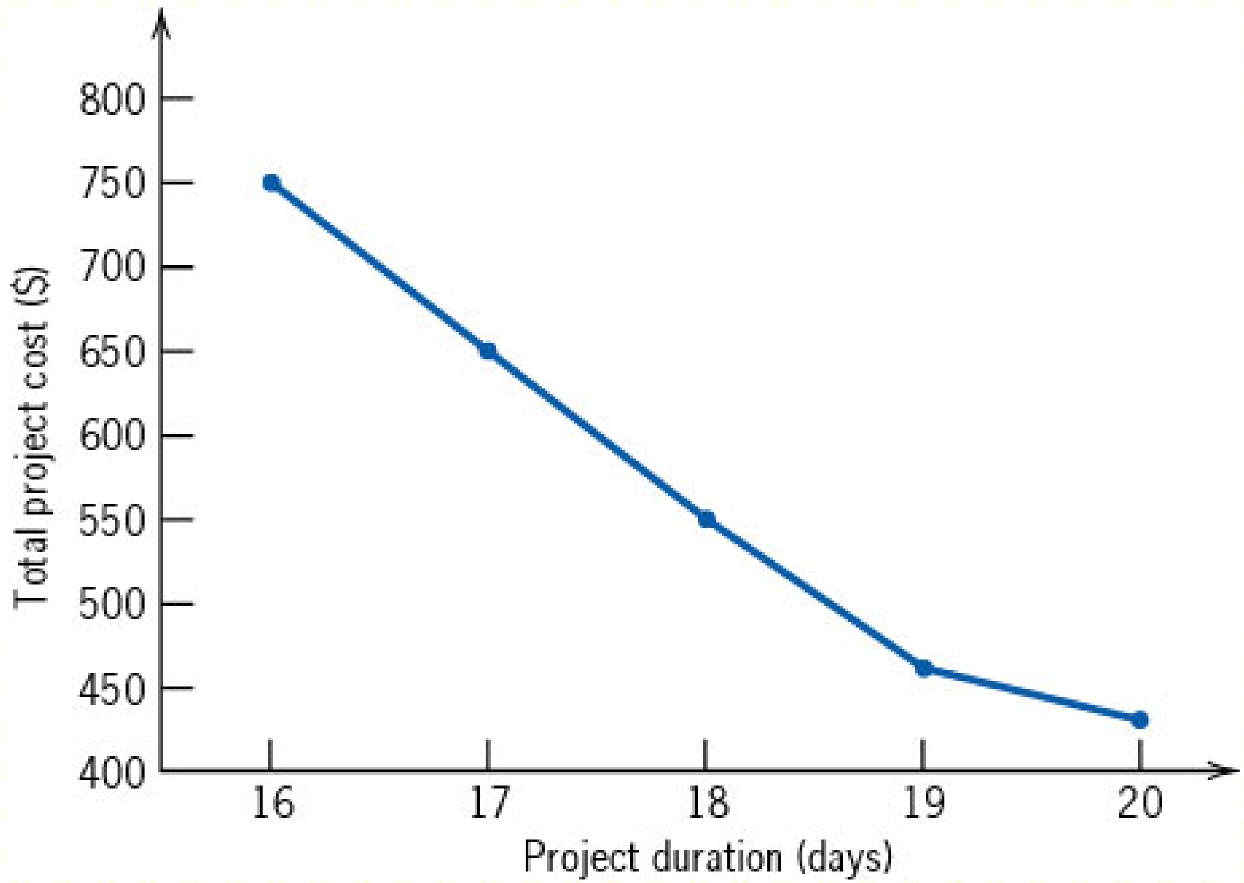
Using Excel's Solver to Crash a Project

- **Target Cell**
  - minimize crashing costs
- **By Changing Cells**
  - amount to crash activities
  - time events occur
- **Constraints**
  - amount each activity can be crashed
  - precedence relationships
  - complete project by specified time
  - nonnegativity

AOA Network of Sample "Crash" Problem



Cost/Duration Graph for Sample Crashing Project



Fast-Tracking a Project

- Used Primarily in Construction Industry
- Building phase started before design and planning phases completed
- Particularly appropriate when large proportion of work is routine

RESOURCE LOADING

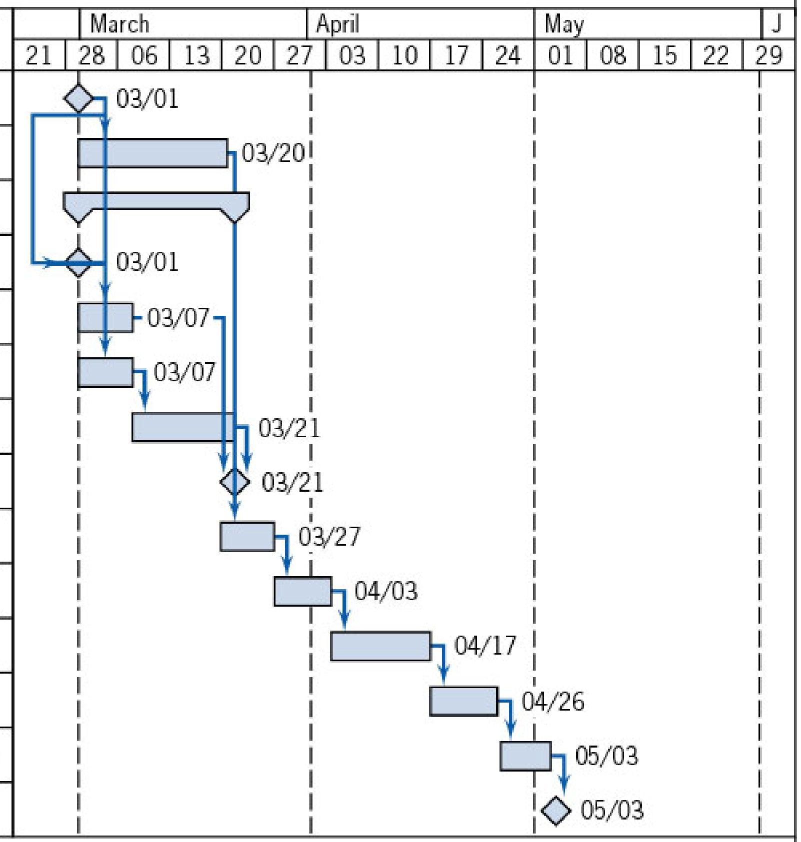
Resource Loading

- **Amount of specific resources that are scheduled for use on specific activities or projects at specific times.**
- **Usually a list or table.**

Action Plan and Gantt Chart for Production of a Videotape

Producing a Videotape
A.J. Lucas

WBS	Task Name	Duration	Resource Names
1	Project approval	0 days	
2	Scriptwriting	14 days	Scriptwriter
3	Schedule shoots	15 days	
3.1	Begin scheduling	0 days	
3.2	Propose shoots	5 days	Producer, client, scriptwriter
3.3	Hire secretary	5 days	Producer
3.4	Scheduling shoots	10 days	Secretary
3.5	Scheduling complete	0 days	
4	Script approval	5 days	Client, producer
5	Revise script	5 days	Scriptwriter, producer
6	Shooting	10 days	Scriptwriter, production staff
7	Editing	7 days	Editor, editing staff, editing room
8	Final approval	5 days	Client, producer, editor, editing room
9	Deliver video to client	0 days	



Start date: 03/01
Finish date: 05/03

Task | Milestone | Summary

The Charismatic VP

- Subordinates have hard time saying no to well liked boss.
- Leads to overcommitted subordinates.
- Problem further compounded because more experienced workers tend to be most over worked.
- One solution is to set specific limits on amount of overscheduling permitted.

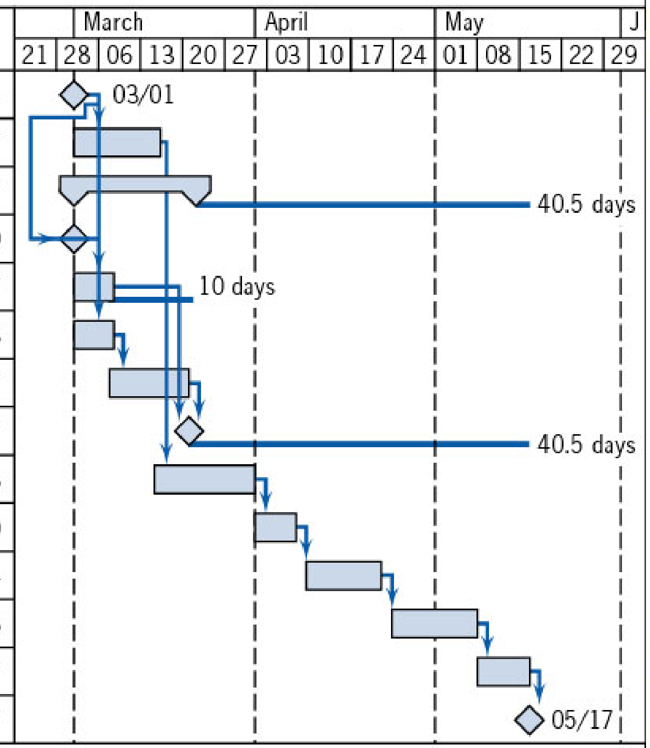
RESOURCE LEVELING

Gantt Chart for Videotape Project, Adjusted for Client Availability

Revised start date: 03/01
Revised finish date: 05/17

Producing a Videotape

WBS	Task Name	Adj. Duration	Start	Finish	Late Start	Late Finish
1	Project approval	0 days	03/01	03/01	03/11	03/11
2	Scriptwriting	14 days	03/01	03/15	03/11	03/27
3	Schedule shoots	15 days	03/01	03/21	04/26	05/17
3.1	Begin scheduling	0 days	03/01	03/01	05/10	05/10
3.2	Propose shoots	6.5 days	03/01	03/07	05/10	05/17
3.3	Hire secretary	5 days	03/01	03/07	04/26	05/03
3.4	Schedule shoots	10 days	03/08	03/21	05/03	05/17
3.5	Scheduling complete	0 days	03/21	03/21	05/17	05/17
4	Script approval	10 days	03/15	03/31	03/27	04/03
5	Revise script	6.63 days	03/31	04/07	04/03	04/10
6	Shooting	10 days	04/10	04/21	04/10	04/24
7	Editing	10.06 days	04/24	05/08	04/24	05/08
8	Final approval	7.19 days	05/08	05/07	05/08	05/17
9	Deliver video to client	0 days	05/17	05/17	05/17	05/17



Slack shown

Task | Milestone | Slippage
Split | Slack | Summary

Adjusted for resource availability

Resource Overallocation Report for Scriptwriter Showing all Activities

Project start date: 03/01
Project finish date: 05/17

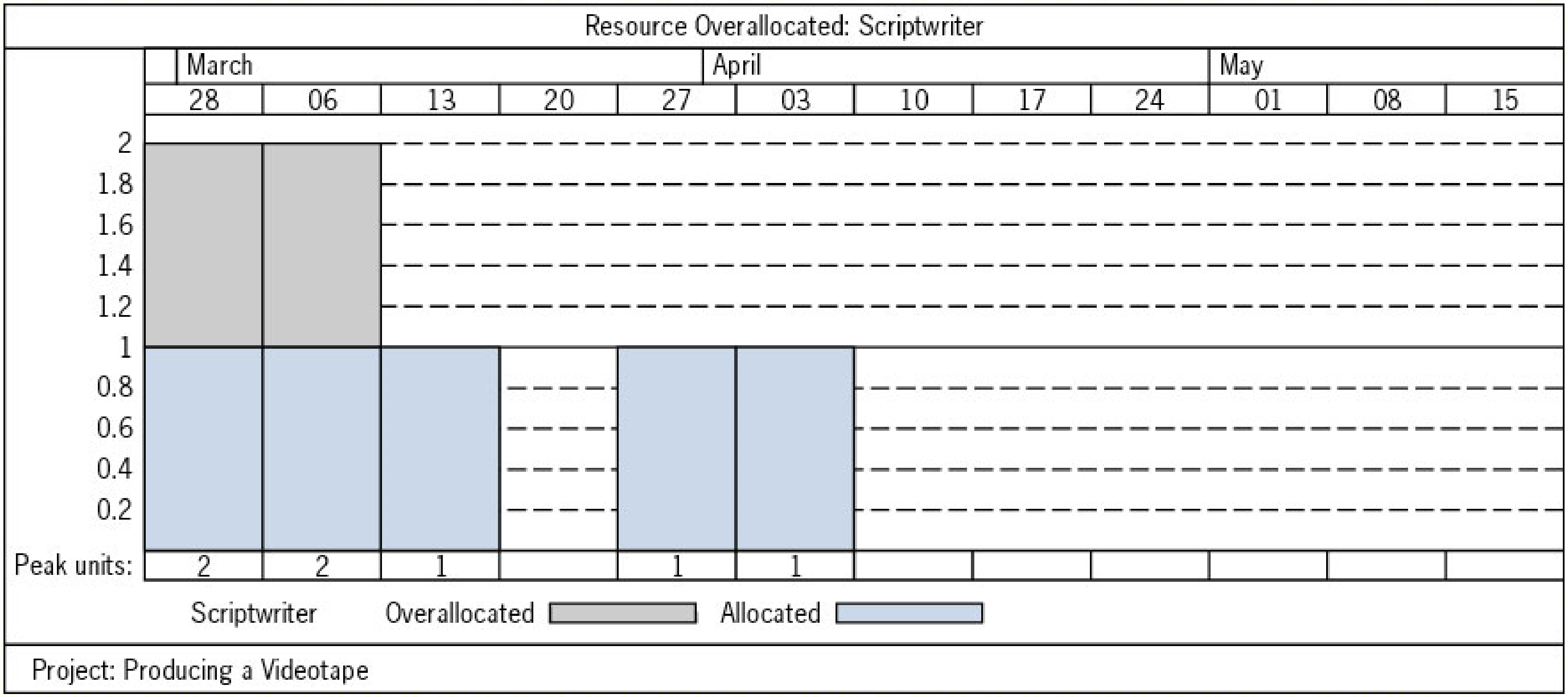
Resource Overallocated: Scriptwriter

WBS	Task Name	Duration	Sch. Start	Sch. Finish	March: 28, 06, 13, 20, 27 · April: 03, 10, 17, 24 · May: 01, 08, 15
2	Scripwriting	14 days	03/01	03/15	Scriptwriter
3.2	Propose shoots	6.5 days	03/01	03/07	Producer, client, scriptwriter
5	Revise script	6.63 days	03/31	04/07	Scriptwriter, producer

Prior to resource leveling

Preleveled task	Preleveled milestone
Preleveled split	Milestone
Task	Delay
Split	Slack
Progress	Summary

Graphic Resource Overallocation Report for Scriptwriter

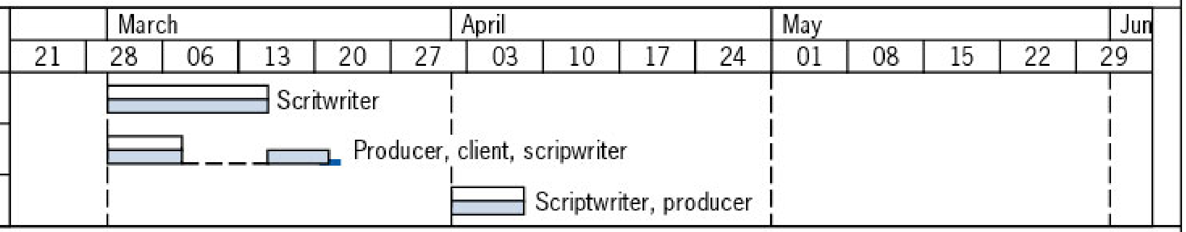


Resource Leveled Report for Scriptwriter Showing all Activities

Project start date: 03/01
Project start date: 05/17

Resource Leveled: Scriptwriter

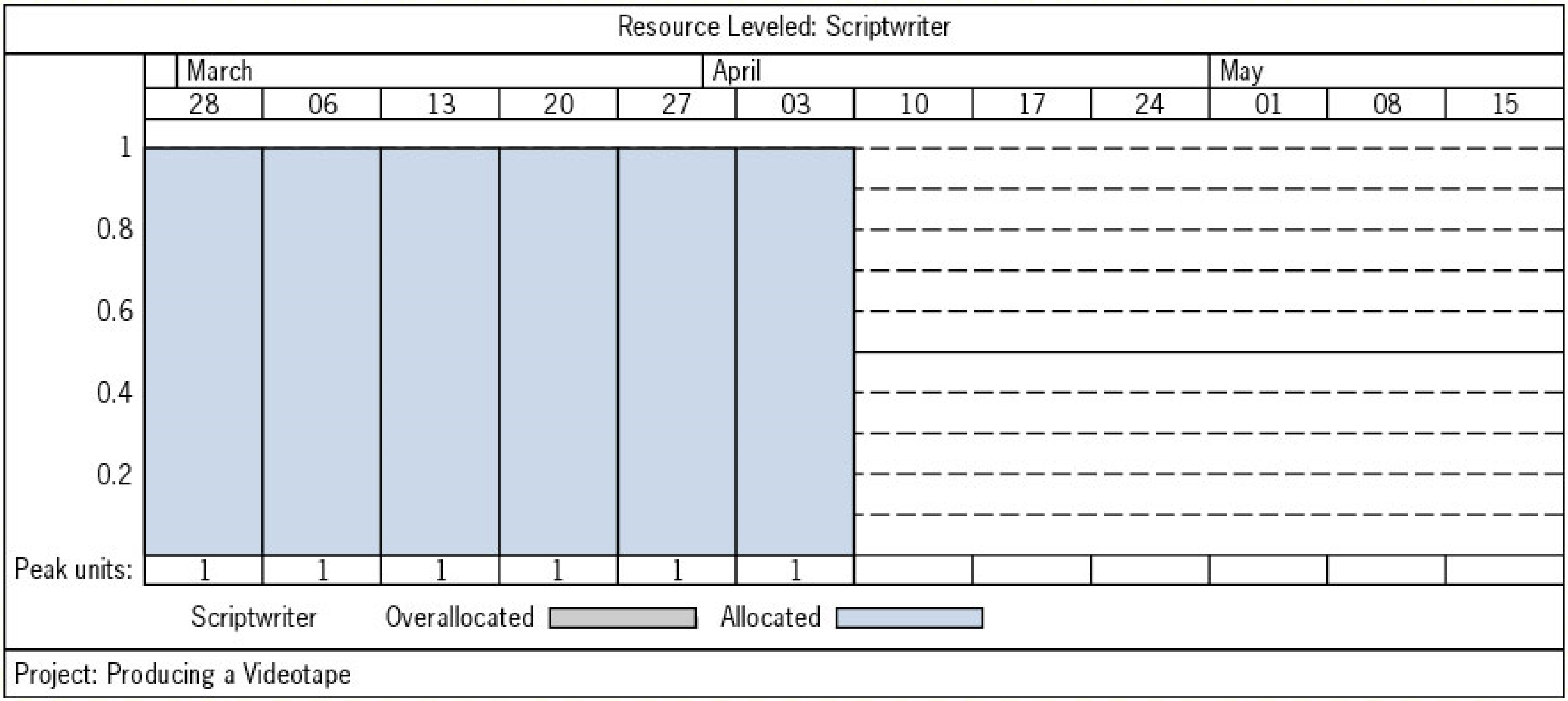
WBS	Task Name	Revised Duration	Revised Start
2	Scripwriting	14 days	03/01
3.2	Propose shoots	10 days	03/01
5	Revise script	6.63 days	03/31



After recource leveling

Preleveled task		Progress		Stack	
Preleveled split		Preleveled milestone		Summary	
Task		Milestone			
Split		Delay			

Graphic Resource Leveled Report for Scriptwriter



Daily Resource Loading Chart for Videotape Project, Scriptwriter Leveled

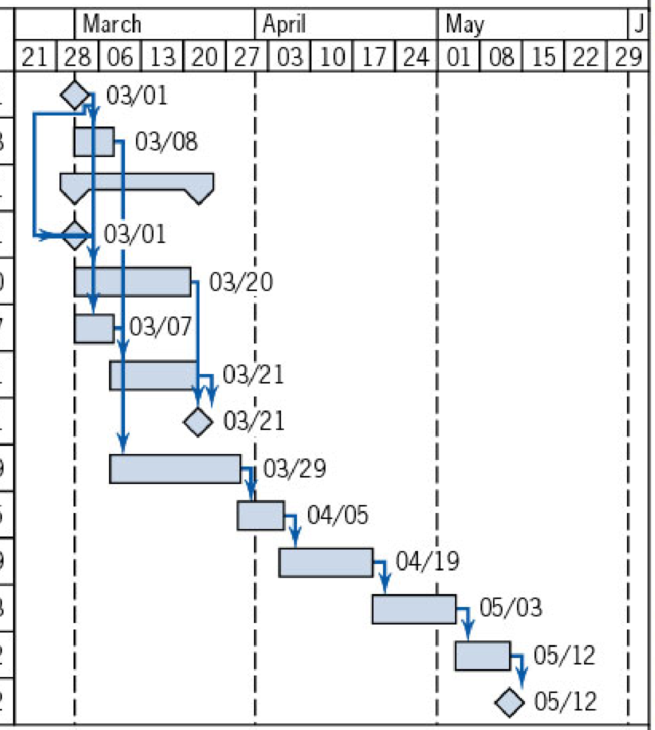
Producing a Videotape
Resource Work Hours
Scriptwriter Leveled

Resource Name	Work						Mar 06, '00							Mar 13, '00					
		W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S
Scriptwriter	192 hrs	9h	9h	9h	9h		9h	9h	9h	9h	9h	9h		9h	9h	9h	9h	9h	9h
Scriptwriting	112 hrs	9h	9h	9h	9h		9h	9h	9h	9h	9h	9h		9h	9h	4h			
Propose shoots	40 hrs	0h	0h	0h	0h		0h	0h	0h	0h	0h	0h		0h	0h	5h	9h	9h	9h
Revise script	40 hrs																		
Producer	200 hrs	16h	16h	16h			16h	16h								4h	8h	8h	
Propose shoots	40 hrs	8h	8h	8h			8h	8h											
Hire secretary	40 hrs	8h	8h	8h			8h	8h											
Script approval	40 hrs															4h	8h	8h	
Revise script	40 hrs																		
Final approval	40 hrs																		
Client	120 hrs	8h	8h	8h			8h	8h											
Propose shoots	40 hrs	8h	8h	8h			8h	8h											
Script approval	40 hrs																		
Final approval	40 hrs																		
Secretary	80 hrs								8h	8h	8h			8h	8h	8h	8h	8h	
Schedule shoot	80 hrs								8h	8h	8h			8h	8h	8h	8h	8h	
Editor	176 hrs																		
Shooting	80 hrs																		
Editing	56 hrs																		
Final approval	40 hrs																		
Production staff	80 hrs																		
Shooting	80 hrs																		
Editing staff	56 hrs																		
Editing	56 hrs																		
Editing room	96 hrs																		
Editing	56 hrs																		
Final approval	40 hrs																		

Final Videotape Project Gantt Chart Schedule, With Two Scriptwriters and Producer Leveled

Producing a Videotape
A.J. Lucas

WBS	Task Name	Resource Names	Duration	Start	Finish
1	Project approval		0 days	03/01	03/01
2	Scriptwriting	Scriptwriter [2]	7 days	03/01	03/08
3	Schedule shoots		15 days	03/01	03/21
3.1	Begin scheduling		0 days	03/01	03/01
3.2	Propose shoots	Producer, client, scripwriter	15 days	03/01	03/20
3.3	Hire secretary	Producer	5 days	03/01	03/07
3.4	Schedule shoots	Secretary	10 days	03/08	03/21
3.5	Scheduling complete		0 days	03/21	03/21
4	Script approval	Client, producer	7.25 days	03/08	03/29
5	Revise script	Scriptwriter, producer	6.5 days	03/29	04/05
6	Shooting	Editor, production staff	10 days	04/05	04/19
7	Editing	Editor, editing staff, editing room	10.06 days	04/19	05/03
8	Final approval	Client, producer, editor, editing room	7.19 days	05/03	05/12
9	Deliver video to client		0 days	05/12	05/12



Start date: 03/01
Finish date: 05/12

Task | Milestone | Summary

Additional scriptwriter added to activity 2

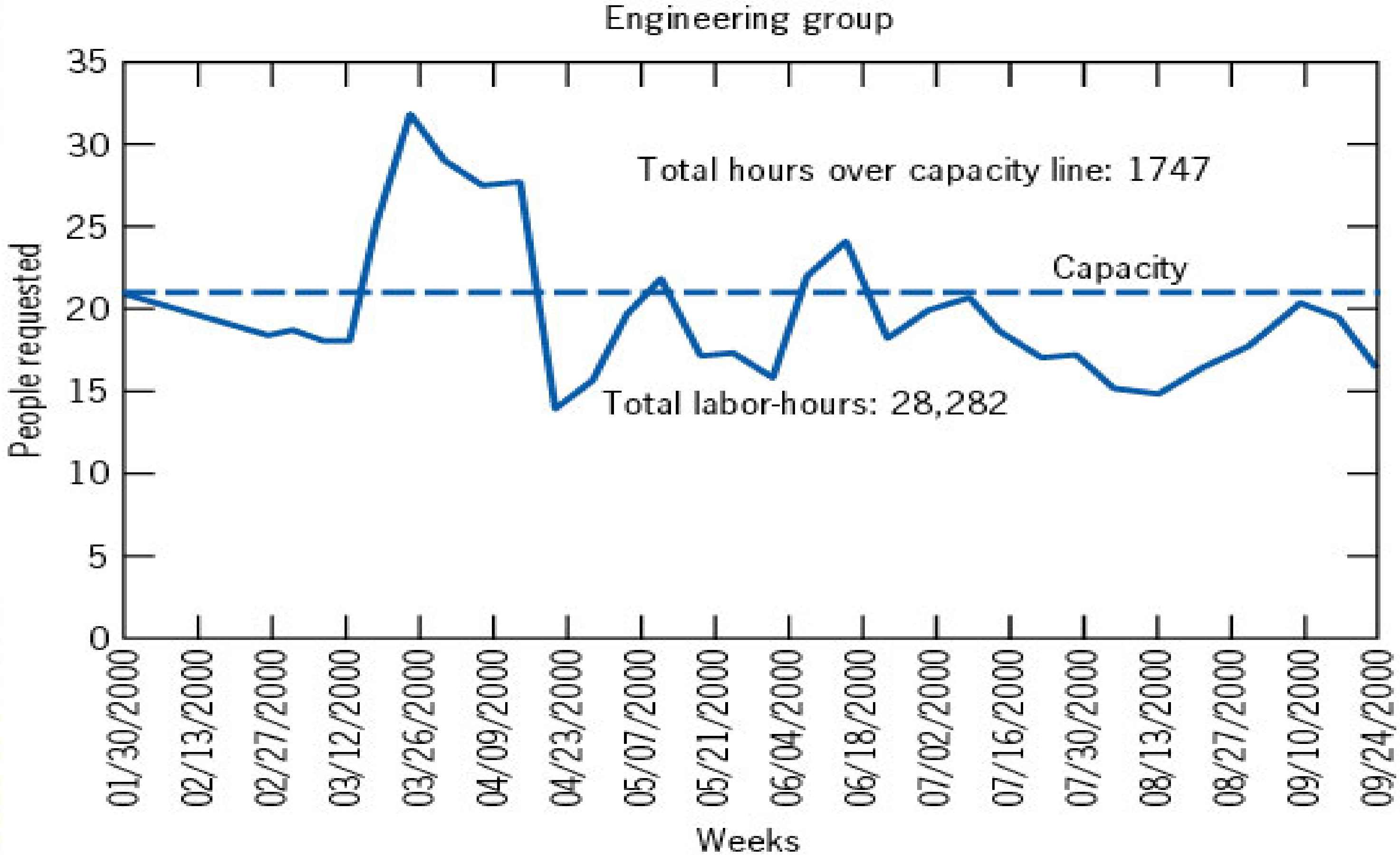
Resource Loading/Leveling and Uncertainty

- **28,282 Hours Needed**
- **Group Capacity**
  - 21 (people) × 40 (hrs/wk) × 34 wk = 28,560 labor hrs
- **Correction for Holidays**
  - 21 × 3 (days) × 8 (hours) = 504 labor hrs
- **Vacations**
  - 11 × 2 (weeks) × 40 = 880 labor hrs

Resource Loading/Leveling and Uncertainty *continued*

- **Hours Available**
  - 28,560 - 504 - 880 = 27,176
  - about 1100 less than needed
  - 28,282/27176 = 1.04
- **What about**
  - Workers getting sick?
  - Task not ready when worker is ready?
  - Change orders?

Thirty-Four-Week Resource Loading Chart for a Software Engineering Group



ALLOCATING SCARCE RESOURCES TO PROJECTS

Use of Software

- Begin with Pert/CPM Schedule
- Activities examined period by period and resource by resource
- In cases where demand for resource exceeds supply, tasks considered one by one and resources assigned to these tasks based on priority rules

Some Comments about Constrained Resources

- Scarcity of resources rarely applies to resources in general
- "Walts"

Some Priority Rules

- As soon as possible
- As late as possible
- Shortest task duration first
- Minimum slack first
- Most critical followers
- Most successor
- Most resources first

Choosing a Priority Rule

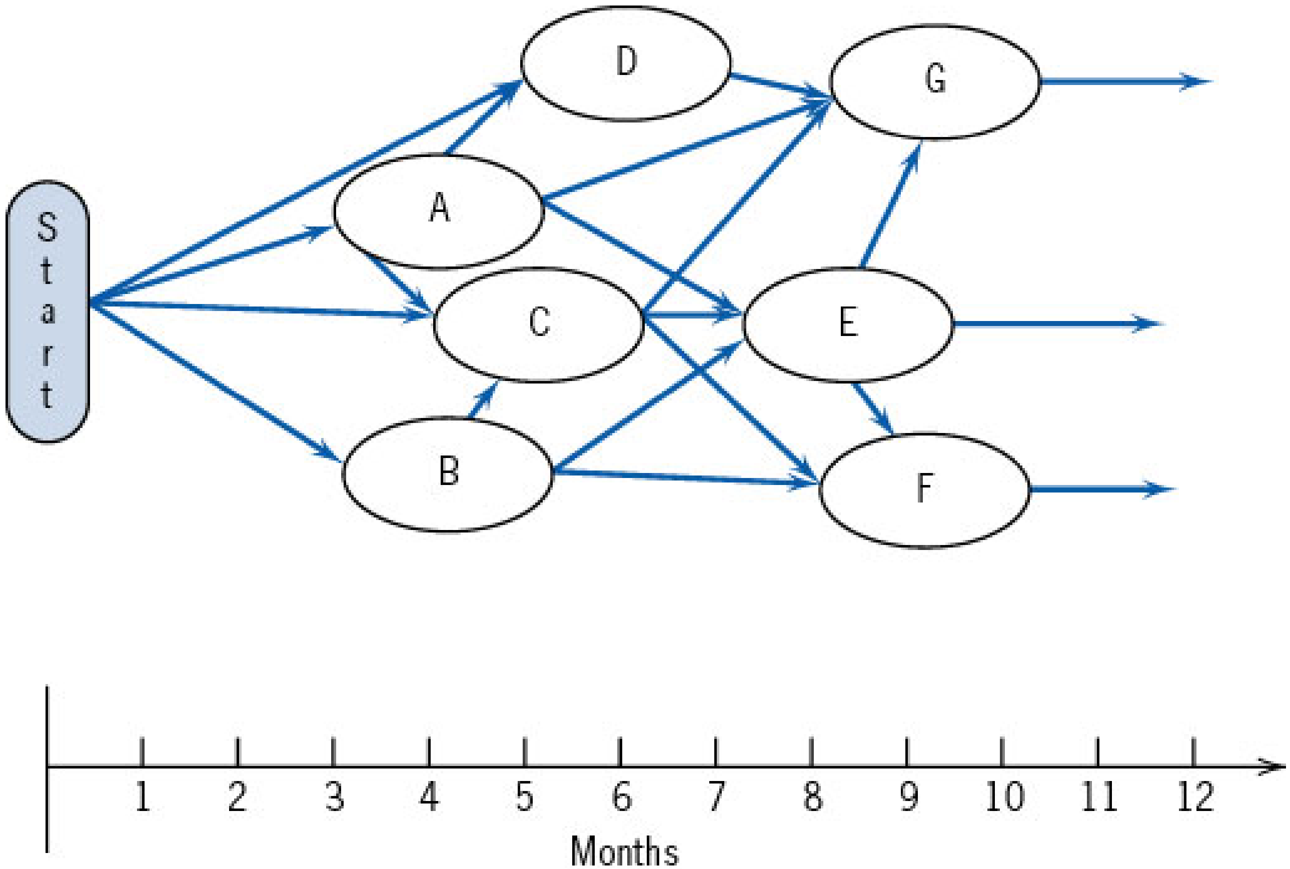
- **Schedule Slippage**
  - amount project or set of projects delayed
- **Resource Utilization**
  - extent that resources are over or underworked
- **In-Process Inventory**
  - amount of unfinished work in the system

ALLOCATING SCARCE RESOURCES TO SEVERAL PROJECTS

Pseudo activities

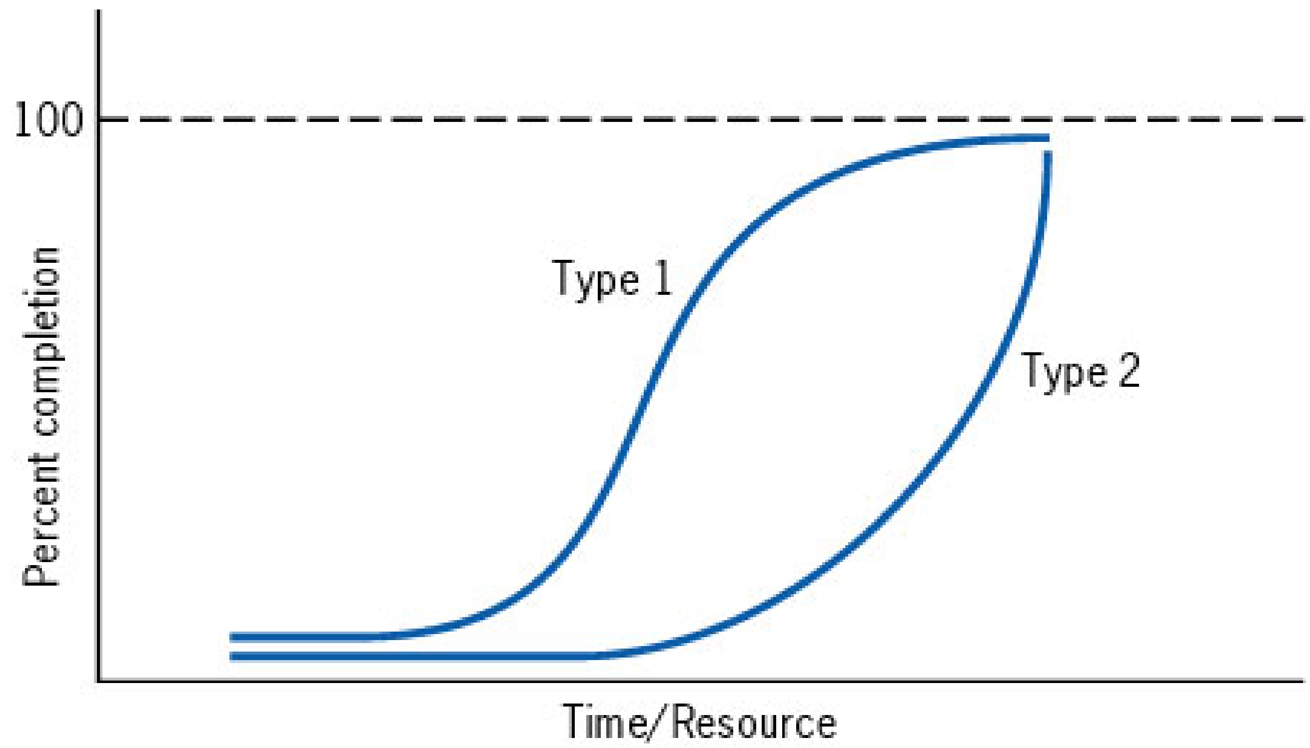
- **Used to link several project together**
- **Have duration but do not require any resources**
- **This approach allows a set of projects to be dealt with as though it were a single project**
  - use of MSP's resource loading and leveling charts and tables

Multiple Projects Connected with Pseudo activities Shown on a Time Line



Resource Allocation and the Project Life Cycle

Project or task life cycles

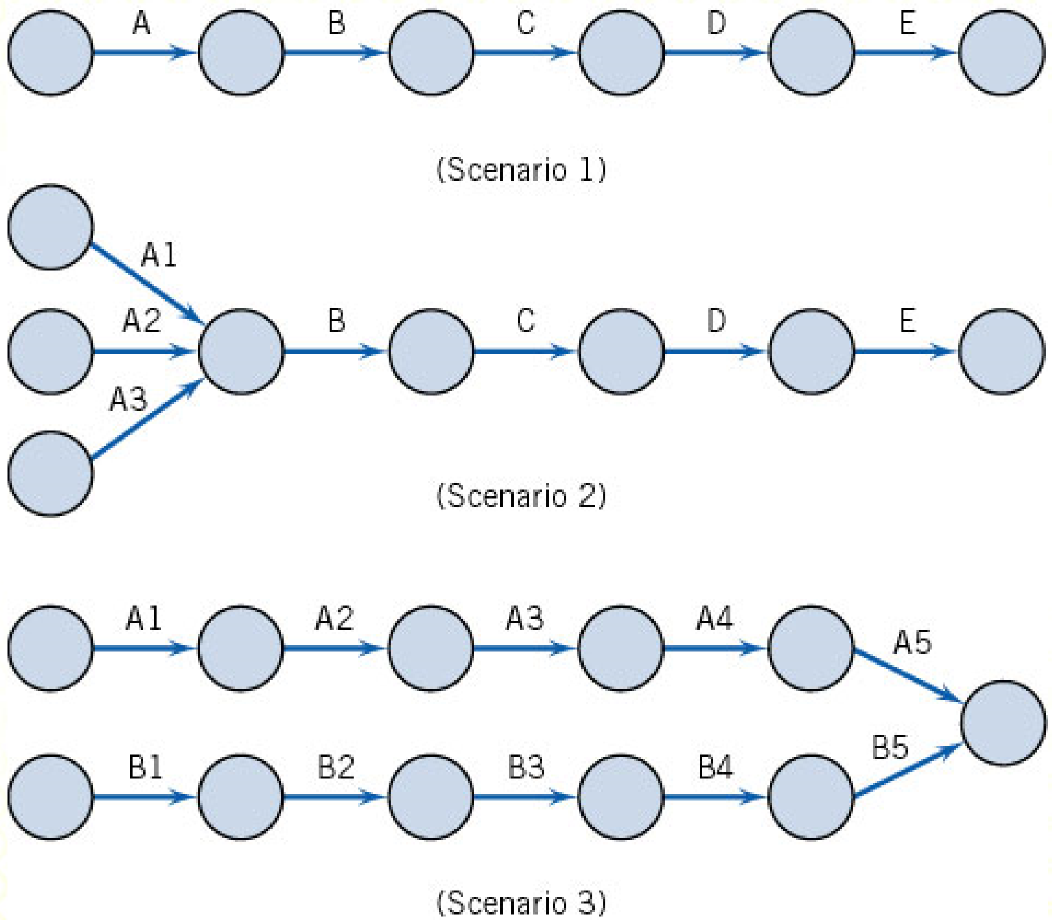


GOLDRATT'S CRITICAL CHAIN

Introduction

- **Similar issues that trouble people about working on projects regardless of type of project**
  - unrealistic due dates
  - too many changes
  - resources and data not available
  - unrealistic budget
- **These issues/problems related to need to make trade-offs**
- **To what extent are these problems caused by human decisions and practices?**

Three Project Scenarios



Project Completion Time Statistics Based on Simulating Three Projects 200 Times

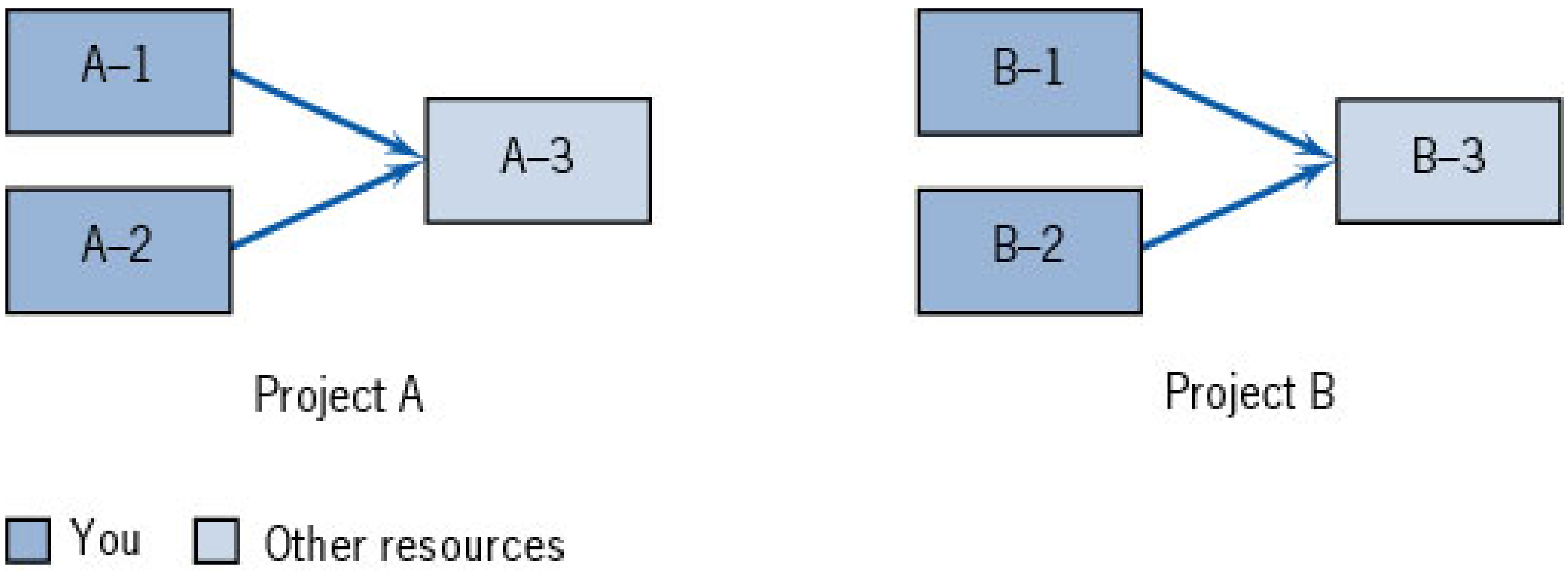
	Scenario 1	Scenario 2	Scenario 3
Average	50.4	51.9	53.4
Std Dev	7.1	6.3	5.3
Max	69.4	72.7	69.3
Min	30.1	36.1	39.3
Median	50.0	51.8	53.1

Observations

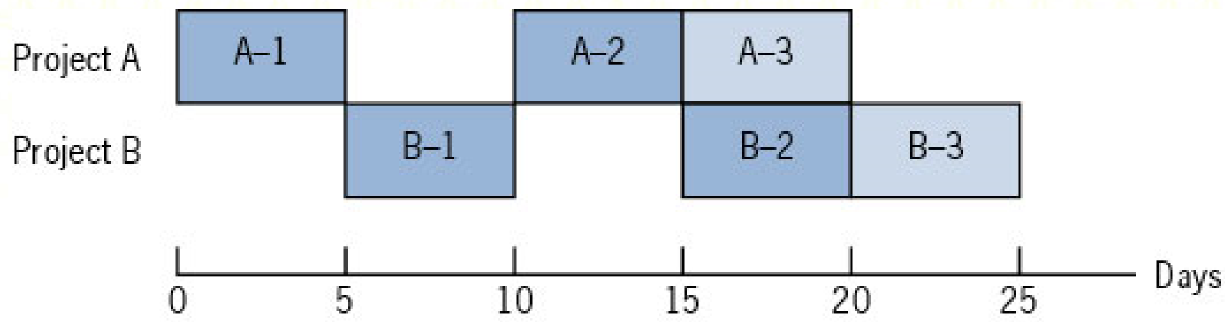
- Average Completion Times
- Implications of Assuming Known Activity Times
- Shape of the Distribution
- Worker Time Estimates
- Impact of Inflated Time Estimates
- Student Syndrome

Multitasking

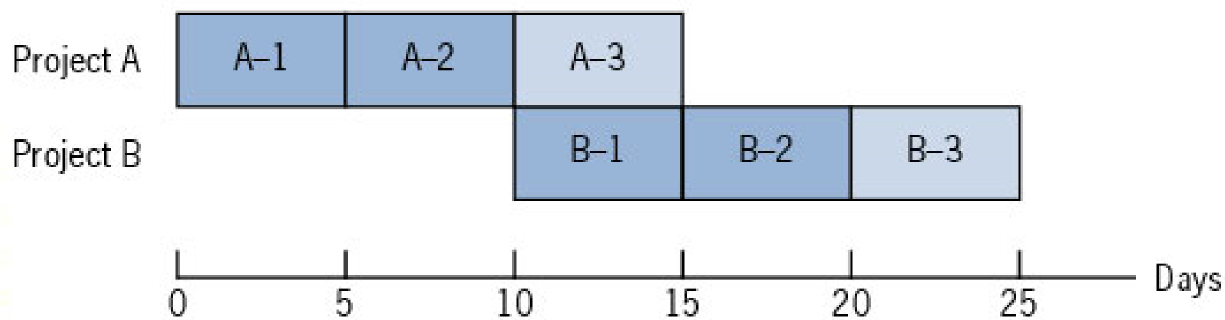
Two Small Projects



Alternative Gantt Charts for Projects A and B



(a)



(b)

Common Chain of Events

- **Underestimate time needed to complete project**
  - assumption of known activity times and independent paths
- **Project team members inflate time estimates**
- **Work fills available time**
  - student syndrome
  - early completions not reported

Common Chain of Events *continued*

- **Safety time misused**
- **Misused safety time results in missed deadlines**
- **Hidden safety time complicates task of prioritizing project activities**
- **Lack of clear priorities results in poor multitasking**

Common Chain of Events *concluded*

- Poor multitasking increases task durations
- Uneven demand on resources also results due to poor multitasking
- More projects undertaken to ensure all resources fully utilized
- More projects further increases poor multitasking

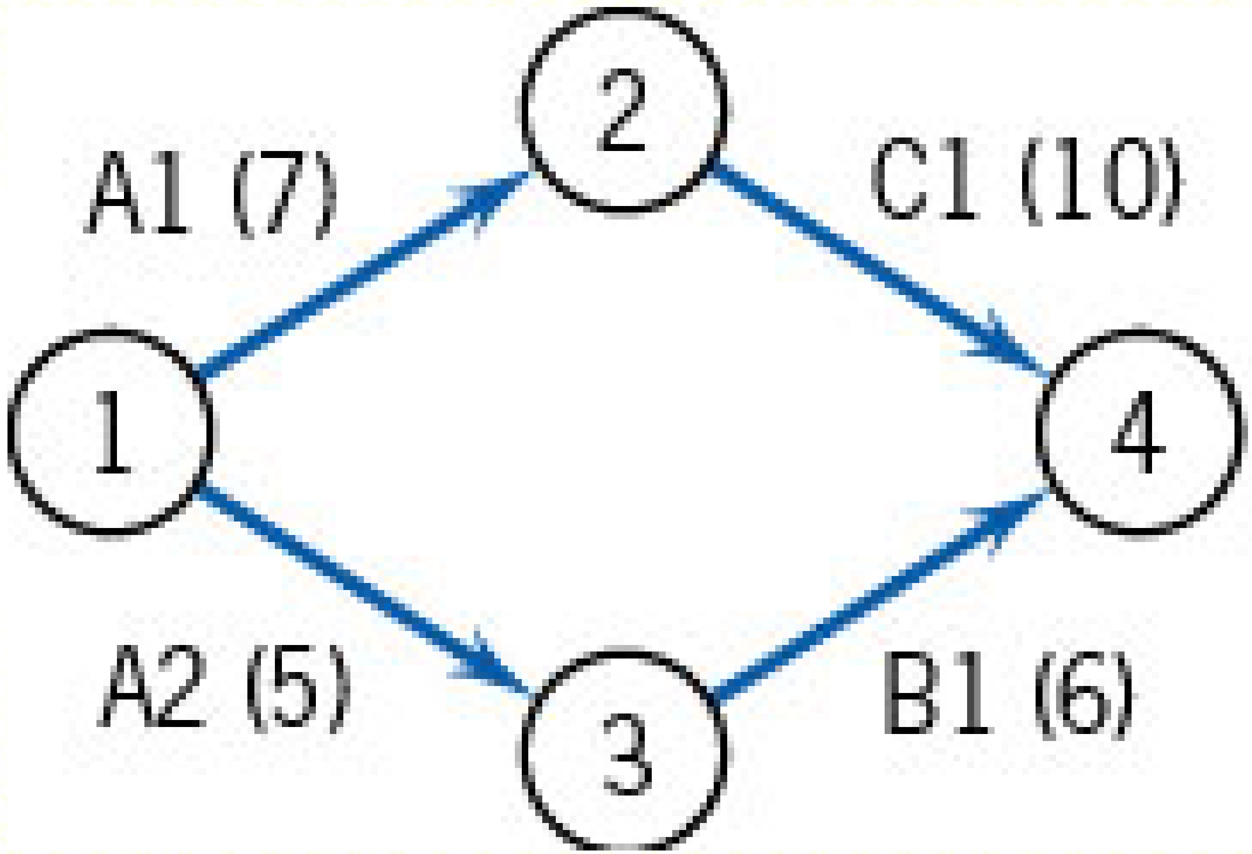
Reversing the Cycle

- **Reduce number of projects assigned to each individual**
- **Schedule start of new projects based on availability of bottleneck resources**
- **Reduce amount of safety time added to individual tasks and then add some fraction back as *project buffer***
  - activity durations set so that there is a high probability the task will not be finished on time

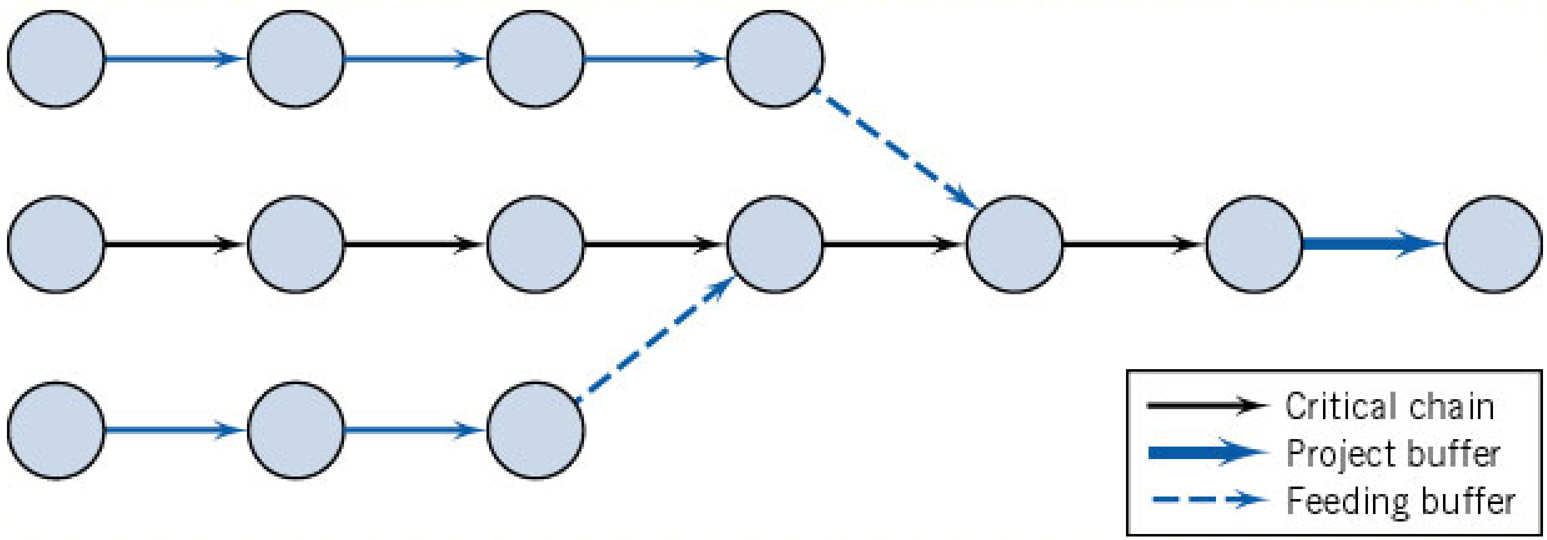
The Critical Chain

- **Longest chain of consecutively dependent events**
  – considers both precedence relationships and resource dependencies
- **Project Buffer**
- **Feeding Buffer**

Sample Network Diagram



Project and Feeder Buffers



Reference

- **Meredith, R. J. & Mantel, J. S. (1995).** ***Project Management – A Managerial Approach*****. John Wiley & Sons, 5th Edition.**