

RESOURCE MANAGEMENT

Dr. Ahmed Elyamany

Outline

2

- Definition of Resources
- Resource Aggregation/Loading
- Problems Associated with Resource
- Resource Leveling
- Resource Scheduling

What a resource?

3

- Any thing that is used by an activity to get the work done, such as: Material, Equipment, Labor, Money,

Resources Classification

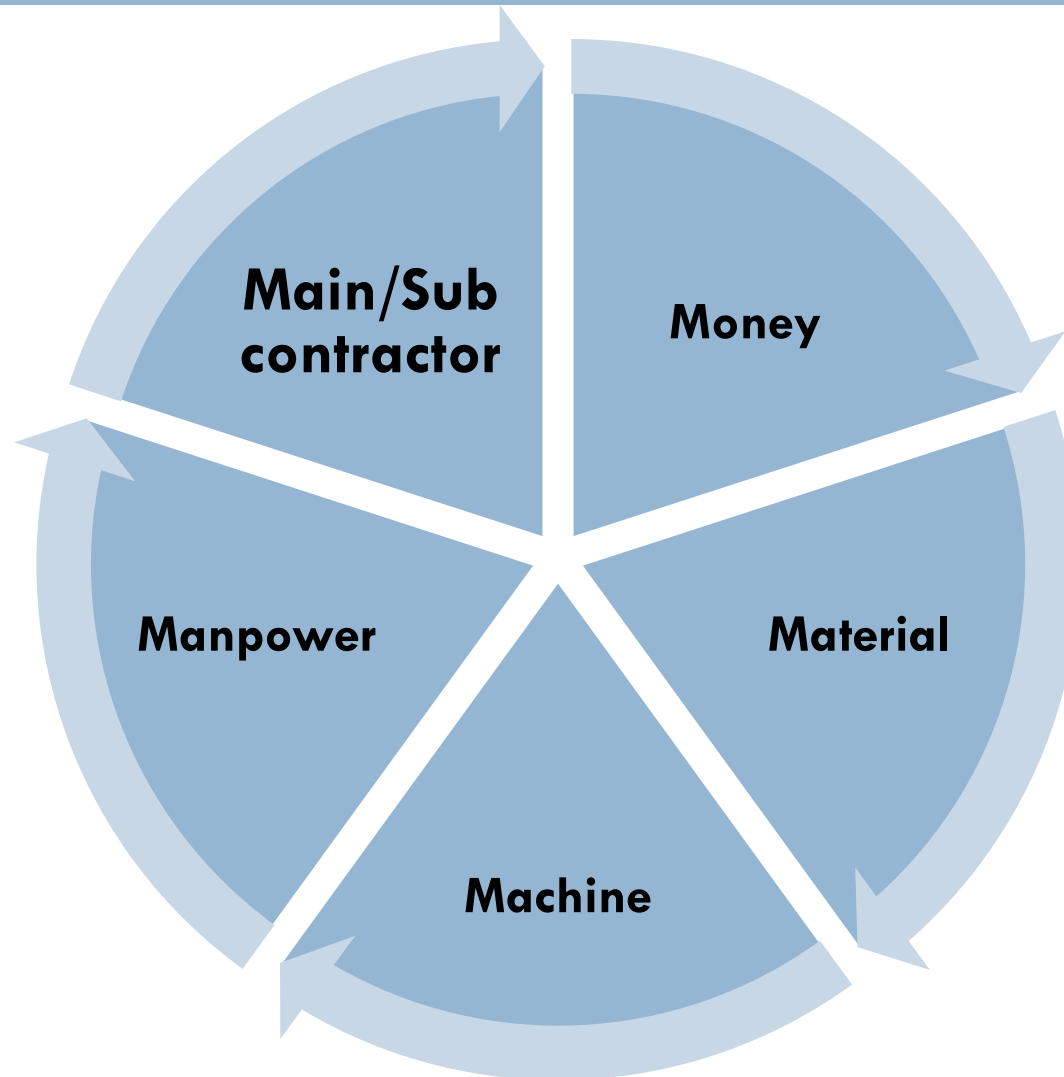
4

- Resources can be:
 - ▣ Consumable (Money, Material,.....)
 - ▣ Non Consumable (Labor, Equipment,...)

- Resources can be:
 - ▣ Key or constrained resources (Skilled labor, Equipment,.....)
 - ▣ Secondary or non-constrained resources (Labor, ...)
 - ▣ General resources, used by all activities

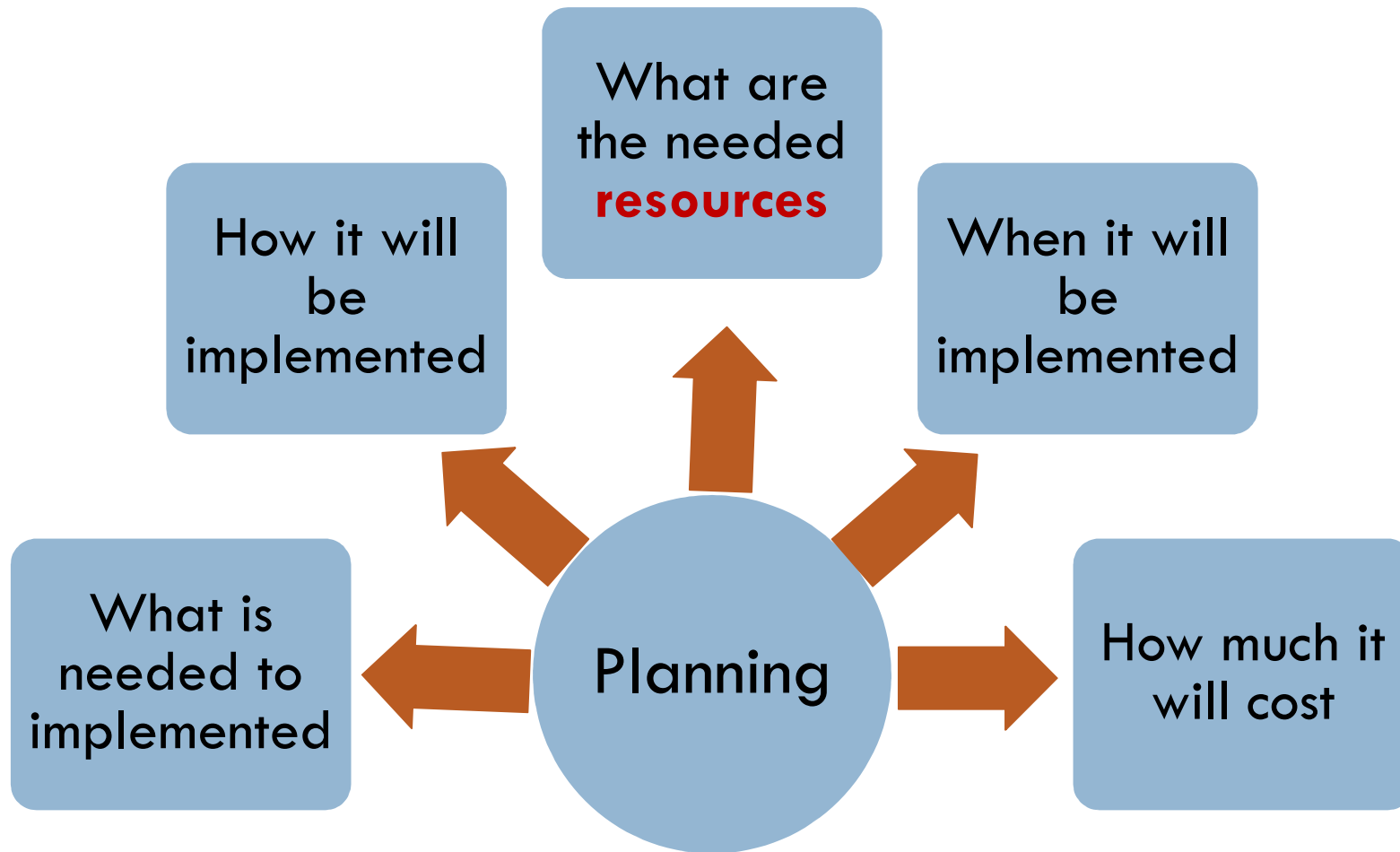
Five “M” Resources

5



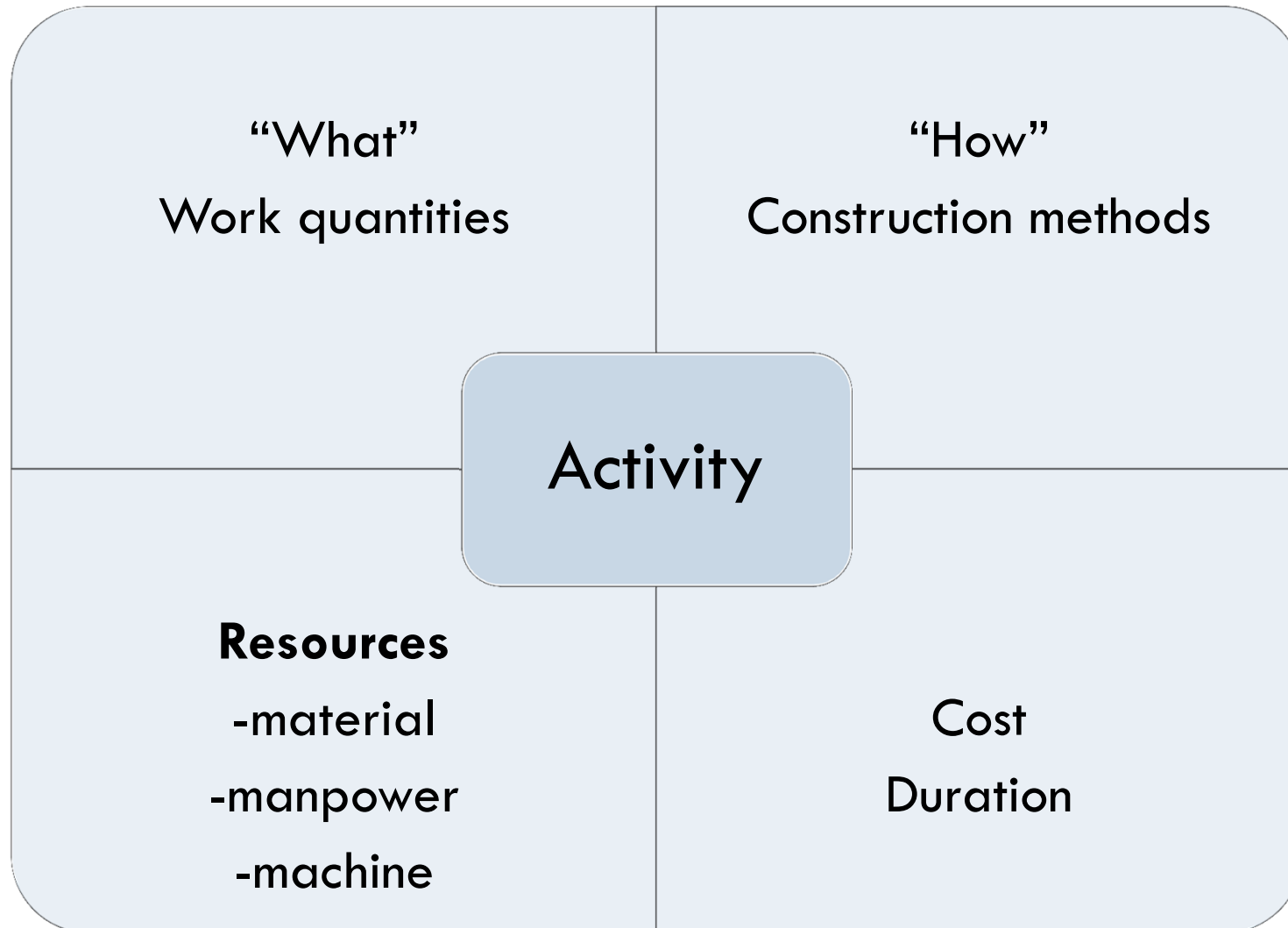
Planning and Resources

6



Activity Analysis

7



Example

8

- Work includes pouring of PC for 20 isolated footing, each is 4m length x 4m width x 0.5m depth.
- Construction method: use one mixer + labor crew
- Production rate: 80 m³/day
- Rental cost of mixer: 400 LE/day
- Labor crew cost rate: 350 LE/day
- Material cost: 250 LE/m³

Example

9

□ Quantity = $4 \times 4 \times 0.5 \times 20$ = 160 m³

□ Duration = $160 / 80$ = 2 days

□ Material cost = 160×250 =

□ Labor cost = 350×2 =

□ Equipment cost = 400×2 =

40,000 LE

700 LE

800 LE

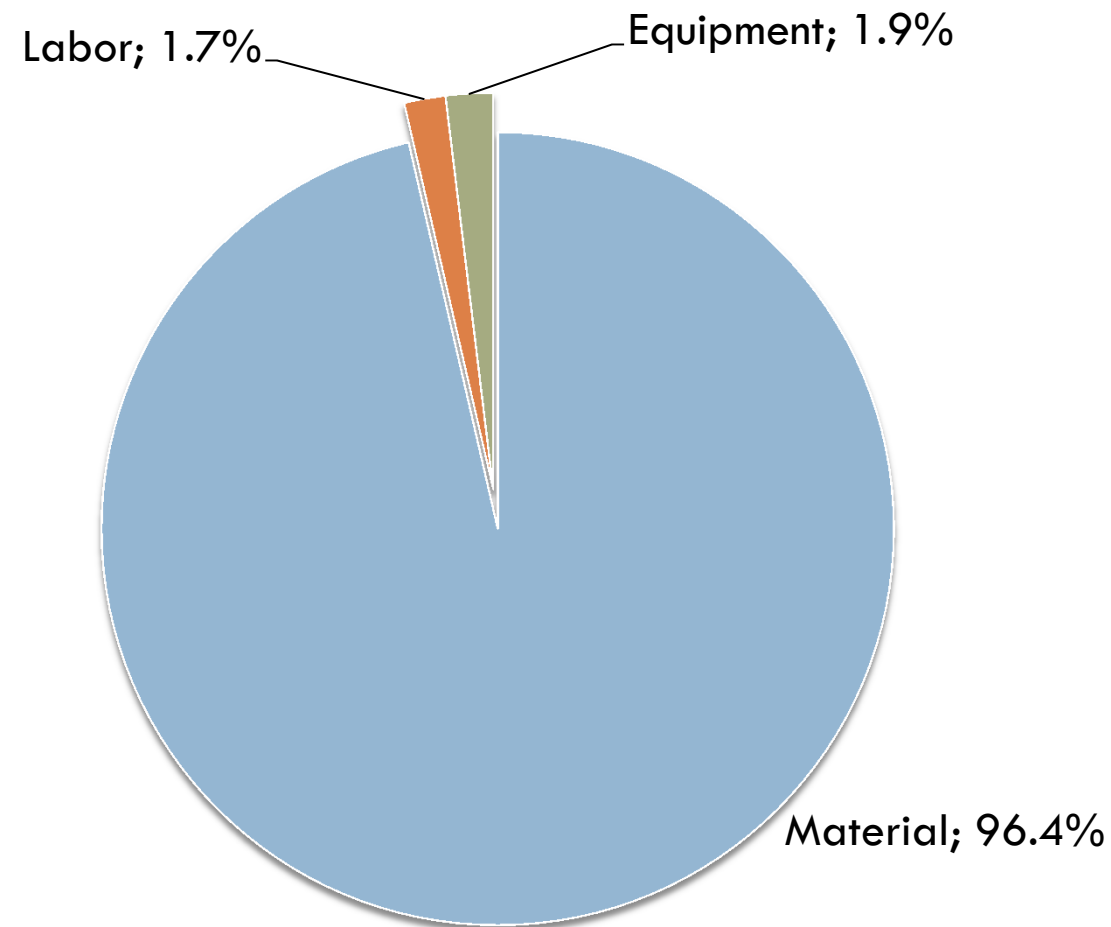
□ Activity total cost = $40,000 + 700 + 800 = 41,500$ LE

□ Activity unit cost = $41,500 / 160$ = 259.4 LE/m³

Example

10

Resource cost distribution



Duration-Driven Schedule

11

- All CPM scheduling techniques are **duration driven schedules**
 - ▣ Basic units: activities, durations, relationships
 - ▣ Assumes resources are available whenever needed

- Difference between:
 - ▣ Working dates
 - ▣ Calendar dates

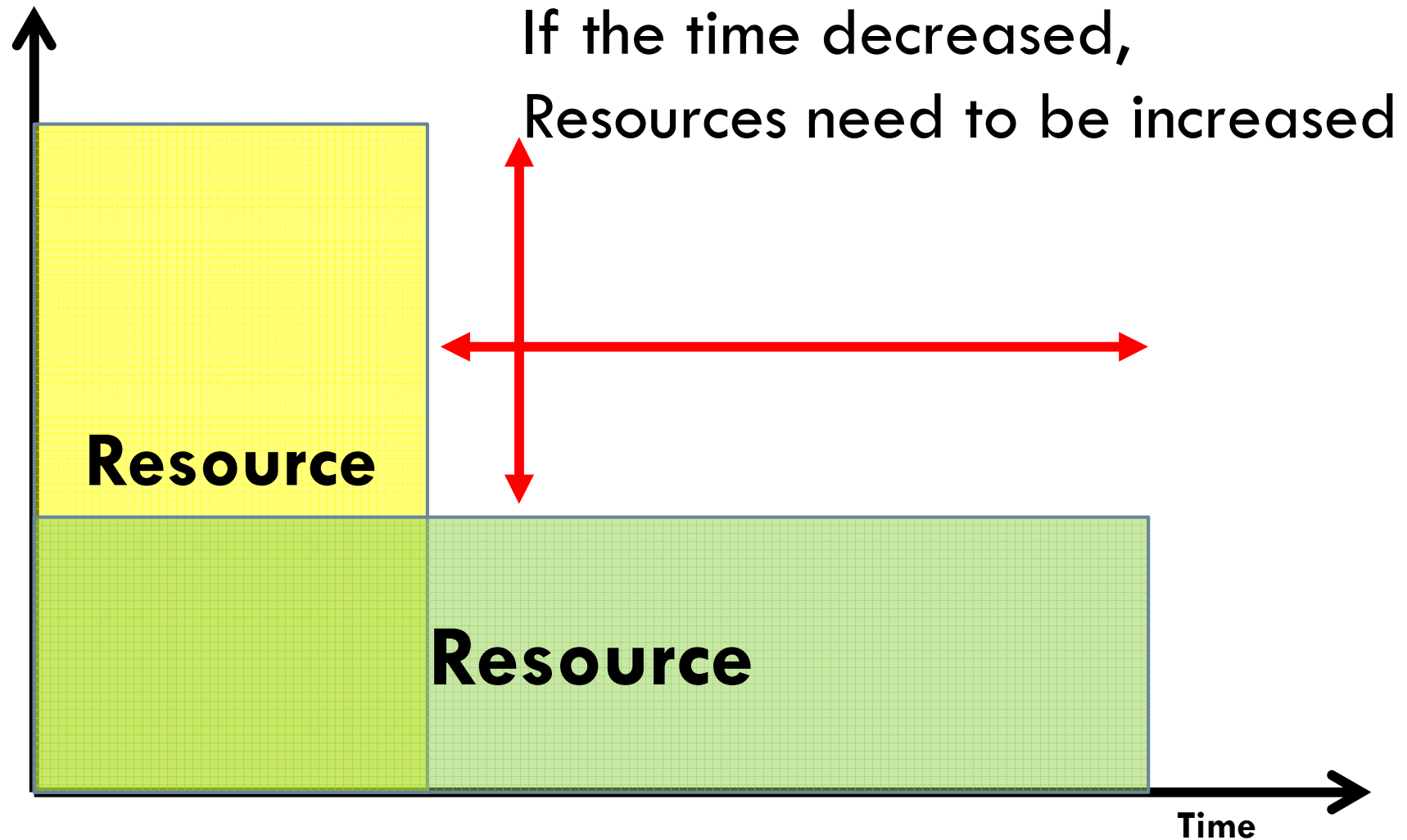
Optimum Resource Usage

12

- Need of resource is fixed along the project construction time
- Impossible to achieve because of activities overlap
- $\text{Work volume} = \text{Area} = \text{resource units} \times \text{time}$
 - ▣ Resource demand
 - ▣ Resource available

Resource – Time relationship

13



Resource Histogram

14

- Graphically represents resource needs
- Relation between **resource units** and **time**

- **Procedure:**
 - ▣ Draw the network
 - ▣ Draw the bar chart
 - ▣ Determine the points where activities start and/or finish.

Preferred Resource Usage

15

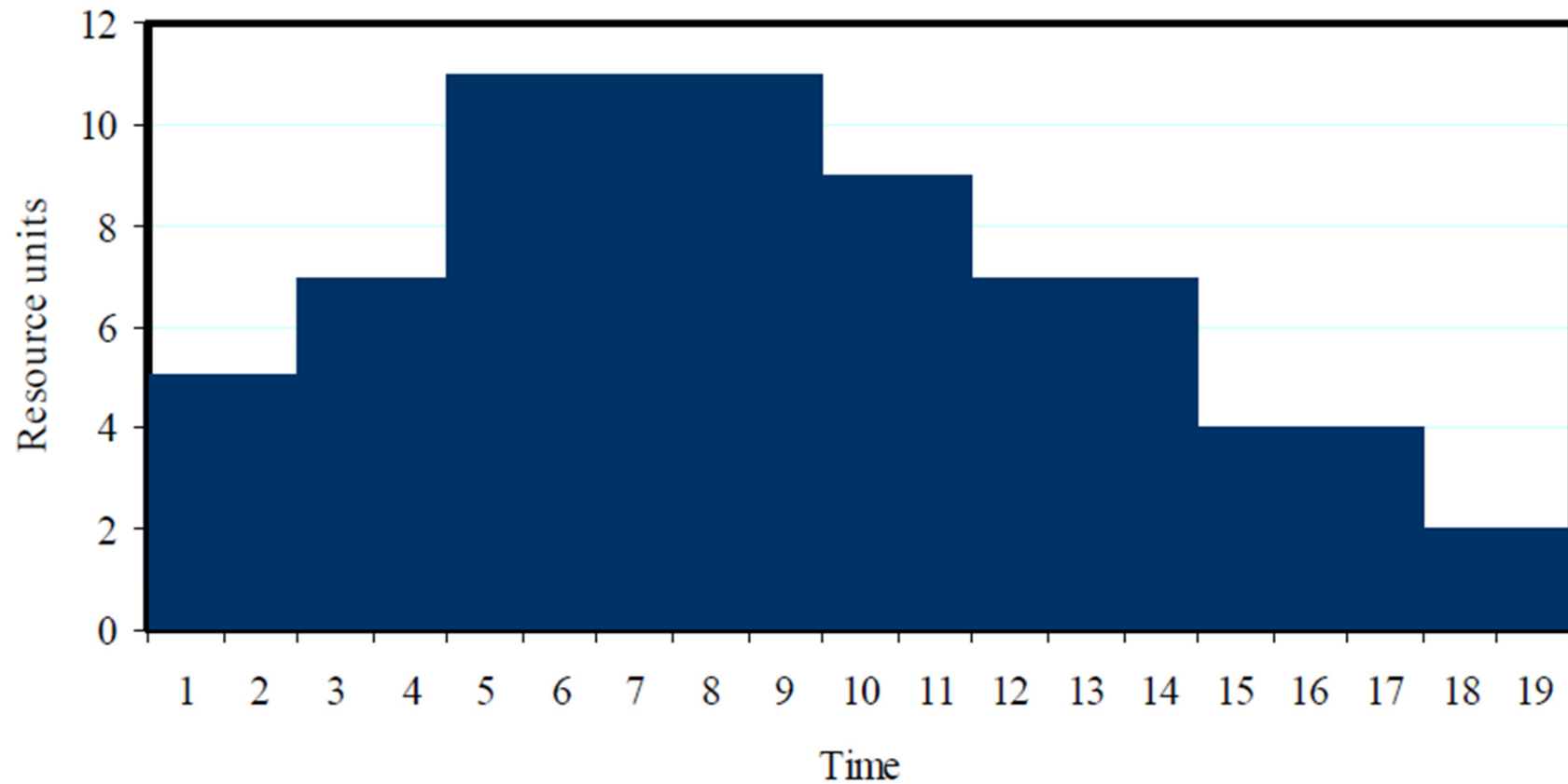


Figure 6.4: Preferred resource usage

Resource Aggregation/Loading

16

- The summation, on a period-by-period basis, of the resources required to complete all activities based on the schedule carried out in the previous stage
- The results are usually shown graphically as a histogram
- A separate graph will be required for each resource

Resource Aggregation/Loading

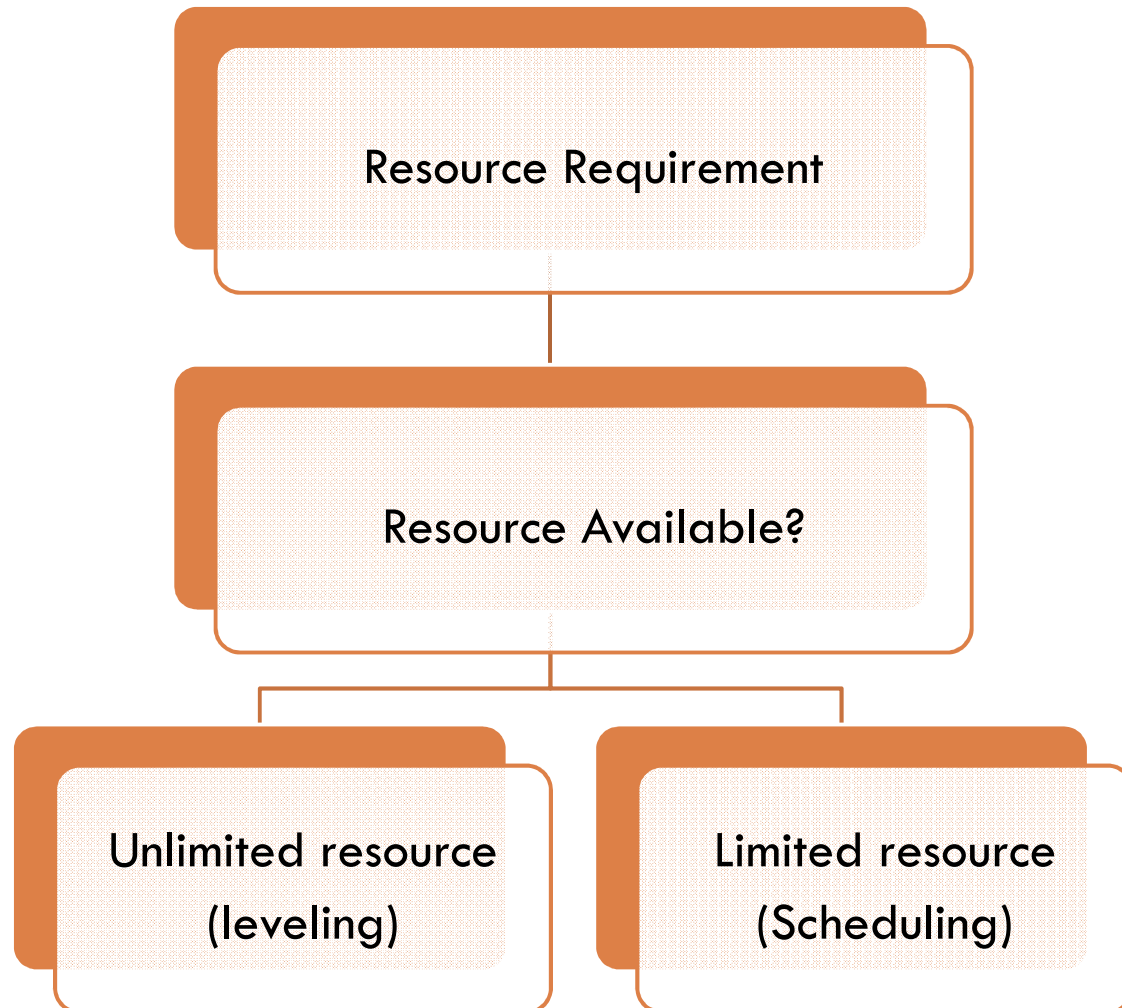
17

- Consider the following activities
- Resource limit = 10 units /week

Activity	Duration (week)	Resources (units/week)
A	2	Shown in the histogram
B	3	
C	2	
D	5	
E	2	

Resource Availability

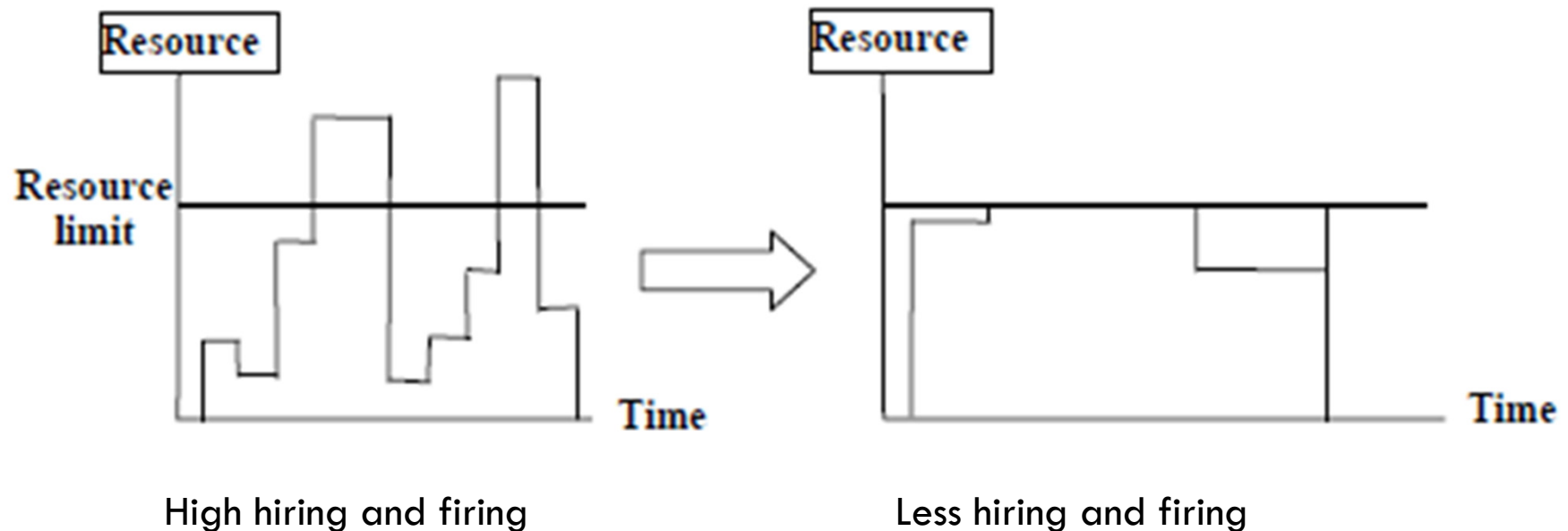
19



Problems Associated with Resource

20

- ▣ Resource Fluctuation (Resource leveling)
- ▣ Resource Over allocation (Resource Scheduling)



Resource Leveling (Smoothing)

21

- Unconstrained resource scheduling (Constrained time)
 - ▣ Resource Leveling
 - Resource unconstrained (No limits on resources)
 - Time (Project completion) constrained; project duration not be delayed
 - Reduce the difference between the peaks and the valleys
 - Average resource usage
 - The objective is to smooth the use of the resources to avoid the resource fluctuation

Resource Leveling (Smoothing)

22

Resource units

— Resource requirement for earliest start

- - - Resource requirement for latest start

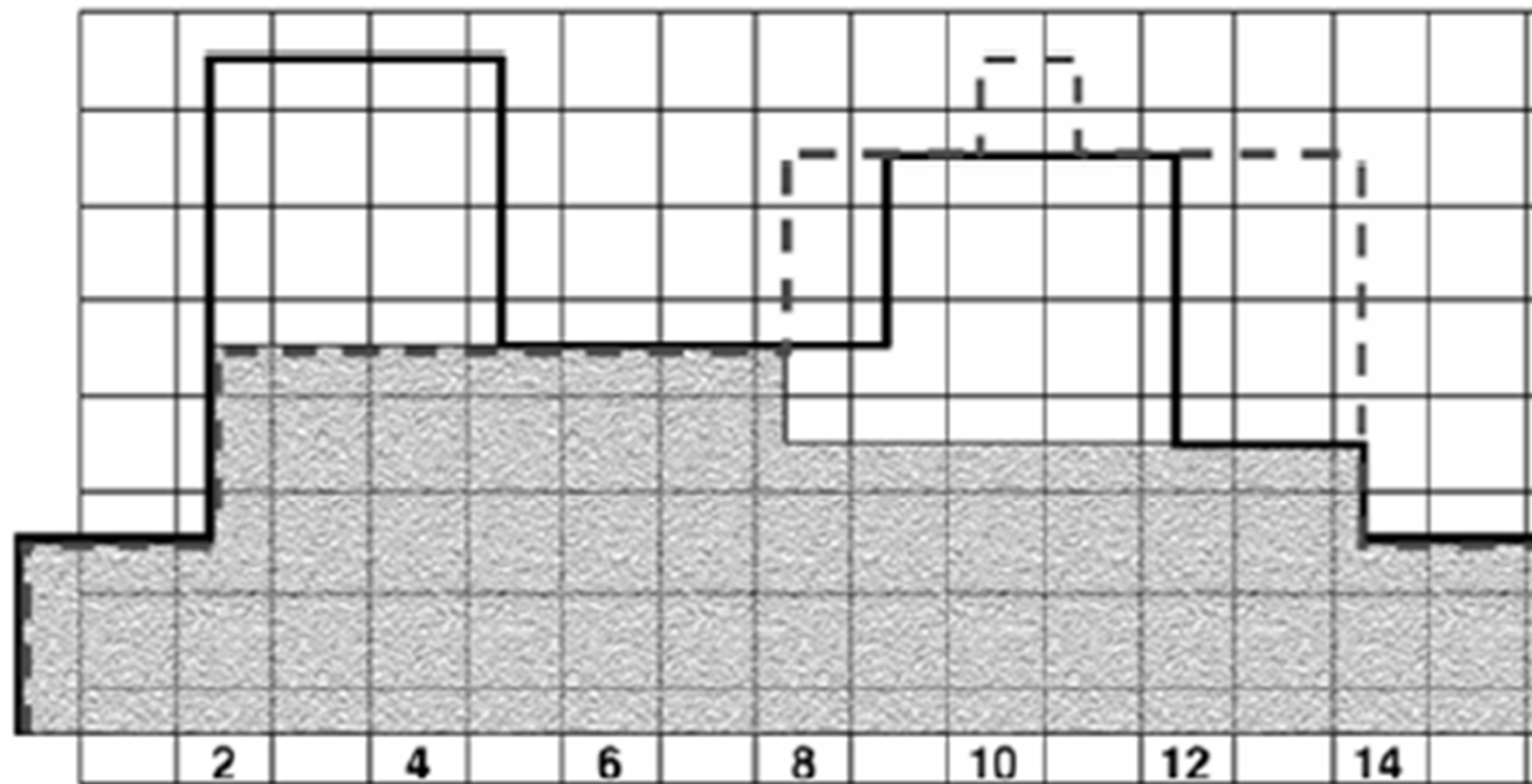
▨ Resource requirement for activities on the critical path

8

6

4

2

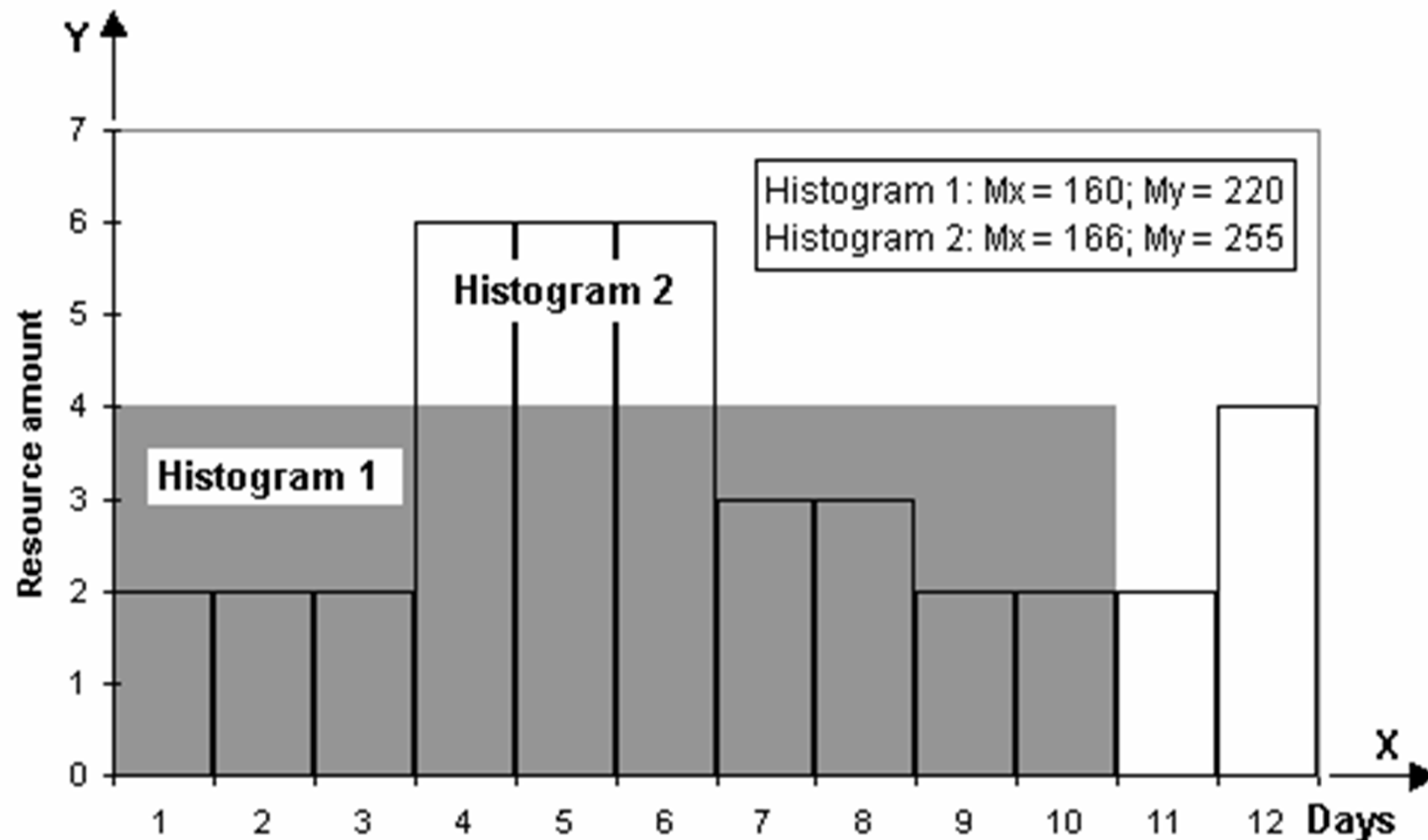


Weeks

Resource Leveling (Smoothing)

23

- Minimum Moment Algorithm $M_x = \sum_{j=1}^n (\text{Resource Demand}_j)^2$



Resource Leveling (Smoothing)

24

□ Heuristic Method Procedure

- Prepare a complete activity schedule
- Draw a bar chart based on ES timings
- Draw the FF as dashed line beside the upper side of the bar and the TF beside the lower side
- Put the resource usage in each bar of the related activity
- Critical activities to be drawn first (do not move them)
- Aggregate the resources in each time period

Resource Leveling (Smoothing)

25

□ Heuristic Method Procedure

- Calculate the total usage of resources = Σ unit period usage
- Calculate the average resource usage = Σ usage / utilization period
- Shift non-critical activities within their FF first, then their TF to decrease the peaks and raise the valleys
- Revise the activities float
- Aggregate the resources in each time period

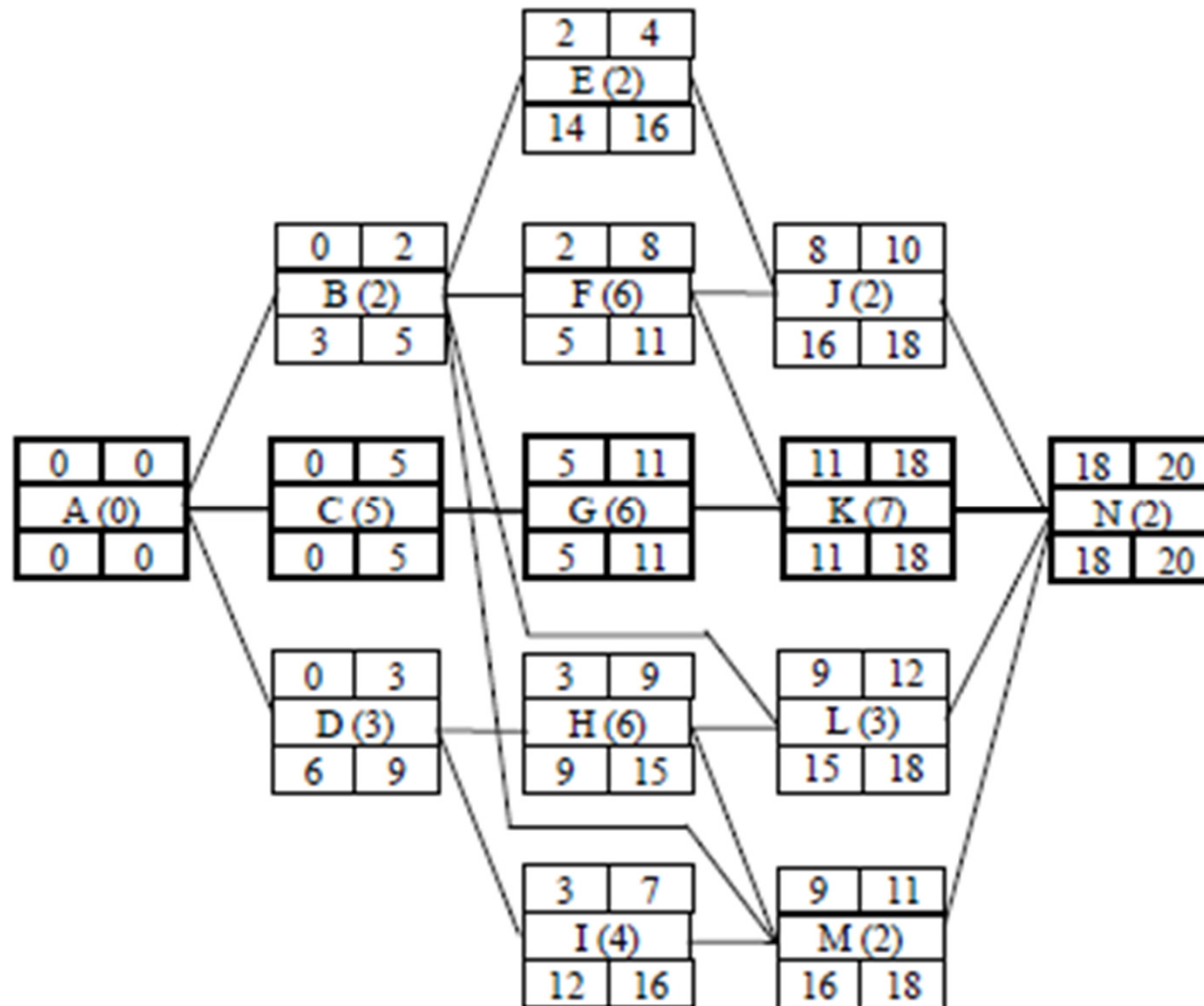
Resource Leveling (Example)

26

Activity	Activity Duration (Weeks)	Predecessors	Resource (units/week)
A	0	-	0
B	2	1	0
C	5	1	2
D	3	1	2
E	2	2	1
F	6	2	2
G	6	3	3
H	6	4	1
I	4	4	0
J	2	5, 6	4
K	7	6, 7	2
L	3	2, 8	2
M	2	2, 8, 9	4
N	2	10, 11, 12, 13	0

Resource Leveling (Example)

27



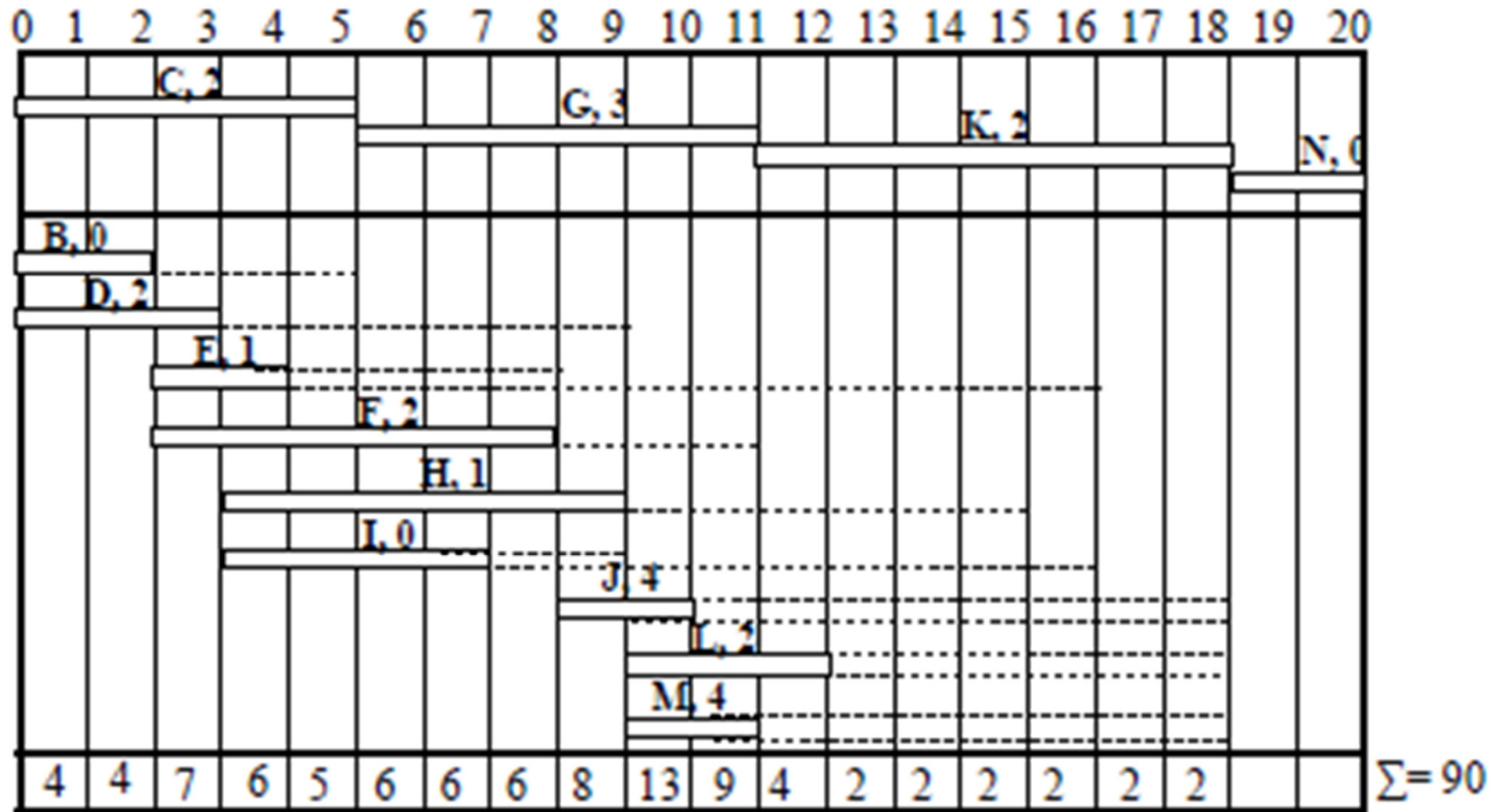
Resource Leveling (Example)

28

Activity	ES	EF	FF	TF
A	0	0	0	0
B	0	2	0	3
C	0	5	0	0
D	0	3	0	6
E	2	4	4	12
F	2	8	0	3
G	5	11	0	0
H	3	9	0	6
I	3	7	2	9
J	8	10	8	8
K	11	18	0	0
L	9	12	6	6
M	9	11	7	7
N	18	20	0	0

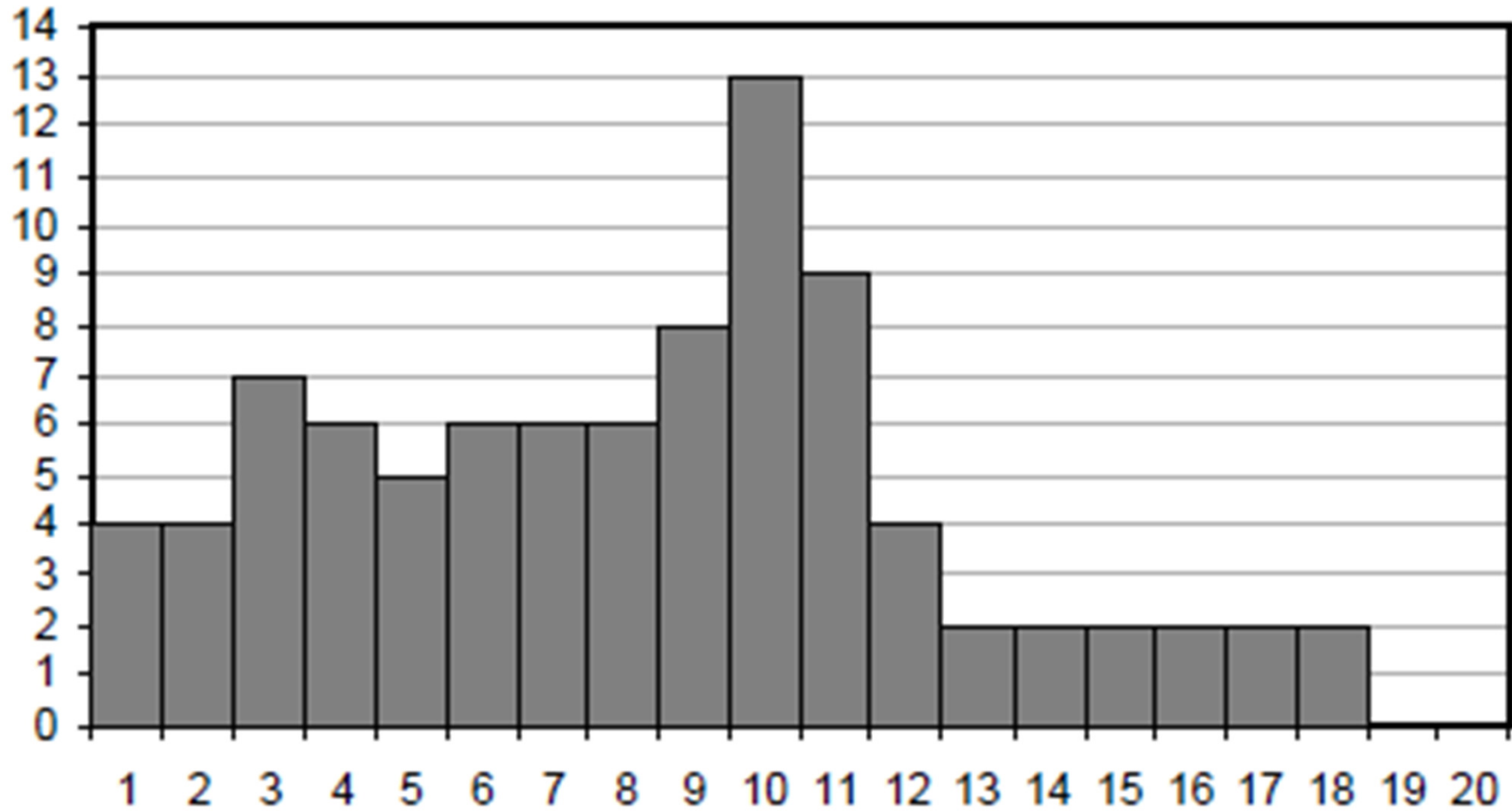
Resource Leveling (Example)

29



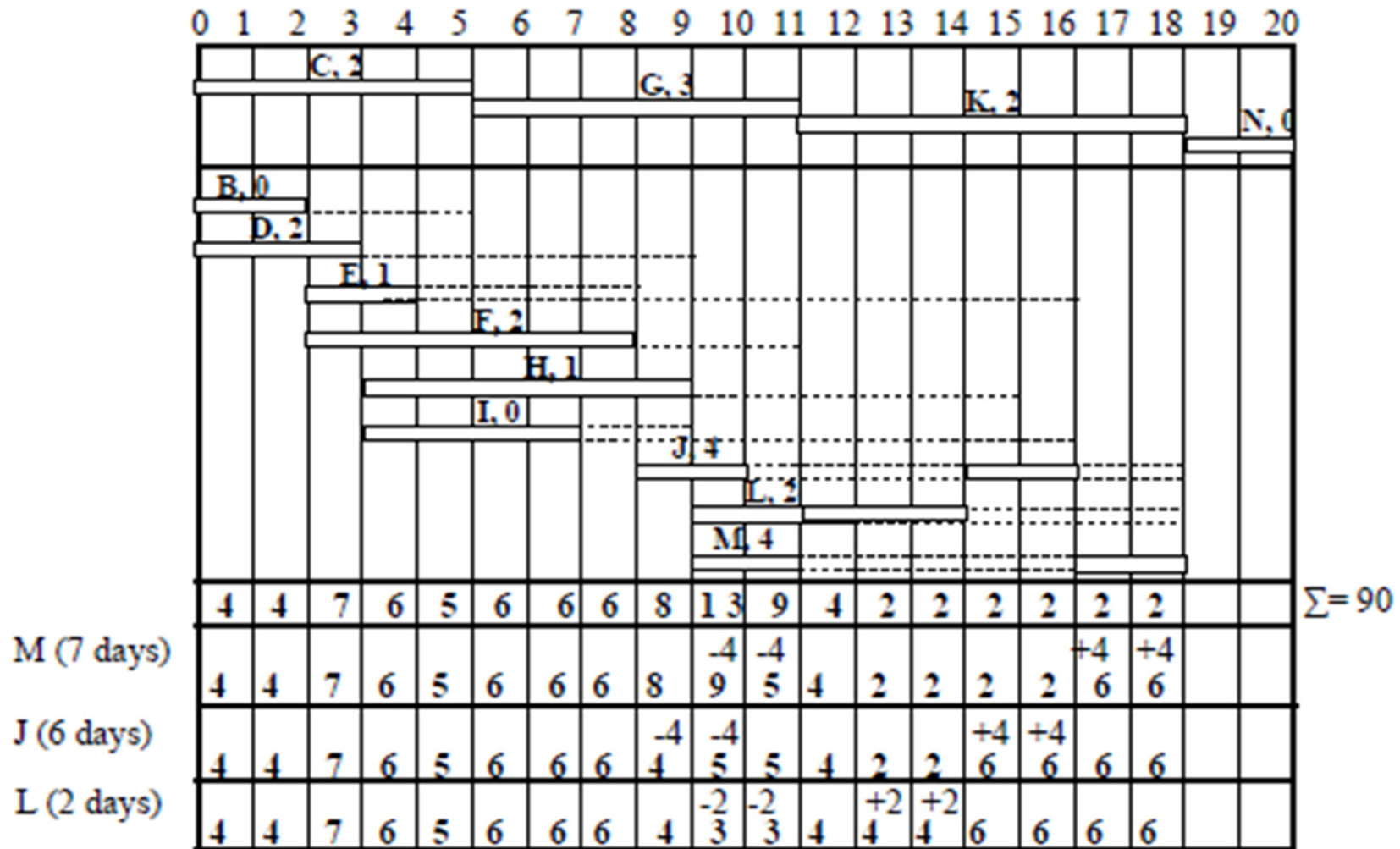
Resource Leveling (Example)

30



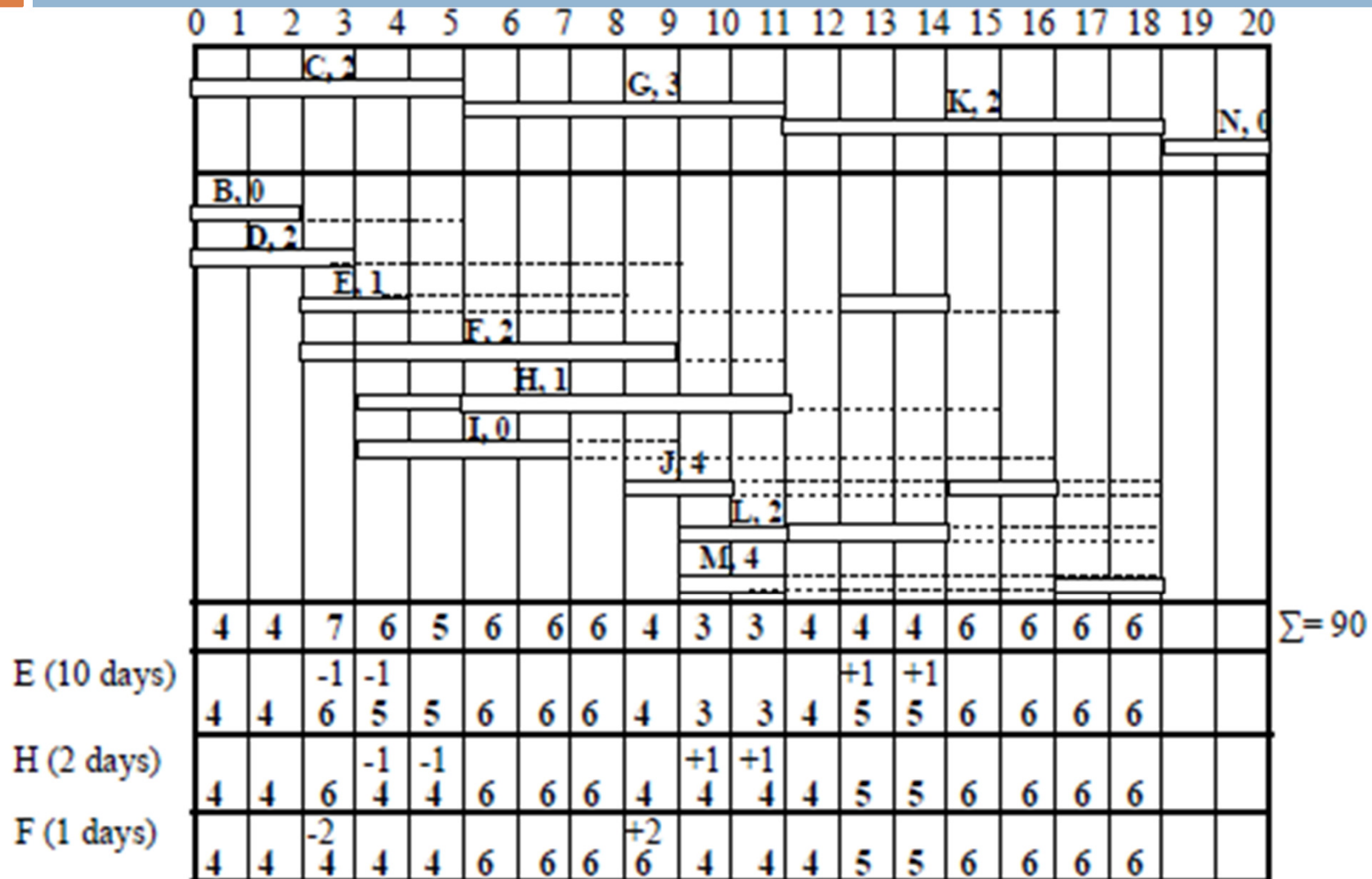
Resource Leveling (Example)

31



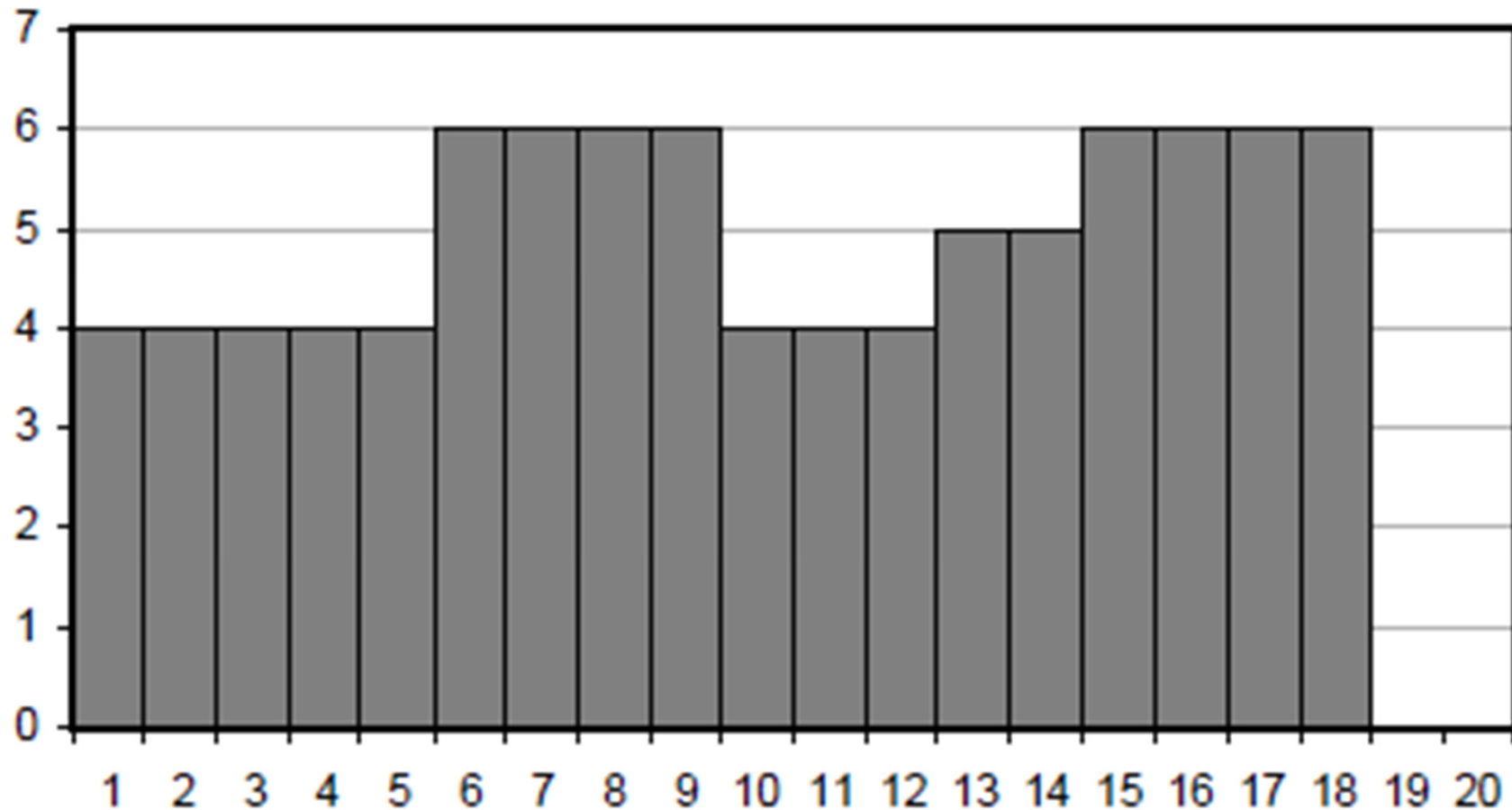
Resource Leveling (Example)

32



Resource Leveling (Example)

33



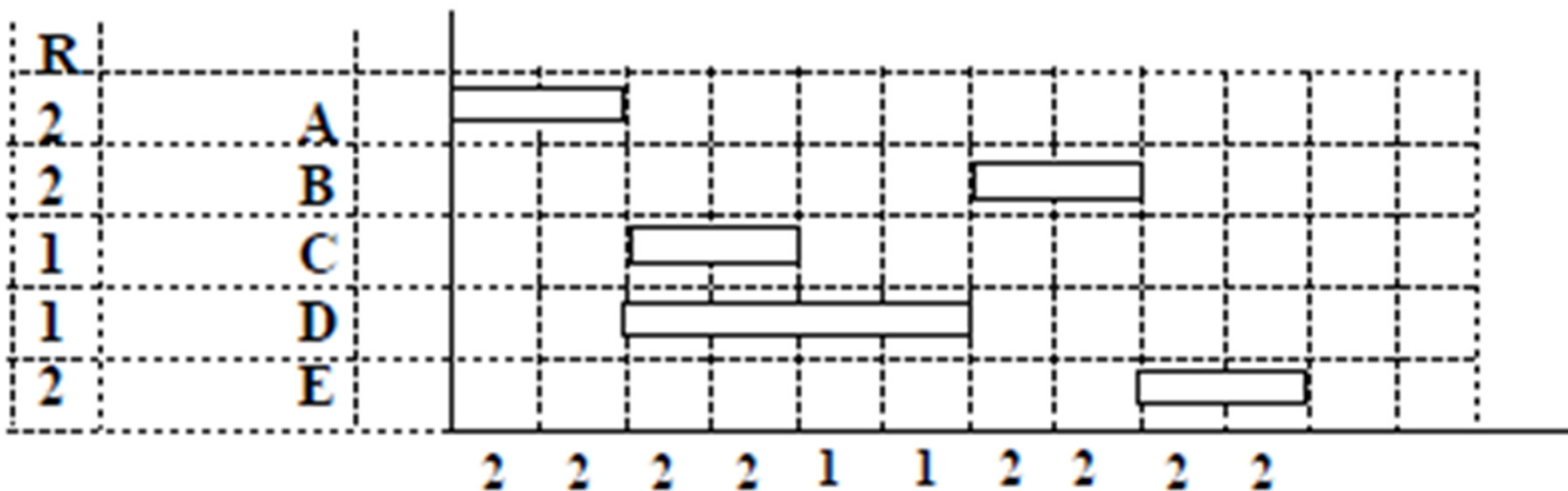
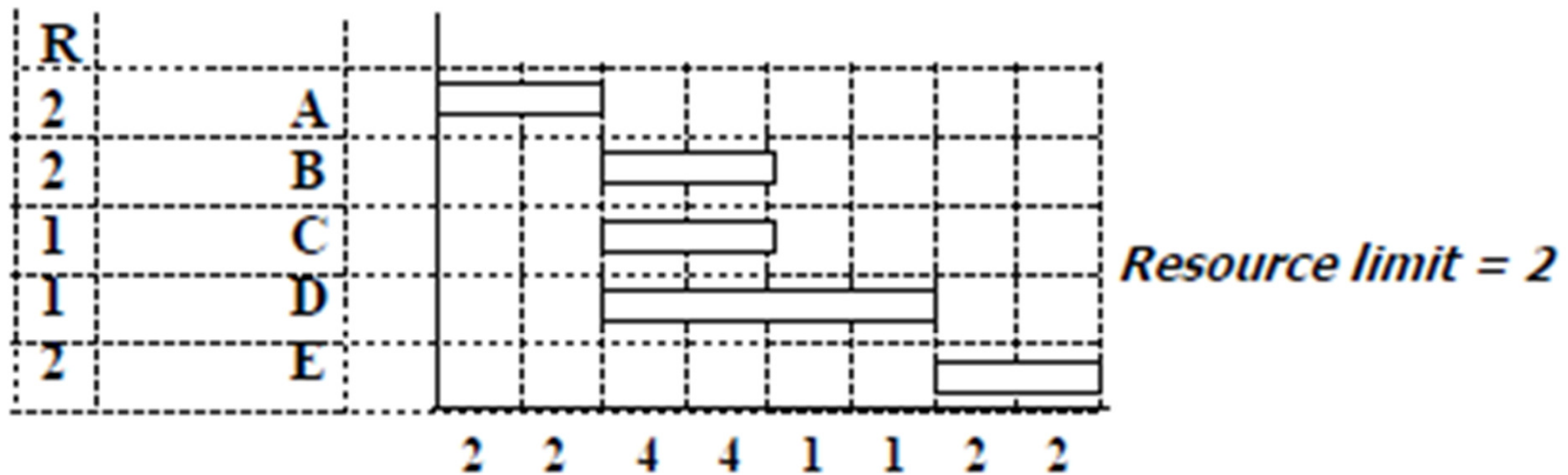
Resource Scheduling

34

- Constrained resource scheduling (Unconstrained time)
- Resource Scheduling
 - ▣ Constrained Resources
 - ▣ Unconstrained project completion; project time may be delayed
 - ▣ Reduce the resource usage to be less than the resource availability
 - ▣ The objective is to meet the resources limits

Resource Scheduling

35



Resource Scheduling

36

Is there is a way to prioritize activities
That compete for the limited resources
so that the net project delay is
minimized?

Resource Scheduling

37

- Resource Scheduling Rules of Thumb
 - ▣ Many rules have been experimented with
 - ▣ Least TF were found to be most effective
 - ▣ Least LS has the same effect as the least TF and doesn't require network recalculations
 - ▣ In case of a tie use least TF

Resource Scheduling

38

□ Procedure

- Prepare a complete activity schedule
- Aggregate the daily resource demand
- If demand greater than available then determine activities compete for resources
- Prioritize these activities based on their LS
- Allocate resources to some activities and delay the others
- Put your solution in table format

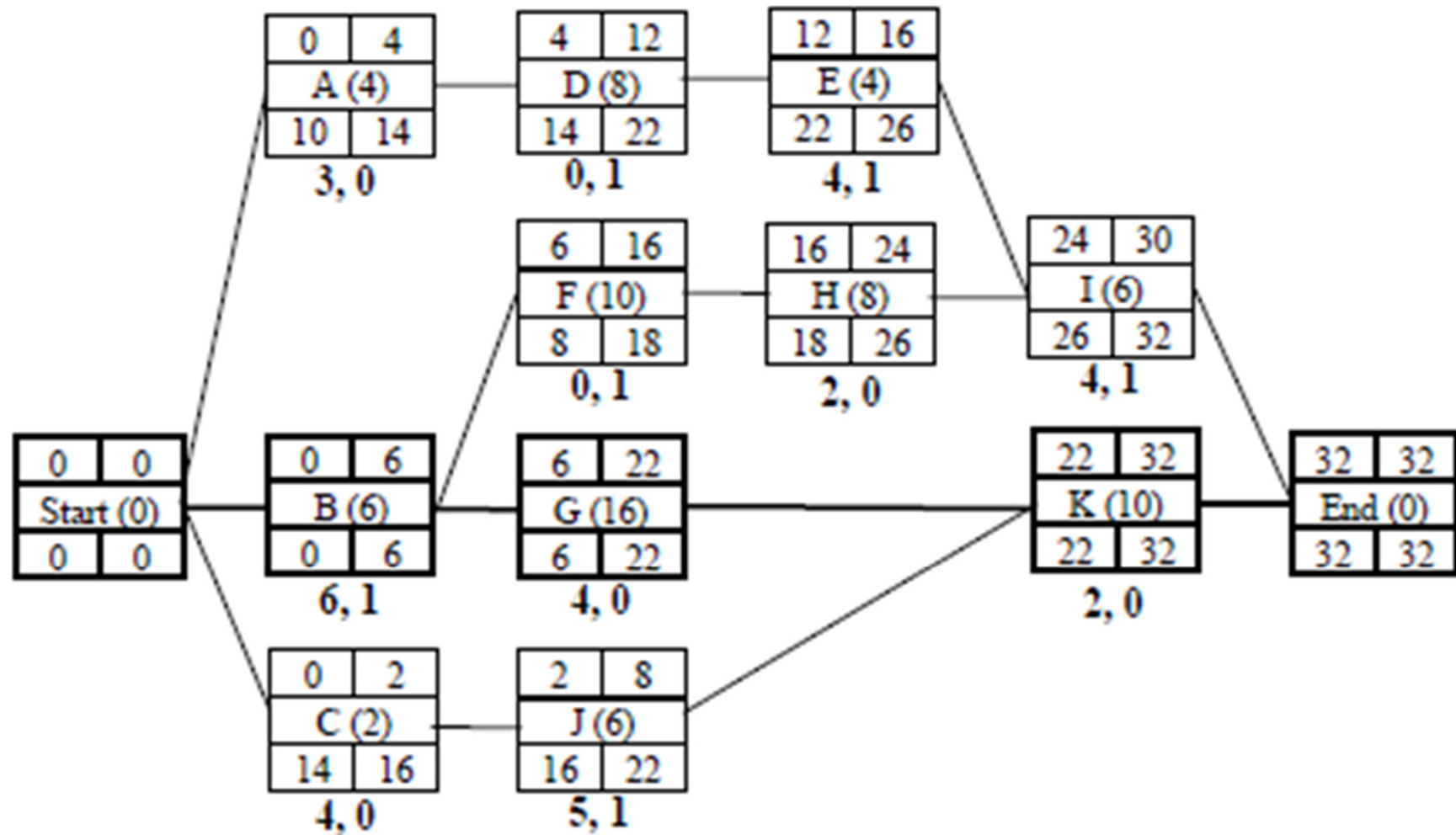
Resource Scheduling (Example)

39

Activity	Duration (Weeks)	Predecessors	Resource (units/week)	
			$R1 \leq 8$	$R2 \leq 1$
A	4	-	3	0
B	6	-	6	1
C	2	-	4	0
D	8	A	0	1
E	4	D	4	1
F	10	B	0	1
G	16	B	4	0
H	8	F	2	0
I	6	E, H	4	1
J	6	C	5	1
K	10	G, J	2	0

Resource Scheduling (Example)

40



Resource Scheduling (Example)

41

Current Time	Eligible Activities	Resources		Duration	Earliest LS	Decision	Finish Time
		R1 ≤ 8	R2 ≤ 1				
0	B	6	1	6	0	Start	6
	A	3	0	4	10	Delay	-
	C	4	0	2	14	Delay	-
6	G	4	0	16	6	Start	22
	F	0	1	10	8	Start	16
	A	3	0	4	10	Start	10
	C	4	0	2	14	Delay	-
10	G	4	0	16	-	Continue	22
	F	0	1	10	-	Continue	16
	C	4	0	2	14	Start	12
	D	0	1	8	14	Delay	-
12	G	4	0	16	-	Continue	22
	F	0	1	10	-	Continue	16
	D	0	1	8	14	Delay	-
	J	5	0	6	16	Delay	-
16	G	4	0	16	-	Continue	22
	D	0	1	8	14	Start	24
	J	5	1	6	16	Delay	-
	H	2	0	8	18	Start	24

Resource Scheduling (Example)

42

Current Time	Eligible Activities	Resources		Duration	Earliest LS	Decision	Finish Time
		$R1 \leq 8$	$R2 \leq 1$				
22	D	0	1	8	-	Continue	24
	H	2	0	8	-	Continue	24
	J	5	1	6	16	Delay	-
24	J	5	1	6	14	Start	30
	E	4	1	4	22	Delay	-
30	E	4	1	4	22	Start	34
	K	2	0	10	22	Start	40
34	K	2	0	10	-	Continue	40
	I	2	0	6	26	Start	40

43

Questions

Contact:

Dr. Ahmed Elyamany

a2hyamany@gmail.com