WEEK-6

Resource Scheduling

Lesson-1:

* We have a good project if we can manage the 2Ms. Material
  Manpower
  Machine
  Money
  } Resource management

* 2 types of resources :- consumable
  - Reusable

Influence of Resources on schedule :-

- Duration of activities depend on usage of resources.
- Sophisticated technologies/resources might lead to better productivity.
- More people ↑ less duration.

↳ Availability of skilled human resource.
↳ Resources are the significant component of project cost.
↳ Proper scheduling of resources will have positive impact on the time as well as cost of the project.
↳ Improper scheduling resources will result in project cost and time overruns.

Q. Span Bridge example.

Resources:
a) Casting operation - Equipment to mix concrete
People resource.
Concrete & Reinforced steel.
Truck to transport.

What decisions do we need to make about resources?
* quantity of resources
* Weekly resource plan.
↳ How much needed in this week.
↳ Manpower, equipments.

* Materials:
- Periodic order quantities.
- Storage requirements and locations
- Quantity discounts - multiple sites
- Custom equipment ordering & delivery.

* Manpower:
- Mobilisation requirements each period.
- Skill requirements during each period.
- Work planning during non-availability period.

* **Machinery:**
  - When special equipment is needed on site.
  - Preparatory works for equipment requirement
  - Sharing equipments with other sites.
* **Money:**
  - Cash flow predictions
  - Credit Planning
  - Project Profitability
  - Tax Planning

Resource loading

- Assume that 1 manpower resource is required per day for each activity. :→(early start)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
A	1	1	1	1	1									
B						1	1	1	1					
C						1	1	1	1	1	1			
D												1	1	1

- Each activity is loaded with one manpower resource based on early start.

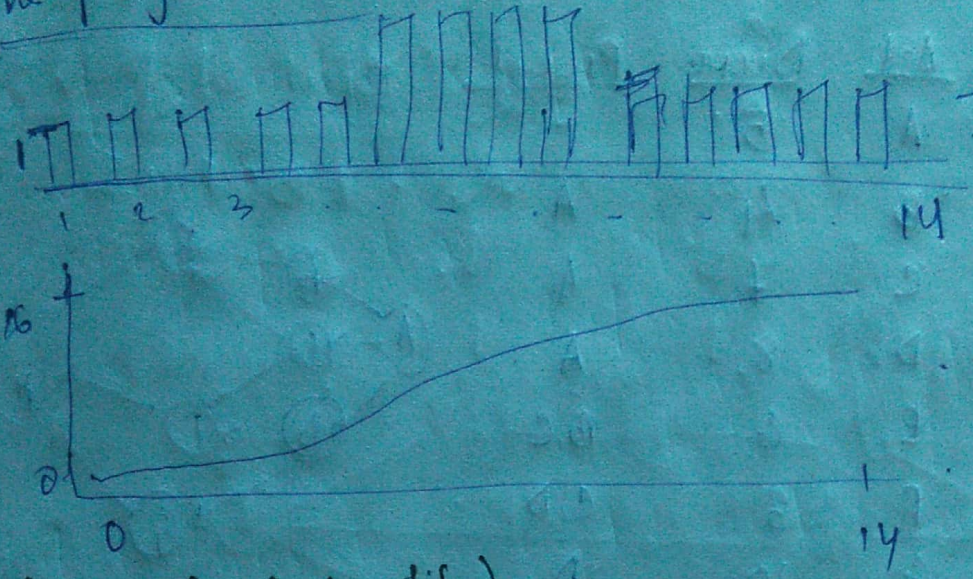
Cumulative Resource Requirement

- Adding up the resource requirement for each activity for each day a cumulative resource requirement for each day can be derived.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
T=	1	1	1	1	1	2	2	2	2	1	1	1	1	1
Cum=	1	2	3	4	5	7	9	11	13	14	15	16	17	18

Resource Bar Chart

- Based on the cumulative resource requirement for each day a resource histogram can be plotted.
- This can be used to visually understand the resource requirement over the total length of the project.



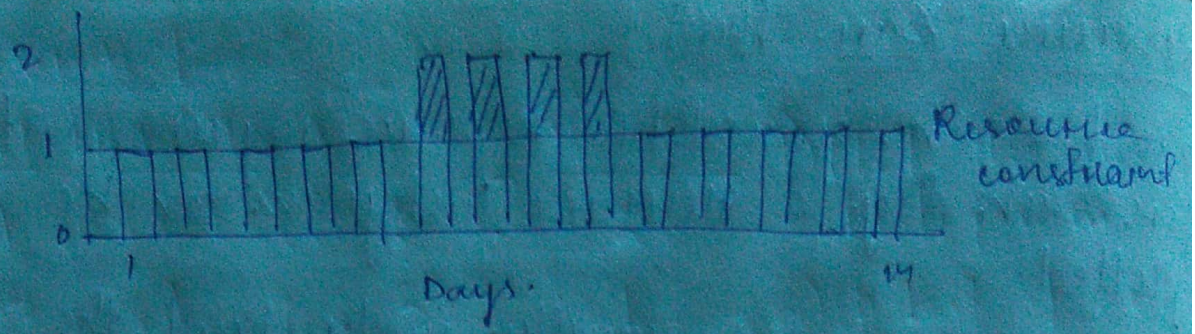
(late start profile)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
A)	1	1	1	1	1									
B)								1	1	1	1			
C)						1	1	1	1	1	1			
D)												1	1	1

(Accordingly graphs).
Called the (Banana Curve).

Resource over-allocation

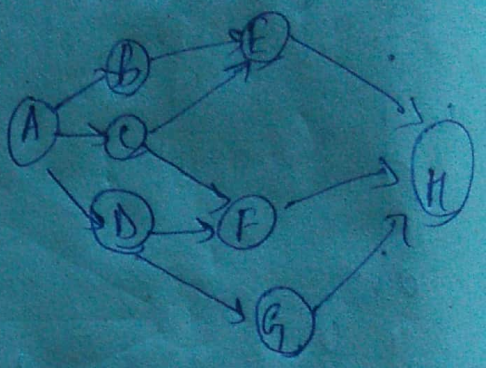
- If we consider that there is maximum available of only one manpower resource on any given day
- In the above examples day 6, 7, 8, 9 have the allocated resources more than the available limit.



Option available: Project is delayed.
Either do B then C (delay by 4 days)

Example:

Act	Dura	Pred.
A	5	-
B	4	A
C	7	A
D	8	A
E	6	B, C
F	3	C, D
G	10	D
H	4	E, F, G



Gantt chart: (early start)

- Histogram

Cumulative resource graph.
Cumulative cost / manpower

Lesson - 2:

Projects and Resources

* 4 scenarios: → Main focus
  - → Single proj - Single resource
  - → Single proj - Multiple resources.
  - → Multiple proj - Single resource
  - → Multiple proj - Multiple resources.

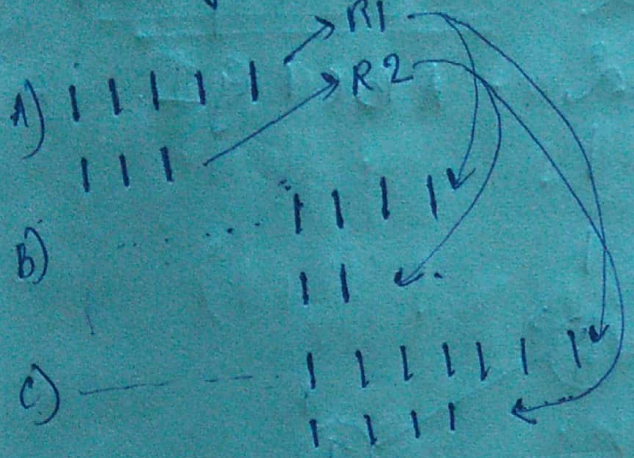
* As a project Manager the challenge faced is (Single project - Multiple Resources)

* Metro Rail → Multi proj - Multi resource.

Example - 2 Resources:

* Manpower + equipment resource.
* Equipment resource required for 1st half of every activity.

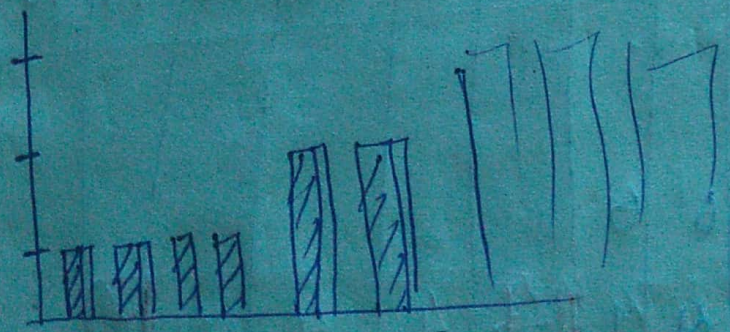
R1 = Manpower
R2 = Equipment (only for first half)



R1)

R2)

Cumulative histogram



Cumulative resource graph.

* We can load cost onto it.

R1 = 250/day
R2 = 500/day

Exercise:

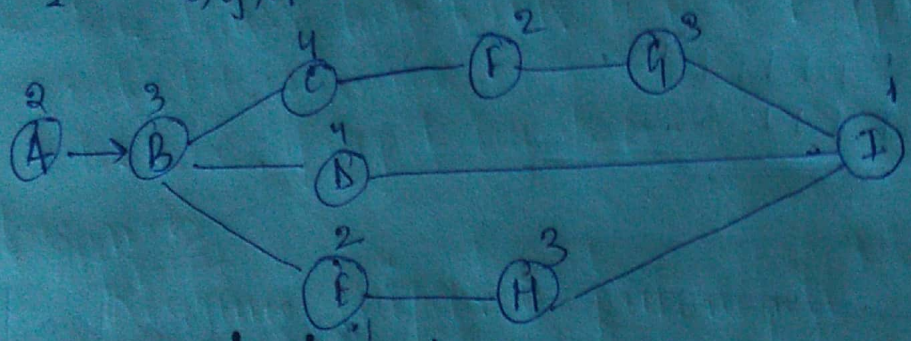
Act	Preced	Duration	Trucks
A	-	2	2
B	A	3	1
C	B	4	6
D	B	4	4
E	B	2	4
F	C	2	2
G	F	3	2
H	E	3	1
I	D,G,H	1	1

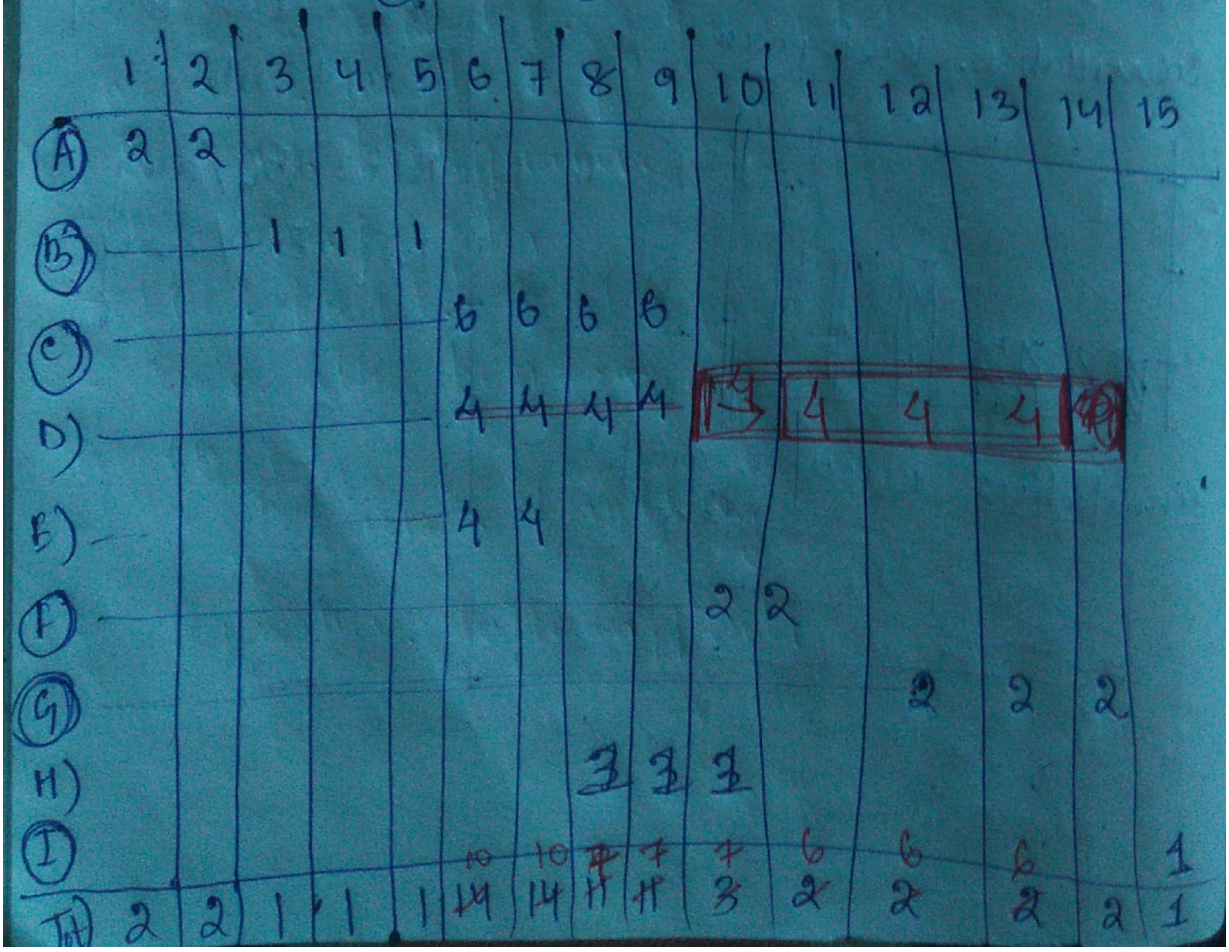
1) Plot the resour histogram.

2) What if only 10 trucks are available?

Critical path:

A-B-C-F-G-I





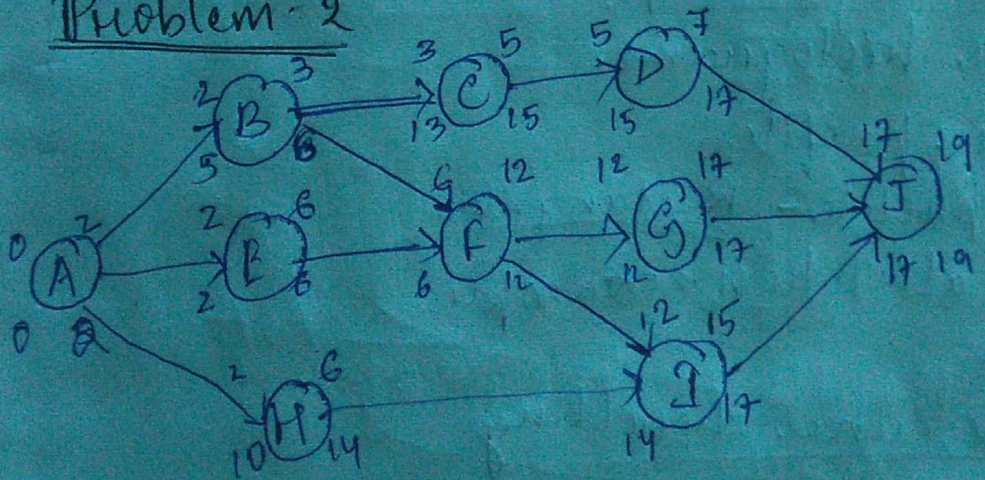
*Given there are 10 trucks available but on day 6 and 7, 14 trucks are needed.
*Hence we need to use the "floats"
* A, B, C, F, G, I are fixed
  ↳ No removal or changes are allowed
* D, E, H can be moved.
* D can be moved to 10-14.

Lesson-5

*Resource overallocation

- In the previous problem we could see this.
- Sol^n: Utilise floats (Moved D)
- Float of D was used.
- There may be chance D is done by a sub-contractor and denies to be moved.
- E, H might be available.
- Hence multiple options available.

Problem-2



Critical - A E F G J.

*Strategies to deal with resource allocations
*floats
*decrease the duration and adjust the money.
*Increase the duration of non-critical activities.
* Split an activity (not necessarily concurrently)

Lesson-4

Problem-1 (2 Resources)

Conflict - Resolving one resource over allocation results in another.

- Split the activity
- ~~Stretch the activity duration b.~~
- Use float to shift activities.
- Increase activity duration - by reducing resource loaded.
- Decrease activity duration - by increasing resource & shift activities using float
- Split activity
- Over time / shift work (Increased effort)
- substitute resources
- Increase project duration.

Lesson-5

Resource Profile Requirements

Resource Profile Req?

- Resource histograms.
- Various profiles.
- Ideal profile - Rectangular
- Over allocation - example

lesson-6

Resource Levelling

- Alternative shifts in floats

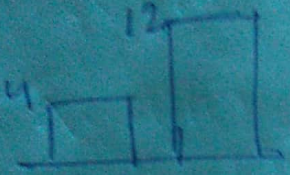
Lesson 11

Minimum Moment concept

- When need a flat profile (rectangular).
- Mathematical approach for zeroing on the best profile - we use this concept

* Moment of the resource histogram about X axis is minimum if the histogram has a rectangular profile.

$$M = \Sigma (y * y/2)$$



$M = 4 \times 4/2 + 12 \times 12/2$

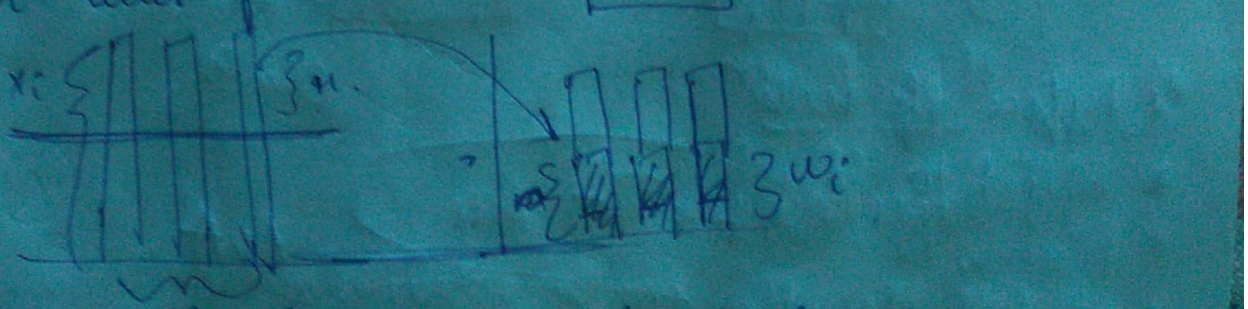
$\boxed{M = 80}$

Improvement fun^n

x_i = Resource level from which m days of resources are removed.

w_i = Resource level to which m days of resources are added

a = level of resources



$$M_1 = \frac{1}{2}\sum_1^m x_i^2 + \frac{1}{2}\sum_1^m w_i^2 \quad \text{(before shifting)}$$

$$M_2 = \frac{1}{2}\sum_1^m (x_i - K)^2 + \frac{1}{2}\sum_1^m (w_i + K)^2$$

$M_1 = M_2$ / $M_1 > M_2$ / $M_1 < M_2$

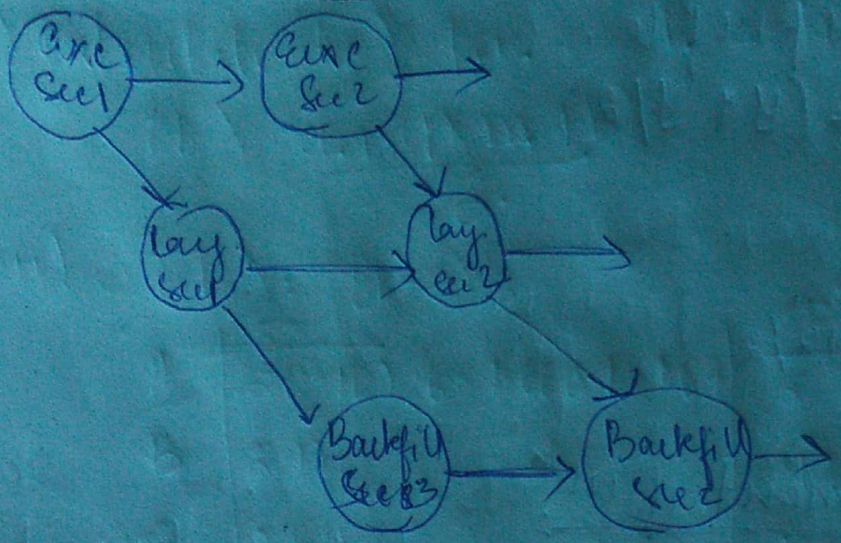
$$\Delta = n\left(\sum_{1}^{m} q_i - \sum_{1}^{m} w_i - m\mu\right)$$

WEEK - 4

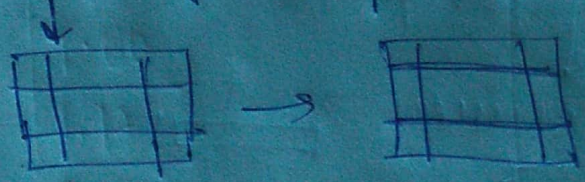
Precedence Diagramming Method

lesson - 1

Introduction



* Attempt to get advantages of AOA's events with a AON type representation



* types of relⁿ
  * Start to Start
  * Finish to Start ← use this — AOA
  * Finish to Finish
  * Start to Finish
* SS0 [Excv 10] → [Lay 5] — Zero lag
* SS1 [Excv 20] → [Lay 5] — Positive Lag