CB 510
Project Management

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What we learned so far

- Planning activities
- Relationships of activities
- Plan representation
  - AOA
  - AON

Scheduling

- Scheduling is determining the start and end dates of each activity

- Consequently, a planner can determine the project total duration

Critical Path Method (CPM)

- CPM was developed in the 1950s
- CPM is a simple and systematic algorithm to calculate the start and end dates of the activities, determine the project duration, and define the critical path
- Critical path is a set of activities in the project that cannot be delayed without delaying the project (later on that later)

CPM

- CPM calculation requires
  - ✓ Develop the relationship of activities
  - ✓ Define the overlap and lag of activities
  - ❑ Calculate the duration of each activity
  - ❑ Carryout the forward path
  - ❑ Carryout the backward path
  - ❑ Calculate floats
  - ❑ Determine the critical path

$$d_i = \frac{q_i}{p_m}$$

Where, *i* is the activity, *d* is the duration of the activity, *q* is the quantity of work in the activity, and *p* is the production rate of construction crew *m*.

CPM – Forward and Backward Paths

- Each activity has early and late dates
  - Early Start (ES)
    - Earliest possible start date of an activity
  - Early Finish (EF)
    - Earliest possible finish date of an activity
  - Late Start (LS)
    - Latest start date of an activity without delaying the project
  - Late Finish (LF)
    - Latest finish date of an activity without delaying the project

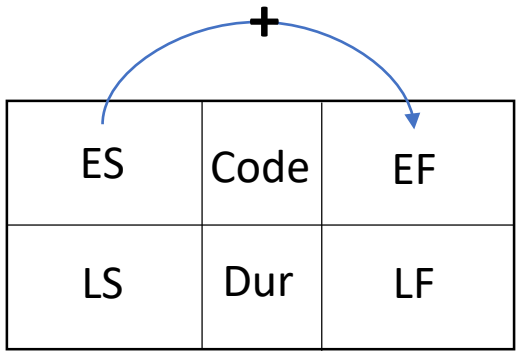
ES	Code	EF
LS	Dur	LF

CPM – Forward and Backward paths

- Forward path steps
  - Calculate ES

    ES = max [Predecessors' EF]
  - Calculate EF

    EF = ES + Duration



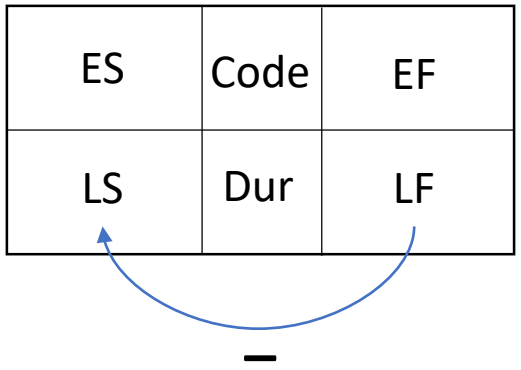
CPM – Forward and Backward paths

- Backward path steps
  - Calculate LF

    LF = min [Successors' LS]

  - Calculate LS

    LS = LF - Duration



Example

Activity	Predecessor	Duration
A	--	5
B	A	3
C	A	2
D	B	7
E	B,C	3
F	D,E	5
G	E	6
H	F,G	2

CPM – Floats

- Free Float (FF)
  - FF is the amount of delay the activity can have without delaying its immediate successors

$$FF = \min [\text{Successors' ES}] - EF$$

- Total Float (TF)
  - TF is the amount of delay the activity can have without delaying the total project

$$TF = LS - ES = LF - EF$$

Example

Activity	Predecessor	Duration
A	--	5
B	A	3
C	A	2
D	B	7
E	B,C	3
F	D,E	5
G	E	6
H	F,G	2

Critical Activities and Critical Path

- Critical Activities are the activities with Zero TF

- Critical Path is the set of Critical Activities

Note:

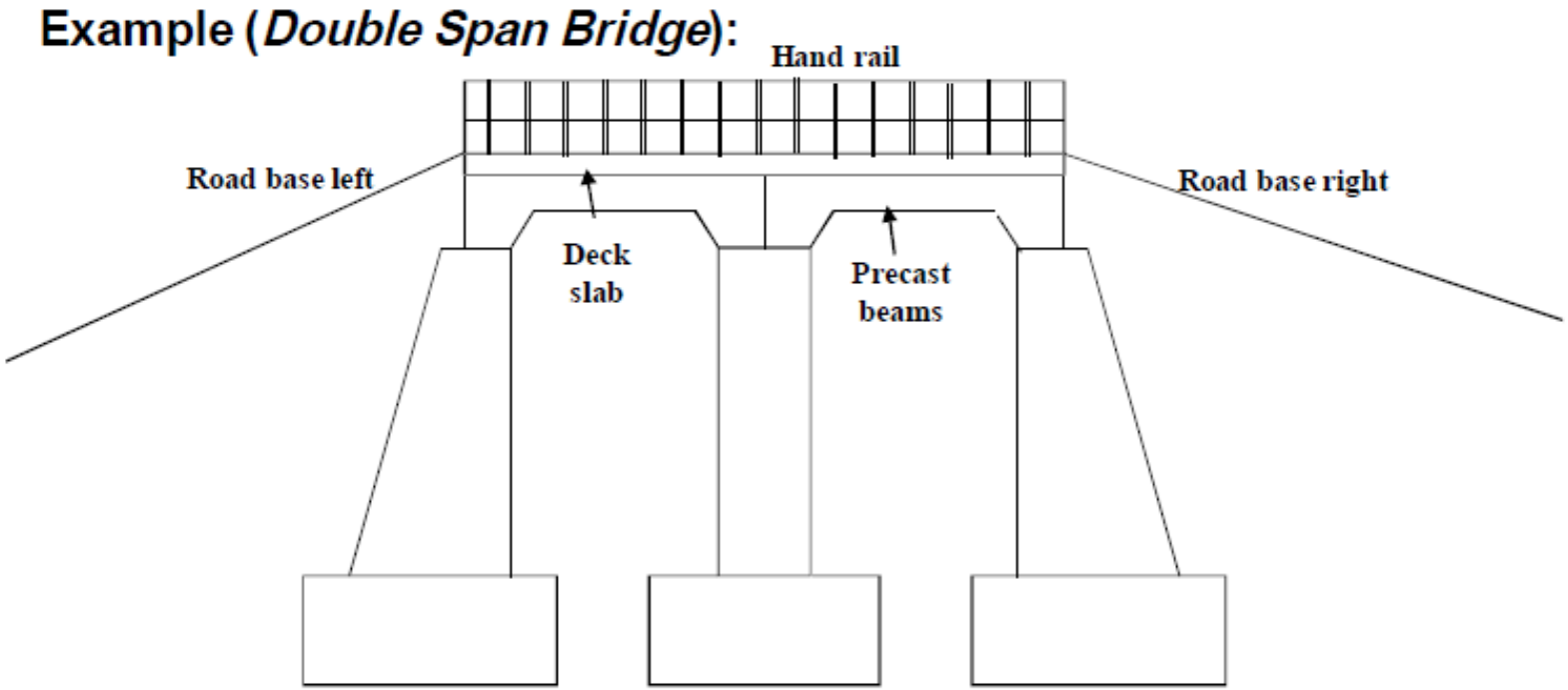
Critical path must be continuous

There can exist more than one critical path

If an activity has a TF = 0, then the FF should be = 0

if an activity has a FF = 0, the TF DOES NOT have to be = 0

Last week example



Code	Description	Predecessor	Duration	Code	Description	Predecessor	Duration
10	Mobilization and site setup	NA	2	100	Construct center pier	70	6
14	Procure Reinforcement	NA	1	110	Erect north precast beam	16,80,90,100	2
16	Procure Precast Beams	NA	1	120	Erect south precast beam	16,80,90,100	2
20	Excavate left abutment	10	5	130	Fill left embankment	80	2
30	Excavate right abutment	10	5	140	Fill right embankment	90	2
40	Excavate Center pier	10	2	150	Construct deck slab	110,120	5
50	Foundation left abutment	14,20	6	160	Left road base	130	3
60	Foundation right abutment	14,30	6	170	Right road base	140	3
70	Foundation center pier	14,40	5	180	Road surfacing	150,160,170	5
80	Construct left abutment	50	8	190	Bridge railing	150	1
90	Construct right abutment	60	8	200	Clear site	180, 190	2