2.3.7. Scheduling and resource planning (for construction)

SCHEDULING

Project scheduling is a method whereby the tasks necessary to be performed in order to achieve project completion are arranged in a logical order. It is a projected timetable of construction operations that will serve as the principle guideline for project execution. In addition to assigning dates to project activities, project scheduling is intended to match the resources of equipment, materials and labour with project work tasks over time.

This type of scheduling is done by way of bar charts; either by hand, or more likely computer generated. In particular, the critical path method of scheduling is commonly required by owners.

CRITICAL PATH METHOD

Of all the techniques available to a project manager, CPM has proven to be the most useful and effective means of developing and displaying the information needed to control the time variables on today's job sites. This method calculates the minimum completion time for a project along with the possible start and finish times for the project activities. The critical path represents the set of activities which will take the longest time to complete. The duration of the critical path is the sum of the activities' durations along the path. The duration of the activities on the critical path represents the minimum time required to complete a project. Any delay along the critical path automatically lengthens the duration of the project. As a consequence of this, identification of the critical activities is an important aspect of job scheduling because it pinpoints those job areas that must be closely monitored at all times if the project is to be kept on schedule. An activity not on the critical path will have a float. Float is a very valuable concept since it represents the scheduling flexibility available to complete particular tasks. For activities with some float, the actual starting time might be chosen to balance work loads over time, to correspond with material deliveries, or to improve the project's cash flow.

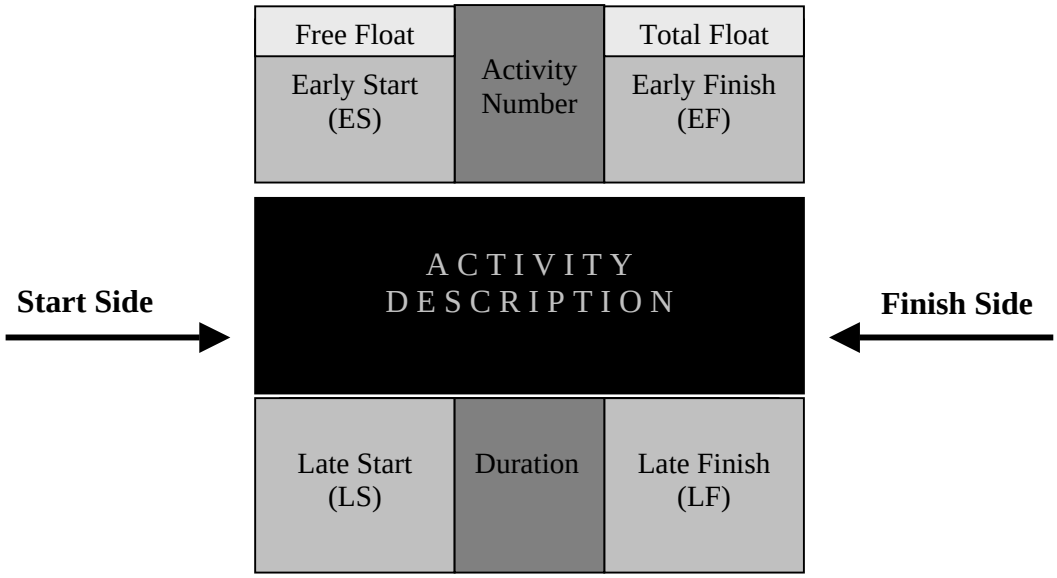
BUILDING PRECEDENCE DIAGRAM

- list the activities and the relationships,
- create a Start node. (start milestone),
- draw arrows from the start node to the first activities node,
- sequentially arrange all activities from the start node,

– repeat process from successors for all activities,

– create a finish node.(finish milestone).

ACTIVITIES ON NODE



- **Early Start (ES)** The earliest day that the **activity** can start provided every preceding **work item** starts at its earliest start day and is **complete**d in its expected time. Earliest event times are computed as the maximum of the earliest start times plus activity durations for each of the activities immediately preceding an event.

ES = Largest EF (predecessor/s)

- **Early Finish (EF)** The earliest day that the activity can finish if it starts on its earliest start and is completed in its expected time.

EF = ES + Duration

- **Late Start (LS)** The latest **time** an activity may begin without **delay**ing the project finish date.

LS = LF - Duration

- **Late Finish (LF)** The latest time an activity may be completed without delaying the project finish date.

LF = Smallest LS (successor/s)

- **Free Float (FF)** The amount of delay that an activity can have before any of its successors is delayed.

FF = Smallest ES (successor) – EF

- **Total Float (TF)** The maximum amount of delay that an activity can have before project completion is delayed.

TF = LS - ES

In all cases, total float equals or exceeds free float. Also, any activity on a critical path has all the values of float equal to zero. The converse of this statement is also true, so any activity which has zero total float can be recognized as being on a critical path.

- **Finish – to – Start (FS)** The 'from' activity must finish before the 'to' activity can start.

- **Finish – to – Finish (FF)** The 'from' activity must finish before the 'to' activity can finish.

- **Start – to – Start (SS)** The 'from' activity must start before the 'to' activity can start.

- **Start – to – Finish (SF)** The 'from' activity must start before the 'to' activity can finish.

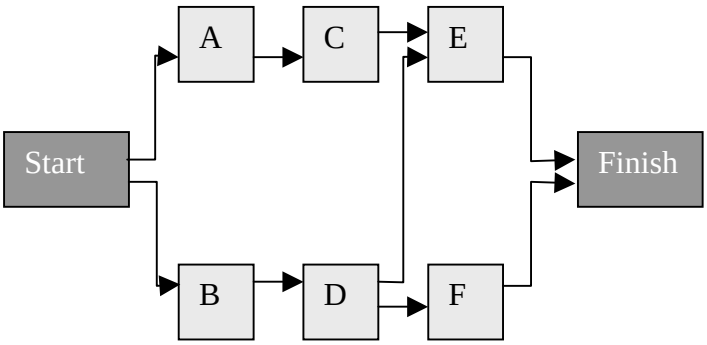
- **Predecessor Activity** An activity that must be completed (or be partially completed) before a specified activity can begin is called a predecessor activity. In the arrow diagramming method, it is defined as the activity which enters a node.

- **Successor Activity** In an arrow diagramming method, the activity which departs a node

- **Successor Task** A task that cannot begin until another task has started or finished.

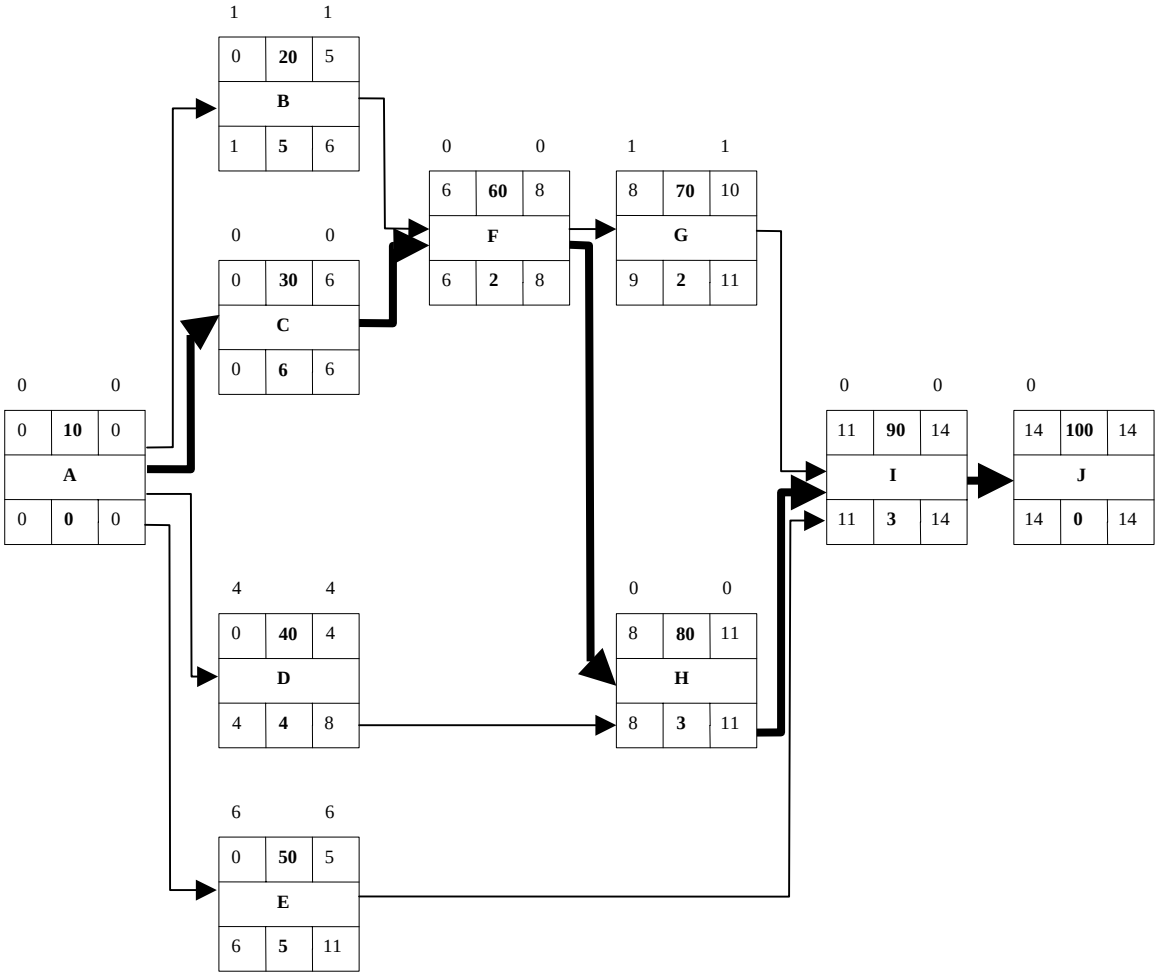
FORMULATING A NETWORK DIAGRAM

Activity	Predecessor(s)
A	-
B	-
C	A
D	B
E	C,D
F	D



CRITICAL PATH SCHEDULING CALCULATION

Activity	Description	Predecessors	Duration
10	A	-	0
20	B	A	5
30	C	A	6
40	D	A	4
50	E	A	5
60	F	B,C	2
70	G	F	2
80	H	D,F	3
90	I	H,E,G	3
100	J	I	0


1 1
0 20 5
B
1 5 6
0 0
6 60 8
F
1 1
8 70 10
G
0 0
0 30 6
C
0 6 6
0 0
0 10 0
A
0 0 0
0 0
11 90 14
I
0 0
14 100 14
J
14 0 14
4 4
0 40 4
D
4 4 8
0 0
8 80 11
H
8 3 11
6 6
0 50 5
E
6 5 11

Activity	Duration	ES	LF	LS	TF
10	**0**	**0***	**0***	**0**	**0***
20	5	0	6	1	1
30	**6**	**0***	**6***	**0**	**0***
40	4	0	8	4	4
50	5	0	11	6	6
60	**2**	**6***	**8***	**6**	**0***
70	2	8	11	9	1
80	**3**	**8***	**11***	**8**	**0***
90	**3**	**11***	**14***	**11**	**0***
100	**0**	**14***	**14***	**14**	**0***

***** Activities having the Total Float (TF) value '0' lies on the critical path.

Communicating the project schedule is a very important aspect for successful project management. A good presentation will greatly ease the manager's problem of understanding the multitude of activities. Graphical presentations of project schedules are particularly useful since it is much easier to comprehend a graphical display of numerous pieces of information than to go through a large table of numbers. A useful graphical representation tool is a bar chart illustrating the scheduled time for each activity. The bar chart lists activities and shows their scheduled start, finish and duration.