Chapter two
Developing network model

- It’s the most important step in using a network as a scheduling tool.
- The network represents a time oriented model of a system.
- Its makes the study of a system easy and give fully understanding for the project.
- Its show all details for the project (activities, durations, ranking ....etc)
How to build a network model

1. Define activities
2. Order activities
3. Establish activity relationships and draw a network diagram
4. Determine quantities assign durations to activities
5. Assign resources and costs
6. Calculate early and late start/finish times
7. Compute float values and identify the critical path
8. Schedule activity start/finish times
Define activities

Construction activities are:

A - production (construction)
Which relate directly to the physical effort of creating the project

B - procurement
Which include arranging for the acquisition of materials, money, equipment, and manpower

C - management
Support tasks often directly impact the project schedule
Ordering activities

The ordering based on the timing of some activities relative to the occurrence of other activities.

For each identified activity the following must be determined:

1. which activities must precede it?
2. which activities must follow it?
3. which activities can be concurrent with it?

To answer these questions we must identify the IPAS for each activity.

IPAS provide no recourse constraints will be imposed on the project.
IPAS

- The immediately preceding activities
- Ensure that no resource constraints will be imposed on the project
- Each activity will be success and generated success activities
- What you mean by the success??
- The success here depends on defining the set of activates that control when each activity can start because an activity can only begin if all of its predecessors are completed
Way to success

Once the IPA list is complete, the network can be created
Constraint
Without constraints all activities will begin on the first day of construction.

But constraints are exist in the real world and its many types :-}
Physical constraints

- Physical constraints exist due to physical process of construction.

- Physical constraints defined by “HOW” the project is to be carried out. (Method of construction).

- You need to erect formwork before you can cast concrete.
Resource constraints

- These constraints imposed wherever two activities cannot be carried out simultaneously because insufficient resources are available.

- E.g. Two activities require a crane to be performed and you have just one crane. So, they should not be performed at the same time.

- E.g. The amount of required concrete per day exceeds the production capacity of a batch plant.
Safety constraints

- Safety constraints imposed by safety requirements through performing the work.
- Sometimes impose that two activities could not be performed at the same time due to non-safe work conditions. (e.g. overhead and ground level work at the same area.)
- Impose specific sequence of the work. (e.g. erecting of scaffolding before external paints can start)
- Impose non-working days due to extremely hot or cold days.
Financial constraints

- Financial constraints: high cost activities could be delayed due to non-availability of cash requirements during construction.

- The amount of cost: a company can pay within a specific period of time usually limited. So, try to avoid overlap between high cost activities.
Environmental constraints.

- Environmental constraints include restrictions to the work to avoid environmental violations.

- E.g. not working in certain area during specific times to avoid affecting proliferation of eagles, fish run.
Management constraints.

- Management constraints reflect decisions of management that result in a reasonable benefit of the company.

- E.g. the management decided to borrow from your project resources to be utilized in another project.

- E.g. the management decided to extend the new year holiday another 2 days.
Contractual constraints

- The owner may impose constraints on the construction process.
- E.g. the owner may require a particular phase of the project to be fully completed and occupied before start construction of next phase.
- And he may require to minimize the noise and dust because that portion is occupied and in operation.
Regulatory constraints

- These type of constraints related to the regulations of the area of construction. Imposed by municipality, government, etc.

- E.g. if the construction site in the downtown, heavy vehicles like concrete mixers prohibited to access the site in a specific times of the day. So, you can just cast concrete at night.
Drawing the network diagram

There are two types of network diagram the precedence diagram and the arrow diagram, but the arrow diagrams are used very little today.

The precedence diagram depicts activities as nodes with logic link lines that depict the dependencies that exist between the activities.
Cont.

Activity

A
Lay out wall

B
Place rebar cage

C
Erect wall forms

D
Tie rebar

E
Check wall forms

F
Place concrete

Logic link line
Assigning Duration to activities

- The duration of an activity is the estimated time that will be required to complete it.

- Defining duration, as in defining the activities themselves, is less of a science than it is an art.
The time unit appropriate for a project depends on the duration of the project and the nature of the work.

Hours would typically be used for shorter projects lasting only several days. For long-term projects that last for several years, days, weeks, or even months may be more appropriate.
Typically in construction the unit of time is days and its assumed that work is performed on continuous and uniform basis within the standard work day and work week.

Activity durations frequently are tied directly to the recourses applied to them and the productivity of these recources.
Consequently durations can frequently be directly related to labor cost estimated for the tasks.
Durations of the project are developed from:

1. Productivity rates.
2. Historical data, meaning quantitative data from actual projects that the company has undertaken previously.
3. Someone with extensive experience.
Calculating early & late start /finish times

The early start time of an activity is the earliest time that the activity can begin based on the relationship that exist in the schedule.

The late start time is the latest time that an activity can start with impacting the date of the project completion.
The early finish time is the earliest that an activity is expected to be completed.

Late finish time is the latest time that an activity can be completed.

If the late finish date is exceeded the project duration can be expected to be increased by the same number of days that the activity is completed beyond the late finish time.
Identify the critical path

- When activity start date is fixed in this way the activity is said to have no float such activities are said to be critical.

- Critical path is the path from the beginning of the network to the end of the network on which all activities are critical.
Chapter Three
Precedence Diagrams
Advantages of using Precedence Diagram:

1. No dummy activities are required.
2. A single number can be assigned to identify each activity.
3. Analytical solution is simpler.
Redundant Linkages

(a) Incorrect Representation

(b) Correct Representation
Closing the network to give Single Beginning and Ending Nodes

(a) Incorrect Representation

(b) Correct Representation

Starting Dummy

Finish Dummy

Nabil Dmaidi
Retaining Wall Precedence Diagram

Wall 1

Footing 1

Footing 2

Wall 2

Footing 1

Footing 2

Wall 1

Wall 2

6/14/2010

Nabil Dmaidhi
Precedence Diagram - Sequence Stepped and Numbered

Start

10 A
20 C

5

15 D

25 E

35 Finish

30 F

2

3

4

6/14/2010
Nabil Dmaid
Constructing the Precedence Diagram

1. Create Activity list and eliminate redundancies.

2. Construct precedence diagram
   - Activities with no dependency arranged at the left
   - Create dummy start if you have more than one start “Contract Award”

3. Arrange activities in a sequential order
Precedence Diagrams

Representing the activity by one node and links between nodes to show the dependency

Most common type of network schedule in use today
Activity relationships

- Start to finish
- Start to start
- Finish to finish
- Finish to start
Nodes represents activity links represents dependency left to right

- Lay out pole location
- Dig holes and set ball
- Set trusses and roof frames
- Install roofing
- Install siding

Activity link
Finish to start is the most common practice........................WHY?

because it makes the computations easier for the manual solution
Steps to make detailed precedence diagram for a project

1- use the project breakdown structure to simplify the project until you reach the single activity.

2- assign activities durations

3- locate activities resources (material, equipment, and labor etc..)
Steps to make detailed precedence diagram for a project (cont.)

4-determine the activities dependencies

5-draw the precedence network

6-calculate early start, early finish, late start, late finish, total float, free float, interfering, and independency
Detailed node contains most considerable information about an activity

*Standard form:

<table>
<thead>
<tr>
<th>Activity description</th>
<th>Duration</th>
<th>LS</th>
</tr>
</thead>
<tbody>
<tr>
<td>ES</td>
<td>FF</td>
<td>TF</td>
</tr>
<tr>
<td>EF</td>
<td>LF</td>
<td></td>
</tr>
</tbody>
</table>
Calculations of precedence network

**Early start (ES):** the earliest time that an activity can start

ES : max. early finish time of all immediately preceding activity

**Early finish (EF):** the earliest time that an activity can finish

\[ EF = ES + \text{ duration} \]
(Cont.)

**Late start (LS):** the latest point of time that an activity can start without delaying the completion of project

\[ LS = LF - \text{duration} \]

OR

\[ LS = ES + TF \]

**Late finish (LF):** the latest time that an activity can be finished without delaying the project completion

Its equal to earliest of the late start of the immediately following activities

\[ LF = EF + TF \]
**Lag:** is time associated with a link line. It indicates the difference between the early finish of activity preceding the link and the early start of the activity following the link.

Lag$_{AB}$ = ES$_B$ - EF$_A$

Lag can be used to calculate TF, FF.
Total float (TF): the amount of time that an activity can be delayed before it impacts the completion of the project. 

\[ TF = LF - EF \]

Free float (FF): the amount of time that an activity can be delayed before it impacts the start of any succeeding activity, and it equals the smallest link lag value of all link lines that occurs immediately after the activity.
Independent float (INDPF): is float that is “owned” exclusively by one activity. As such the independent float of one activity is not available for use by any other activity.

The word independent means that the float of the activity has nothing to do with the late finish times of succeeding activities. Its also called the “safe” float.

\[
\text{INDP float}_{\text{activity } A} = \text{ES}_{\text{following}} - \text{LF}_{\text{preceding}} - \text{duration}_A
\]
Interfering float (shared float) (INTRF):

The interfering float of an activity is the portion of the total float of that activity that is shared with other activities, the interfering float is the amount of time that its early start can be delayed without delaying the project but it will delay at least one of the following activities

\[ \text{INTRF}_A = \text{TF}_A - \text{FF}_A \]

Interfering float is held in common at least by two or more activity