Project stages

Inception  Feasibility  Design  Tender  Construction  Commissioning

(Scofield and Wilkinson, 2010)
Definitions: Programming

Programme: Agenda, timetable, calendar, list, schedule, to-do-list, plan, rota/roster

Programming

• Arrange or plan (an event) to take place at a particular time.
• Make arrangements for (someone or something) to do something.
• Setting an order and time for planned events
Programming techniques

Bar charts
- Linked bar charts
- Arrow diagrams
- Node/Precedence diagrams
- Flowline diagrams
...

CPM Method

(adapted from Cooke & Williams 2010)
Bar chart

‘a graphic representation of project activities, shown in a time-scaled bar line with no links shown between activities’ (Mubarak 2010, p. 14)

= Gantt chart, after Henry Gantt 1917
## Bar chart

<table>
<thead>
<tr>
<th>Site</th>
<th>Foundation</th>
<th>Frame</th>
<th>Cladding</th>
<th>Interior</th>
<th>Services</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

### Gantt Chart

- Site: 
- Foundation: 
- Frame: 
- Cladding: 
- Interior: 
- Services:
Bar chart - advantages

Easy to create
Easy to understand
→ Simplicity in general

Time-scaled unlike networks

(Hinze 2012, Mubarak 2010)
Bar chart - disadvantages

Lack of logical representation (relationships)

Not practical for complex projects, unless
- You use summary bars
- Show just a part of the project:
  - One subcontractor at a time
  - Certain section of the project
  - Certain phase of the project

Not practical for projects with repetitive tasks
- Does not show the productivity
- Does not show clashes

(Hinze 2012, Mubarak 2010)
Linear scheduling =

- Line of balance
- Time-location matrix
- Time-space scheduling
- Location-based scheduling
- Location-based management
- Flowline

(Andersson & Christensen, 2007)
## Simple Flowline

<table>
<thead>
<tr>
<th>PROJECT</th>
<th>BUILDINGS</th>
<th>FLOORS</th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Jan</td>
</tr>
<tr>
<td></td>
<td></td>
<td>63 1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5 6</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>11 12</td>
<td>13</td>
</tr>
</tbody>
</table>

### Locations

- Building 2
  - 4th floor
  - 3rd floor
  - 2nd floor
  - 1st floor

- Building 1
  - 4th floor
  - 3rd floor
  - 2nd floor
  - 1st floor

### Tasks

- **Plasterboard Walls**
- **Finishing work to walls and ceilings**
- **Tiling**
- **Priming and sealing**

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Gantt chart vs. location-based

Location specific task bars

1 task in flowline = 8 in Gantt view

50 tasks in LOB can be 15,000 tasks in Gantt!
Linear scheduling - advantages

- continuous flow of work through locations
- location is free of unnecessary materials and other crews
  - optimum productivity rates
  - optimum safety
  - optimum craftsmanship
Network diagrams/models

= time oriented model of the project with strong emphasis on the order of activities

= network of activity paths
Network types

Arrow diagram
= Activity On Arrow
= AOA

Node diagram
= Activity On Node
= AON
Critical Path Method (CPM)

Critical path
= which activity path drives the schedule
in every project there is at least one

Activities on the critical path
= any delay in the start or finish of the activity will delay the entire project
Finding the critical path

How many different paths does the network have?
How long does each of them take?
Which path is the longest? (= Critical Path)
Benefits of CPM

Shows dependencies

Shows complex interrelationships
Programming

- Project completion date
- Start and end of a specific activity
- Coordination among trades and subcontractors
- Predict and calculate cash flow
- Improve work efficiency
- Use as a project control tool
- Evaluate the effect of changes and prove delay claims

(Mubarak, 2010)
Programming steps

1. Determine the work activities
2. Determine activities duration
3. Determine activities relationships
4. Review and analyse the programme
5. Cost/resource allocation
6. Resource levelling
7. Implement the programme
8. Monitor and control the programme
9. Revise the database and record feedback

(adapted from Mubarak 2010)
<table>
<thead>
<tr>
<th>WBS</th>
<th>Programme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comprehensive classification of project scope</td>
<td>Actual work to be done (only the activities on the last level of the WBS)</td>
</tr>
<tr>
<td>Contains no activity duration</td>
<td>Contains activity durations</td>
</tr>
<tr>
<td>No resource assignments</td>
<td>Contains assignment of resources to activities</td>
</tr>
<tr>
<td>No dependencies</td>
<td>Contains dependencies</td>
</tr>
</tbody>
</table>
Duration of activities

- **Example:**
  - Excavation of 90 m³
  - Labour constant (Machine excavation): 0.20 hours/m³

- **Duration** = Total quantity of the activity x Labour constant

\[
\text{Duration} = 90 \text{ m}^3 \times 0.20 \text{ h/m}^3
\]

\[
= 18 \text{ h} = 2.25 \text{ days} = 3 \text{ days}
\]

When rounding the numbers, always round **up** to full days. Normal rounding rules don’t apply. E.g. 2.25 days is 3 days, **not** 2.

(Mubarak 2010)
You are not allowed to just guess. If you are not able to access all the information that you need to calculate the durations, you have to use the information that you have got and based on that make an educated guess.
determining of work activities
things to be considered

1. Nature of the work/homogeneity
2. Location/floor
3. Size/duration
4. Timing/chronology
5. Responsibility
6. Others

= programmer’s mentality in breaking down the project

(Mubarak 2010)
Quantity Take-off

- Construction manager’s point of view
  - order of the activities
  - right size activities
    → how to build the building

  vs.

- Quantity surveyor’s point of view
  - what is the total amount of quantities
    → how much does it cost to build the building
Activity relationship types

Four different types

- Finish to Start (FS)
  - Example: Concrete can not be placed before formwork has been built

- Start to Start (SS)
  - Example: Formwork can not start before trench excavation has started

- Finish to Finish (FF)
  - Example: Landscaping can not finish before the driveway is finished

- Start to Finish (SF)
  - Example: ?
Constraints

HARD LOGIC
- Physical constraints = logical relationship

SOFT LOGIC
- Resource constraints
- Safety constraints
- Financial constraints
- Environmental constraints
- Contractual constraints
- Regulatory constraints
- Other constraints

(Hinze 2008)
References


