Lecture 17:
Project Scheduling 1

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Slides adapted from Ahmed E. Hassan
Project Management

Project management is the application of knowledge, skills, tools and techniques to achieve **specific targets** within specified **budget** and **time constraints**
Project Management

- Very important field
  - Has been studied in theory and practice for many years

- Before discussing project management, we need to understand what a project is
Project

- A project is
  - a temporary endeavor undertaken to create a "unique" product or service
- A project is composed of
  - a number of related activities that are directed to the accomplishment of a desired objective
Project

■ A project starts when
  – at least one of its activities is ready to start

■ A project is completed when
  – all of its activities have been completed
Activity

- An activity
  - Must have a **clear start** and a clear **stop**
  - Must have a **duration** that can be forecasted
  - May require the **completion of other activities** before it begins
  - Should have some **deliverables** for ease of monitoring
Project Planning

The goal of time activity and time planning is to:

- Define the activities required to accomplish the project
- Bring activities into an appropriate sequence
- Determine the resources and time needed to perform an activity
- Create a schedule based on an analysis of the activities and their relationships
Project Planning

- Managers should consider:
  - **Resource availability** - resources are there when needed
  - **Resource allocation** - there are no competing resources
  - **Staff responsibility** - which staff carry out each activity
  - **Cash flow forecasting** - a timed cash flow forecast

- Managers need to monitor and re-plan as the project progresses
Work Breakdown Structure (WBS)

- Overall work has to be decomposed into manageable units
- Complex tasks are broken down into subtasks and further refined called Work Breakdown Structures (WBS)
Work Breakdown Structure (WBS)

- Contains a list of activities, derived from:
  - Previous experience
  - Expert brainstorming

- WBS helps in
  - Identifying the main activities
  - Break each main activity down into sub-activities which can further be broken down into lower level sub-activities
Creating WBS

- Phase based approach
- Product based approach
- Hybrid approach
Example of Phase-based Approach

Work Breakdown Structure (an extract)
Phase-based Approach

- **Advantage**
  - Activity list likely complete and non-overlapping

- **Disadvantage**
  - May miss some activities related to final product
Product based approach

- Product Breakdown Structure (PBS)

A Product Breakdown Structure (an extract)
Hybrid Approach

- A mix of the phase-based and product-based approaches (most commonly used)
- The WBS consists of
  - a list of the products of the project; and
  - a list of phases for each product
Schedule Development Methods

- Need to develop a schedule in which planned start and end dates are assigned to all activities

- Need to consider:
  - Activity precedence
  - Activity duration
  - Available resources
Project Scheduling

■ Steps
  – Define activities
  – Sequence activities
  – Estimate time

■ Techniques
  – Gantt chart
  – CPM
  – PERT
Defining Activities
Gantt Chart

- Developed in 1918 by H.L. Gantt

- Graph or bar chart with a bar for each project activity that shows passage of time

- Provides visual display of project schedule
Example of Gantt Chart

Activity
- Design house and obtain financing
- Lay foundation
- Order and receive materials
- Build house
- Select paint
- Select carpet
- Finish work
Gantt Chart Limitations

■ Does not clearly indicate details regarding the progress of activities

■ Does not give a clear indication of interrelation between the activities
Sequence Activities
Critical Path

- Sequential activities upon which the project completion depends

- Calculated as the longest path through a network (i.e. longest overall duration)
  - The shortest time possible to complete the project
All projects have a critical path

Any delay in activities on the critical path will impact the project completion time

Shortening non-critical path tasks does not necessarily shorten the project schedule
Scheduling Network for House Building Project

- **Start**
  - Design house and obtain financing (1 3)

- **Lay foundations**
  - Order and receive materials (3 1)

- **Build house**
  - Select paint (5 1)

- **Finish work**
  - Select carpet (6 1)

- **Final step** (7 1)
Critical Path

- Critical path
  - Longest path through a network
  - Minimum project completion time

A: 1-2-4-7
   3 + 2 + 3 + 1 = 9 months

B: 1-2-5-6-7
   3 + 2 + 1 + 1 + 1 = 8 months

C: 1-3-4-7
   3 + 1 + 3 + 1 = 8 months

D: 1-3-5-6-7
   3 + 1 + 1 + 1 + 1 = 7 months
Activity Start Times

Start

1
3

Start at 3 months

2
2

Start at 5 months

3
1

4
3

Finish at 9 months

5
1

Start at 5 months

6
1

7
1

Finish
Estimating Time
Critical Path Method (CPM) Overview

- Developed for industrial projects where activity times are generally known

- Process to determine and optimize critical path

- Should consult with functional expert
Critical Path Method (CPM) Overview Cont’d…

■ Plan for the fastest completion of the project

■ Identify activities whose delays is likely to affect the completion date for the whole project

■ Very useful for repetitive activities with well known completion time
Critical Path and Events

- Critical event: an event that has zero slack
- Critical path: a path joining critical events

Benefit of Critical Path Analysis:
- Shortening the critical path will reduce the overall project duration (planning stage)
- Pay more attention to those activities which fall in the critical path (management stage)
CPM Forward Pass

- Calculate the **earliest start** (ES) and the **earliest finish** (EF) dates of the activities

- Always start from left to right

- If several tasks converge, use the largest EF time to determine the ES for the next activity
Earliest Activity Start and Finish Times

- **Start**
- **Design house and obtain financing** (1, 0, 3)
- **Lay foundations**
  - Duration: 2, 3, 5
  - Earliest start: 1, 2
  - Earliest finish: 3, 5
- **Build house**
  - Duration: 4, 5, 8
  - Earliest start: 2
  - Earliest finish: 5
- **Order and receive materials**
  - Duration: 3, 3, 4
  - Earliest start: 3
  - Earliest finish: 6
- **Select paint**
  - Duration: 5, 5, 6
  - Earliest start: 1
  - Earliest finish: 6
- **Select carpet**
  - Duration: 6, 6, 7
  - Earliest start: 1
  - Earliest finish: 7
- **Finish work**
  - Duration: 7, 8, 9
  - Earliest start: 1
  - Earliest finish: 9
CPM Backward Pass

- Determine the **latest finish** (LF) and **latest start** (LS) times

- From right (end node) to left

- Subtract duration from connecting node’s latest start time
Latest Activity Start and Finish Times

- **Design house and obtain financing**
  - Start: 1
  - Duration: 3
  - Earliest start: 1
  - Earliest finish: 4
  - Latest start: 3
  - Latest finish: 6

- **Lay foundations**
  - Start: 2
  - Duration: 3
  - Earliest start: 2
  - Earliest finish: 5
  - Latest start: 4
  - Latest finish: 9

- **Build house**
  - Start: 3
  - Duration: 5
  - Earliest start: 3
  - Earliest finish: 8
  - Latest start: 7
  - Latest finish: 12

- **Order and receive materials**
  - Start: 5
  - Duration: 4
  - Earliest start: 5
  - Earliest finish: 9
  - Latest start: 6
  - Latest finish: 13

- **Select pain**
  - Start: 1
  - Duration: 6
  - Earliest start: 1
  - Earliest finish: 7
  - Latest start: 6
  - Latest finish: 18

- **Select carpet**
  - Start: 6
  - Duration: 6
  - Earliest start: 6
  - Earliest finish: 12
  - Latest start: 11
  - Latest finish: 17

- **Finish work**
  - Start: 1
  - Duration: 8
  - Earliest start: 1
  - Earliest finish: 9
  - Latest start: 6
  - Latest finish: 16
## Activity Slack

**Slack:** amount of time an activity can be delayed without delaying the project

**Critical activities:** have zero slack and lie on a critical path.

**Activity slack**

\[
\text{activity slack} = \text{LS} - \text{ES} = \text{LF} - \text{EF}
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