Project Scheduling and Tracking

Basic Concepts

- The process of building a schedule for any case study helps really understand how it's done.
- The basic idea is to get across to break the software project into well-defined tasks, determine the interdependencies among the tasks, determine the time duration for each task, and assign the tasks to project team members.
- Each task must have defined outcomes and be associated a meaningful project milestone.

Why are Projects Late?

- An unrealistic deadline established by someone outside the software development group
- Changing customer requirements that are not reflected in schedule changes;
- An honest underestimate of the amount of effort and/or the number of resources that will be required to do the job;
- Predictable and/or unpredictable risks that were not considered when the project commenced;
- Technical difficulties that could not have been foreseen in advance;
- Human difficulties that could not have been foreseen in advance;
- Miscommunication among project staff that results in delays;
- A failure by project management to recognize that the project is falling behind schedule and a lack of action to correct the problem

Relationship between People and Effort

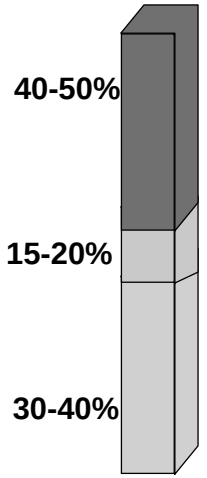
- The most important point to get across is that adding people to a project in an arbitrary manner does not reduce the project completion time (and may in fact lengthen the completion time).
- There are times when a project schedule has slipped so badly that adding people cannot save it and the only option a manager has it to renegotiate the completion date with the customer.

Project Scheduling

- Scheduling has the ultimate goal of deciding on how to distribute effort over time.
- Making decision to go on without considering team organization and careful scheduling will also cause problem.
- It will be impossible to know the progress of the project and whether more people can improve the progress.
- A 100 person-months project does not mean can be completed by 1 person in 100 months or 100 persons in 1 month. Usually, more people mean more communication paths and lower efficiency – ***Putting more people into a late project may make it later***.

Effort Allocation

- Front End Activities
  - Customer Communication
  - Analysis
  - Design
  - Review and Modification
- Construction Activities
  - Coding or code generation
- Testing and Installation
  - Unit and Integration Test
  - White-box & Black box Testing
  - Regression



Effort Distribution

- Classical Rule 40-20-40
  - Planning, Analysis, Design / coding / quality assurance
- Later 60-10-30
  - Emphasis on better Analysis & Design
- Now 50-10-40
  - Emphasis on Quality Assurance

Features of Tasks Scheduling

- Design and Test planning can run in parallel.
- Detail design and Coding of each unit can run in parallel.
- All tasks converge with the test plan before Integration test.
- Milestones typically take the form of a document produced by the corresponding progress review.
- It is used as a checkpoint to ensure the project is on schedule.
- In a task network, a milestone can be shown as a task without duration.

Defining a Task Set for the Software Project

- A ‘Task set’ is a collection of engineering tasks, milestones and deliverables.
- The software process selected for project provides much guidance in determining the task set.
- Task set is also dependent on the project type.
- Three Steps
  - Selecting Software Engineering Tasks
  - Refinement of Major Tasks
  - Defining a Task Network

Selecting Software Engineering Tasks

- Scheduling involves taking the software engineering task set and distributing it on the project time line.
- The details of how to do this will depend on whether the software process model is linear, iterative or evolutionary.

Refinement of Major Tasks

- Refining a major scheduling task (concept scooping) into smaller activities needed to create a detailed project schedule.

Scheduling Principles

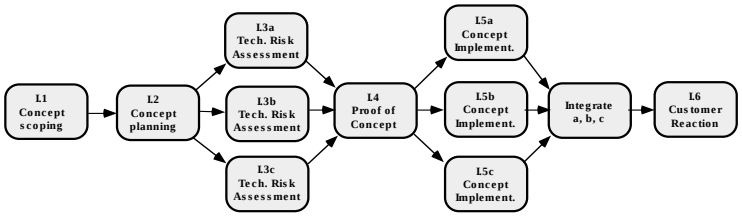
- Compartmentalization — Define distinct tasks
- Interdependency — Indicate task interrelationships
- Validation — Be sure resources are available
- Defined Responsibilities — People must be assigned
- Defined Outcomes — Each task must have an output
- Defined Milestones — Review for quality

Defining Task Sets

- Determine type of project
- Assess the degree of rigor required
  - Identify adaptation criteria
  - Compute task set selector (TSS) value
  - Interpret TSS to determine degree of rigor
- Select appropriate software engineering tasks

Defining a Task Network

- Building a task graph or activity network is the key to building a feasible schedule.
- The task graph represents inter-task dependencies very clearly.
- This allows managers to determine which tasks may be done in parallel and which tasks need to done first.

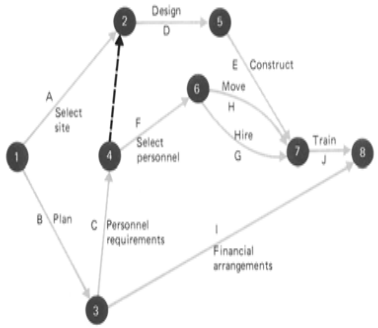


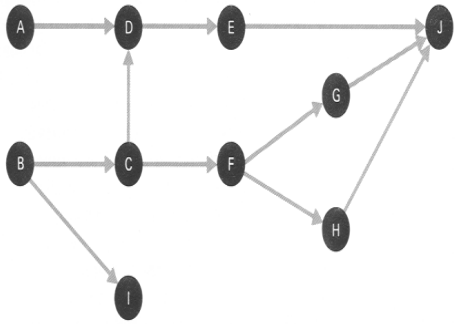
Three L3 tasks are applied in parallel to 3 different concept functions

Three L3 tasks are applied in parallel to 3 different concept functions

Task Network

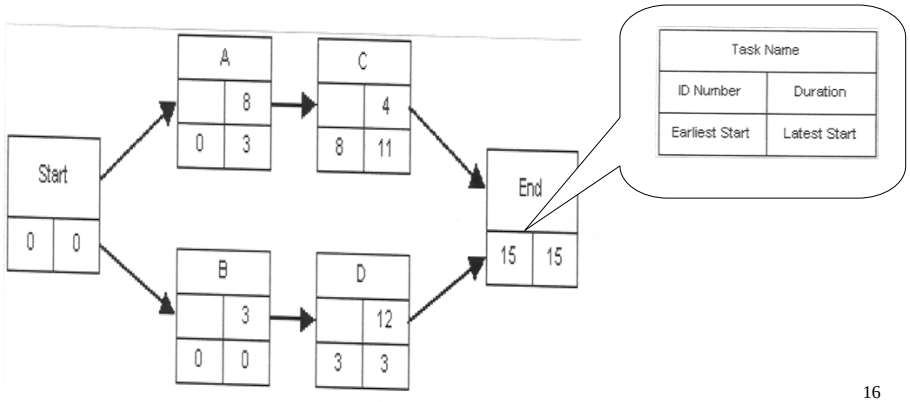
- There are two ways to draw a network diagram.
- In the first figure, arcs are used to represent activities while in the second figure, nodes are used to represent them.





Another Notation for Task Network

- Some notation has more information on the node:

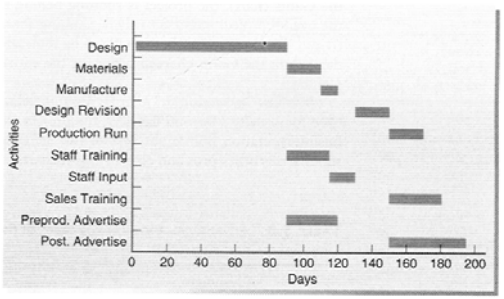


Project Scheduling

- When project scheduling, the project manager must know:
  - Duration of each activity.
  - Order of which the activities will be performed.
  - Start and end times for each activity
  - Who will be assigned to each specific task.
  - Tasks that are dependent on other activities.
- Several graphical planning aids can help a project manager in the scheduling process:
  - Gantt charts
  - PERT (Program Evaluation and Review Technique)
  - CPM (Critical path Method)

Gantt Chart

- To track the progress of a project is one of the most important responsibilities of project managers.
- A common tool for this purpose is the Gantt Chart.
- The Gantt Chart was developed by Henry L. Gantt in 1918 and it is used to display and monitor the project progress.



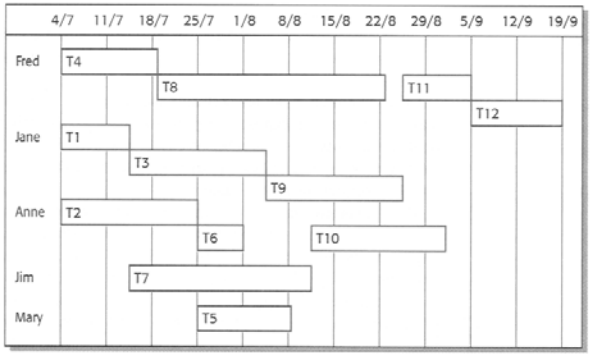
Gantt Charts

- A Gantt chart is a horizontal bar chart that illustrates a schedule.
- In the Gantt chart the analyst displays time on the horizontal axis and arranges the activities vertically, from top to bottom, in the order of their start dates.
- The horizontal position of the bar shows the start and end of the activity, and the length of the bar indicates its duration.

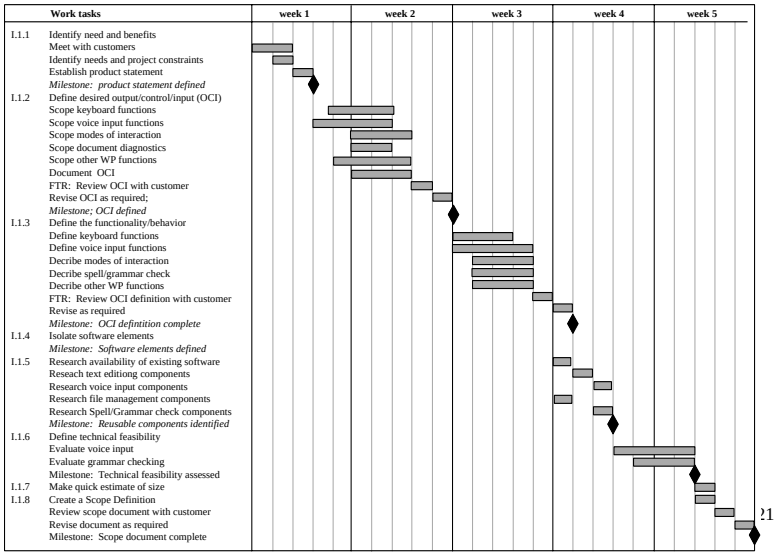
ID	Task Name	Duration	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
1	**Planning**	2w	1/26	2/6						
2	**Analysis**	12w	2/9				5/1			
3	**Design**	12w			3/23			6/12		
4	**Implementation**	3w					6/15			8/7

Example of Gantt Charts – Resource Allocation Chart

- It is the chart for human resource versus timeline. It is constructed to aim at evenly distributed the human resource.



Use Automated Tools to Derive a Timeline Chart

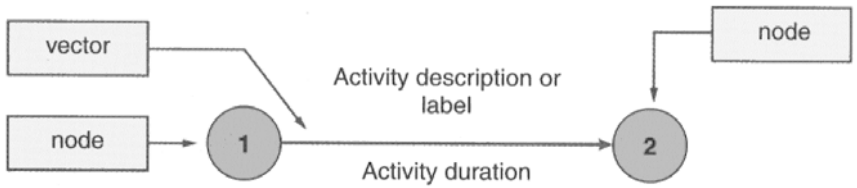


Program Evaluation & Review Technique (PERT)

- PERT was developed in 1950s by the Navy Special Projects Office in co-operation with the management consulting firm of Booz, Allen and Hamilton.
- The primary objectives of PERT are to determine the minimal possible completion time for the projects and to determine a range of start and finish times for each activity so that the project can be completed in minimal time.

PERT/CPM

- A PERT/CPM chart shows a project as a network diagram.
- The activities are shown as **Vectors**, and the events are displayed graphically as **Nodes**.
- Each event is identified by a number – event 1 is the beginning of the activity, and event 2 marks the end.
- Each activity is identified by a short description above the vector, or with a letter or code explained in a table.

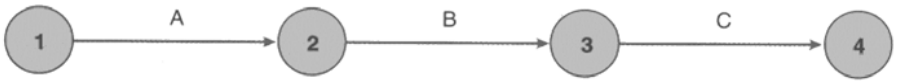


Dummy Activities

- A dummy activity indicates an event dependency, but does not require any resources or completion time.

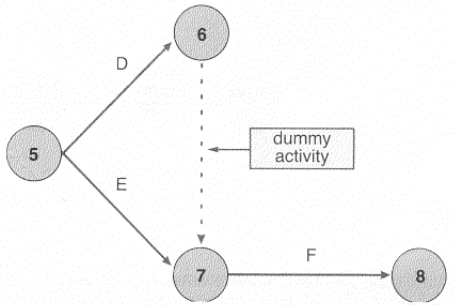
Dependent / Serial Activities

- When tasks must be completed in sequence, they are called dependent, or serial activities.
- Activity A must end before activity B can begin. Event 3, which marks the end of activity B, must occur before activity C can start.

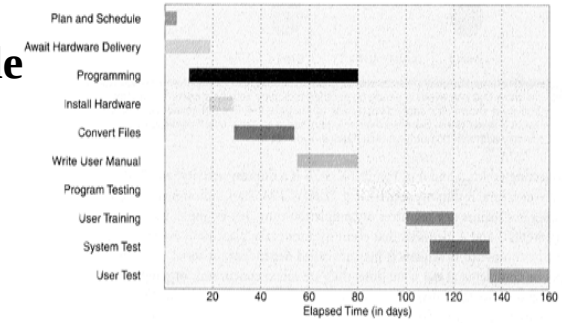


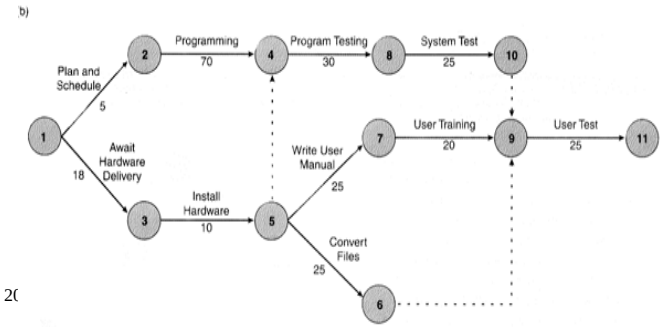
Concurrent / Parallel Activities

- When activities can be completed at the same time, they are called concurrent, or parallel activities.
- Activities D and E are parallel activities that can be done at the same time, but the length of the two tasks may be different.



Example

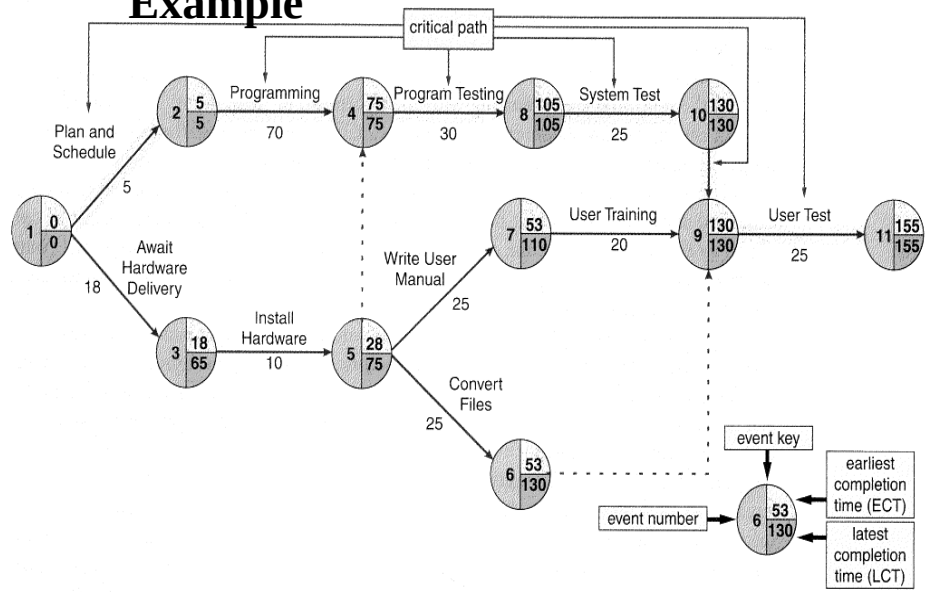




Example

- After identifying the tasks and durations, the project manager determines the overall length of the project.
- Determine the **Earliest Completion Time** (ECT) for each event, which is the minimum amount of time necessary to complete all the activities that precede the event..
- Determine the **Latest Completion Time** (LCT) for an event, which is the latest time at which the event can occur without delaying the project.
- At least one complete path will exist through a PERT/CPM network for which every node has equal ECTs and LCTS. That path is called the Critical.
- A Critical Path is a series of events and activities with no slack time.

Example



Critical Path Method (CPM)

- CPM was developed in 1957 by J.E. Kelly of Remington Rand and M. R. Walker of DuPont.
- CPM assumes the completion time of an activity can be determined with certainty which only depends on the amount of money allocated to the activities.
- The process to reduce an activity's completion time by additional resources is known as **Crashing**.

Critical Path Method (CPM)

- The first step is to identify the work breakdown of the project and the precedence relations between them.
- An Work Breakdown Structure (also named Activity List / Precedence Relations Chart) can be used to identify the separate activities of the project and their precedence relations.
- Then a Task Network Diagram of the project can be constructed.

Work Breakdown Structure (WBS)

- It is a list of all the tasks in the project, which includes the task dependency, duration and the human resource required.

ACTIVITY	DESCRIPTION	IMMEDIATE PREDECESSORS	TIME	RESOURCES
A	Select Office Site	—		
B	Create Organizational and Financial Plan	—		
C	Determine Personnel Requirements	B		
D	Design Facility	A, C		
E	Construct Interior	D		
F	Select Personnel to Move	C		
G	Hire New Employees	F		
H	Move Records, Key Personnel, etc.	F		
I	Make Financial Arrangements with Institutions in Des Moines	B		
J	Train New Personnel	H, E, G		

Program Evaluation & Review Technique (PERT)

- The distinctions between PERT & CPM have become blurred over time.
- The most important difference between PERT & CPM is that PERT treats the completion time of the activities as random variables with specific probability distributions.
- Three time estimates are used for each activity, they are
  - A = Optimistic time (best case)
  - M = Most likely time
  - B = Pessimistic time (worst case)

Program Evaluation & Review Technique (PERT)

- Usually, it is assumed that the probabilities follow a Beta distribution and the mean activity completion time and its standard deviation are:
  - Mean = (A + 4M + B) / 6
  - Standard Deviation = (B – A) / 6
- The mean completion time of the whole project is the sum of mean completion time of the **Critical Path**, and variance of the project is the sum of variances of the activities of the **Critical Path**.

Information from PERT/CPM

Critical path (CP)	The sequence of tasks that cannot slip without increasing the earliest possible completion date (EPCD) of the project. Any delay of a stage in the critical path will delay project completion. Thus, float in the tasks of the CP are always zero.
Total float	It measures the slack in the schedule which can be made use of without affecting the CP
Earliest possible starting date (EPSD)	Achievable date of a task if all the tasks this one depends upon has taken minimum time.
Latest possible starting date (LPSD)	Latest date start of a task without affecting the EPCD of the project.
Earliest possible finishing date	
Latest possible finishing date	

Gantt Charts vs. PERT/CPM

- PERT/CPM charts differ from Gantt charts in two aspects:
  - A PERT/CPM chart for even a small project can be rather complicated, and the degree of complexity increases significantly for larger projects.
  - The picture presented by a PERT/CPM chart is not as clear as a Gantt chart, which graphically displays the timing and duration of the activities.
- PERT/CPM and Gantt charts are not mutually exclusive techniques. Project managers often use both methods.