

# Software Project Management

## References:

Chapter 22- Project Management and Chapter 23- Project Planning  
From the book Software Engineering, I. Sommerville

# Outline

- Concepts and principles of software project management
- Project planning and scheduling
- Risk management
- Cost estimation

# Software Project Management

- Why software project needs to be managed ?
  - Constraint of time and budget
- Project management success criteria:
  - Deliver the software to the customer at agreed time
  - Keep overall costs within budget
  - Deliver software that meets customer's expectation
  - Maintain a happy and well functioning development team

# Management Activities

- Most managers take responsibility at some stage for some or all of the following activities:
  - Proposal writing
  - Project planning and scheduling
  - Project cost estimation
  - Risk management
  - Project monitoring and reviews
  - Personnel selection and evaluation
  - Report writing and presentations

# Proposal writing

- May involve writing a proposal to win a contract to carry out the work
- Describes objectives of the project and how it will be carried out
- Usually includes cost and schedule estimates

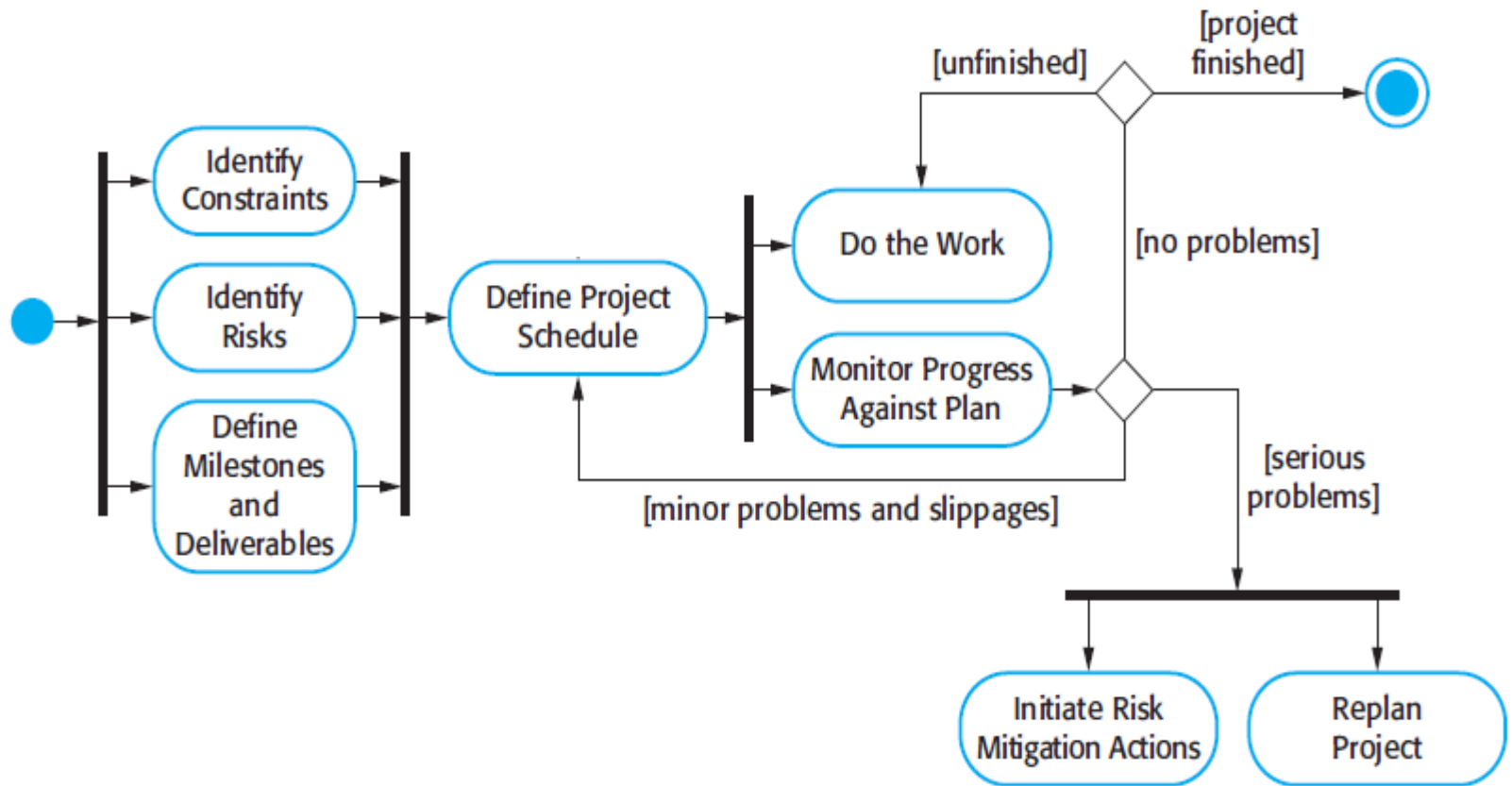
# Project Planning

- The project plan sets out the resources available to the project, the work breakdown and a schedule for carrying out the work.
- The plan should also define project monitoring mechanisms.
  - Keep track of the progress of the project and compare actual and planned process and costs.
- The schedule, cost estimate, and risks all have to be revised as the software is developed
- The project plan is often solely concerned with the development process.

# Project planning activities

- Assess the constraints
  - Time, budget, staff, tools
- Define milestone and deliverables
  - Milestones are points in the schedule which allow to assess the progress
- Define project schedule (more details in later slides)
- Monitor and control progress
  - Minor slippages are normal at the earlier stage so need to make modifications to the original plan
- Re-plan project

# Project planning process



(I. Sommerville, 2001)



# Example - Milestones in the Requirements Process

## ACTIVITIES



## MILESTONES

# Project scheduling activities

- Split project into tasks and estimate time and resources required to complete each task.
- Organise tasks concurrently to make optimal use of workforce.
- Minimise task dependencies to avoid delays caused by one task waiting for another to complete.
- Dependent on project managers intuition and experience.

# Activity organisation

- *Activities* in a project should be organised to produce tangible outputs for management to judge progress.
- *Milestones* are the end-point of a process activity.
- *Deliverables* are project results delivered to customers.

The waterfall process model allows for the straightforward definition of progress milestones.

# Bar charts and activity networks

- Graphical notations used to illustrate the project schedule.
- Show project breakdown into tasks. Tasks should not be too small. They should take about a week or two.
- **Bar charts** show schedule against calendar time.
- **Activity charts** show task dependencies and the critical path.

# Project activities/tasks

- A project planning tool is used to manage project schedule information
- Project activities are the basic planning element. Each activity has
  - A duration in calendar days or months
  - An effort estimate (number of person-days or person-months) to complete the work
  - A deadline by which the activities should be completed
  - A defined endpoint (milestone) represents a tangible result of completing the activity

# Task durations and dependencies - Example

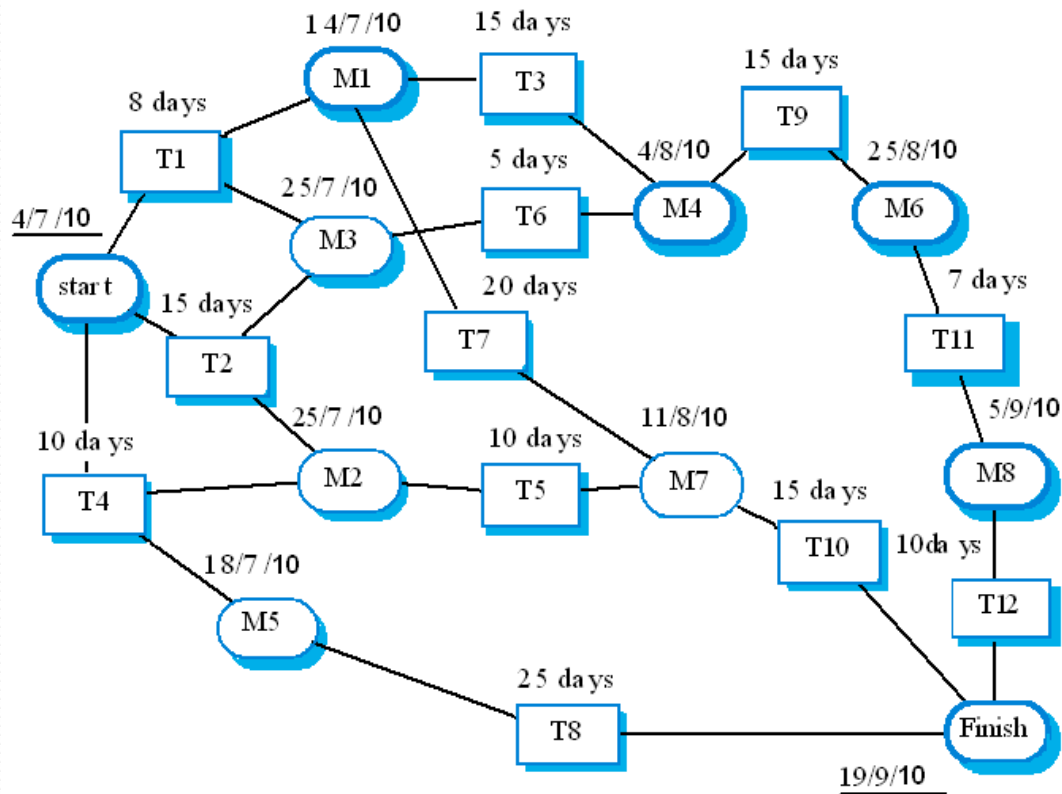
Milestone 1

Task	Effort (person-days)	Duration (days)	Dependencies
T1	15	10	
T2	8	15	
T3	20	15	T1 (M1)
T4	5	10	
T5	5	10	T2, T4 (M3)
T6	10	5	T1, T2 (M4)
T7	25	20	T1 (M1)
T8	75	25	T4 (M2)
T9	10	15	T3, T6 (M5)
T10	20	15	T7, T8 (M6)
T11	10	10	T9 (M7)
T12	20	10	T10, T11 (M8)

# Activity Network

- Develop activity network (milestone and tasks or task dependency)
- Identify critical path (the longest path)
- Adjust milestones to match the deadline
- Adjust Task by changing/ adding team/persons

# Activity network example



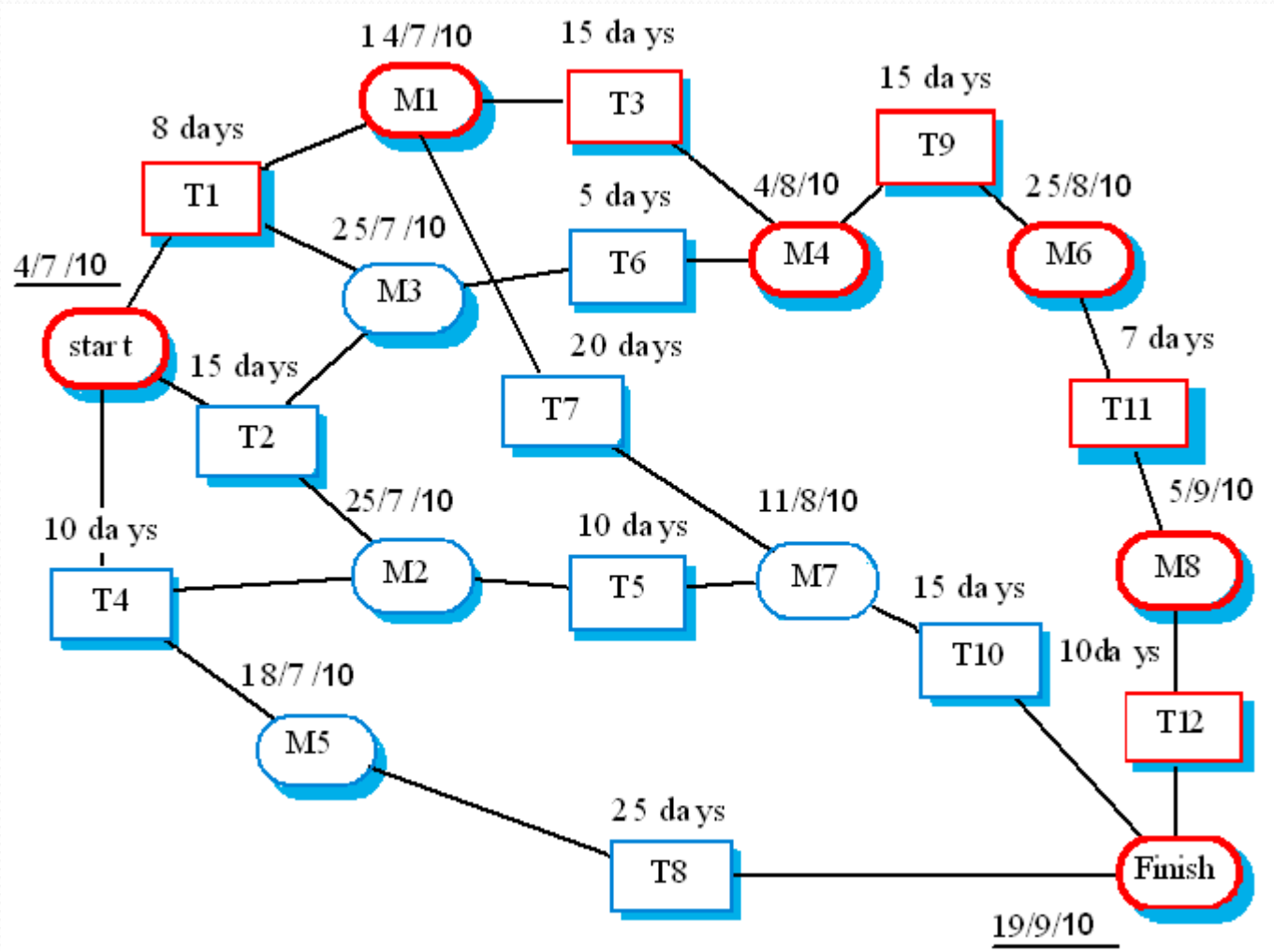
Activity	Duration (days)	Dependencies
T1	8	
T2	15	
T3	15	T1 (M1)
T4	10	
T5	10	T2, T4 (M2)
T6	5	T1, T2 (M3)
T7	20	T1 (M1)
T8	25	T4 (M5)
T9	15	T3, T6 (M4)
T10	15	T5, T7 (M7)
T11	7	T9 (M6)
T12	10	T11 (M8)

An activity/task may start when its preceding milestone has been reached.

The minimum time required to finish the project can be estimated by considering the longest path in the activity graph: the critical path.



# Activity network- Critical path

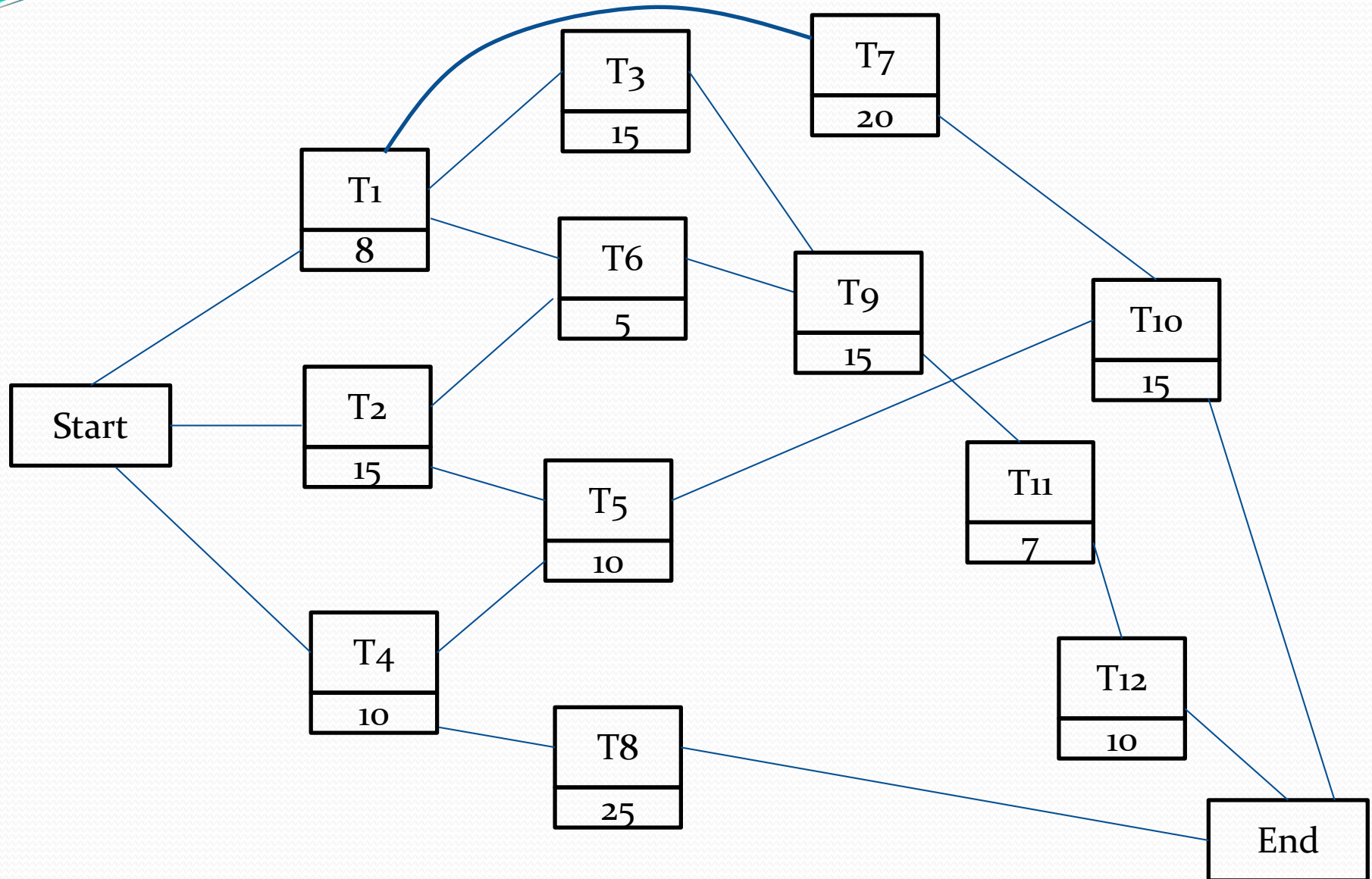


Critical path: T1, T3, T9, T11, T12. Total 55 days

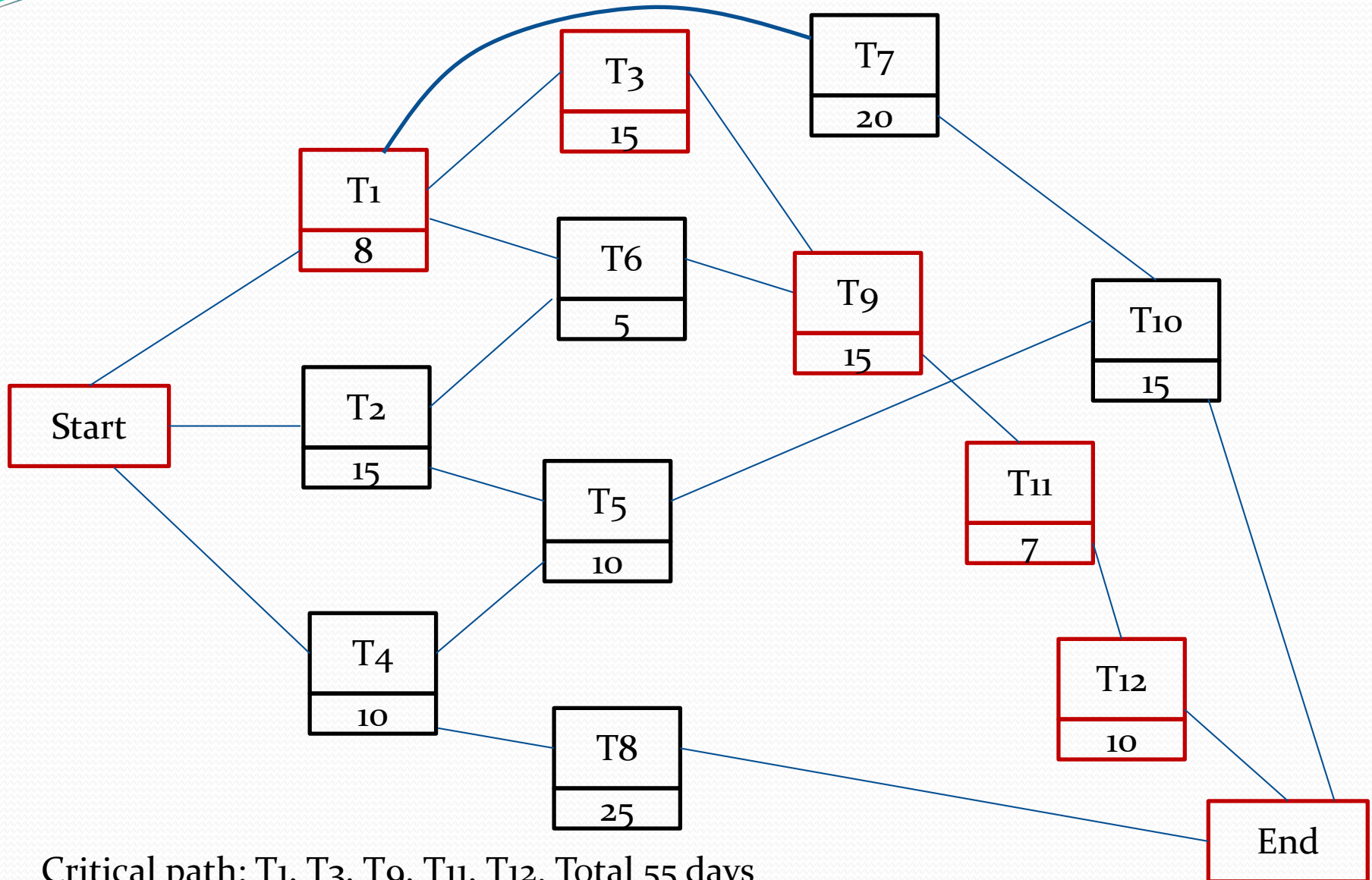
# Activity network – task dependency

Activity	Duration (Days)	Dependencies
T1	8	
T2	15	
T3	15	T1
T4	10	
T5	10	T2, T4
T6	5	T1, T2
T7	20	T1
T8	25	T4
T9	15	T3, T6
T10	15	T5, T7
T11	7	T9
T12	10	T11

# Activity network – Another presentation



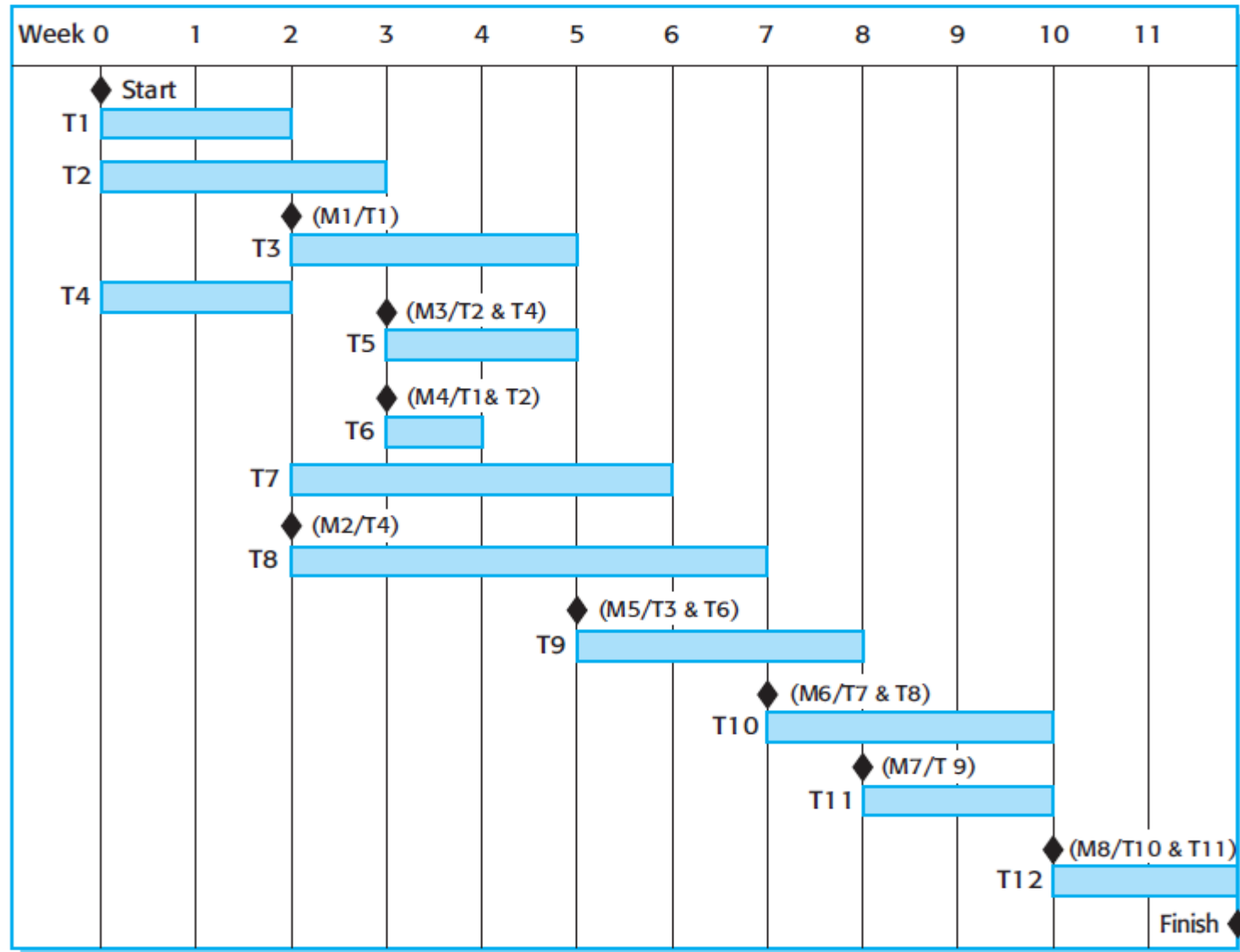
# Activity network – Critical path



# Critical Path

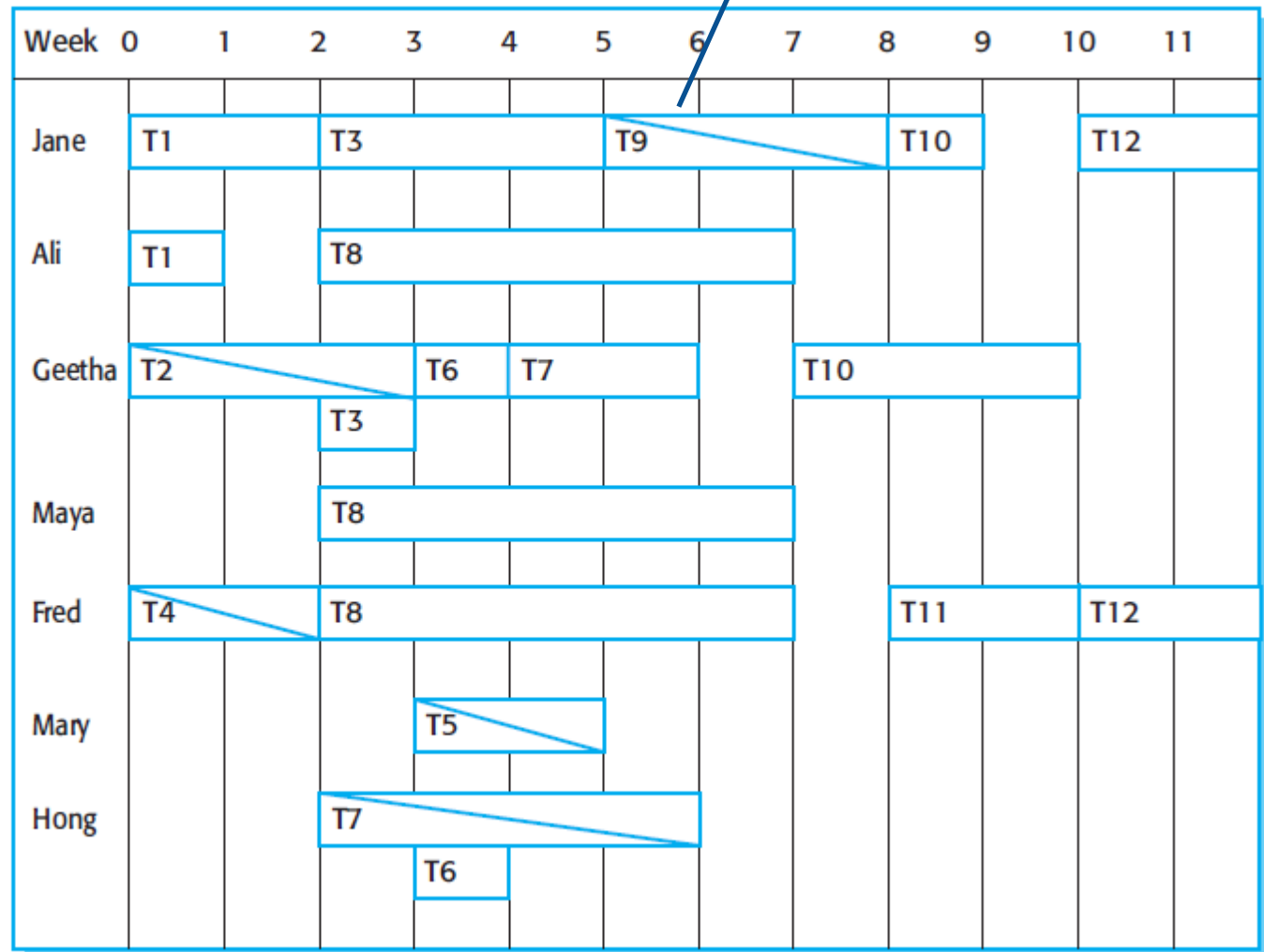
- Any slippage in the completion in any critical activity causes project delays
  - Following activities can't start until delayed activity has been completed
- However, delays in activities that do not lie on the critical path do not necessarily cause an overall schedule slippage
  - So long as these delays do not extend these activities so much that the total time for that activity plus future dependent activities does not exceed the critical path, the schedule is not affected!

# Activity timeline (Gantt Chart/Bar chart)



# Staff allocation

Part-time assignment



**Figure 23.7** Staff allocation chart

# Scheduling problems

- Estimating the difficulty of problems and hence the cost of developing a solution is hard.
- Productivity is not proportional to the number of people working on a task.
- Adding people to a late project makes it later because of communication overheads.
- The unexpected always happens.
- Always allow contingency in planning.



# Risk management

- Risk management is concerned with identifying risks and drawing up plans to minimise their effect on a project.
- A risk is a probability that some adverse circumstance will occur
  - **Project risks** affect schedule or resources;
  - **Product risks** affect the quality or performance of the software being developed;
  - **Business risks** affect the organisation developing or procuring the software.

# Example of common risks

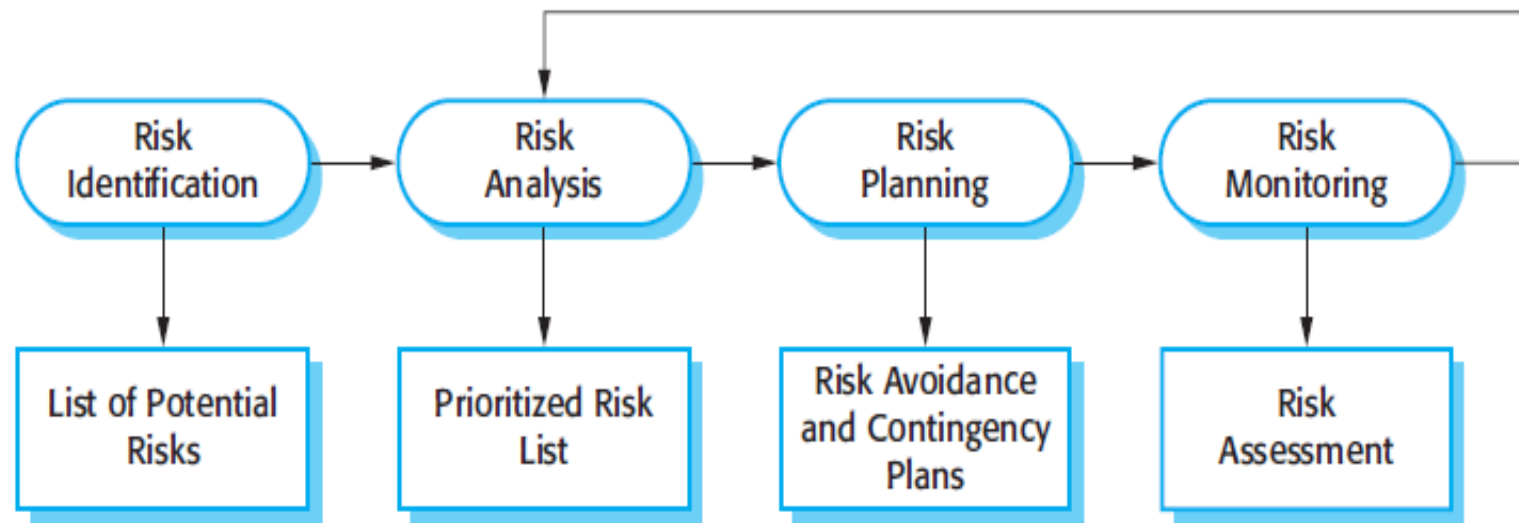
Risk	Affects	Description
Staff turnover	Project	Experienced staff will leave the project before it is finished.
Management change	Project	There will be a change of organizational management with different priorities.
Hardware unavailability	Project	Hardware that is essential for the project will not be delivered on schedule.
Requirements change	Project and product	There will be a larger number of changes to the requirements than anticipated.
Specification delays	Project and product	Specifications of essential interfaces are not available on schedule.
Size underestimate	Project and product	The size of the system has been underestimated.
CASE tool underperformance	Product	CASE tools, which support the project, do not perform as anticipated.
Technology change	Business	The underlying technology on which the system is built is superseded by new technology.
Product competition	Business	A competitive product is marketed before the system is completed.

(I. Sommerville, 2011)

# Risk management process

- Iterative process with steps:
  - **Risk identification:** identify possible project risks, product risks and business risks
  - **Risk analysis:** assess the likelihood and consequences of them
  - **Risk planning:** make plans to address the risks: either by avoiding it or minimizing its effects
  - **Risk monitoring:** regularly assess the risk and the plan for risk mitigation and revise these (when get more available information about the risks)

# The risk management process



# Risk analysis

- Judgment about the probability and seriousness of each risk

Risk	Probability	Effects
Organizational financial problems force reductions in the project budget (7).	Low	Catastrophic
It is impossible to recruit staff with the skills required for the project (3).	High	Catastrophic
Key staff are ill at critical times in the project (4).	Moderate	Serious
Faults in reusable software components have to be repaired before these components are reused. (2).	Moderate	Serious
Changes to requirements that require major design rework are proposed (10).	Moderate	Serious

# Risk planning

- Development of strategies to manage risks
- Possible strategies:
  - *Avoidance strategies*: the probability that the risks will arise will be reduced.
  - *Minimization strategies*: the impact of the risk will be reduced.
  - *Contingency plans*: prepare for the worst and have a strategy in place to deal with it.

# Risk planning example

Contingency

Minimi-  
zation

Avoidance

Risk	Strategy
Organizational financial problems	Prepare a briefing document for senior management showing how the project is making a very important contribution to the goals of the business and presenting reasons why cuts to the project budget would not be cost-effective.
Recruitment problems	Alert customer to potential difficulties and the possibility of delays; investigate buying-in components.
Staff illness	Reorganize team so that there is more overlap of work and people therefore understand each other's jobs.
Defective components	Replace potentially defective components with bought-in components of known reliability.
Requirements changes	Derive traceability information to assess requirements change impact; maximize information hiding in the design.
Organizational restructuring	Prepare a briefing document for senior management showing how the project is making a very important contribution to the goals of the business.
Database performance	Investigate the possibility of buying a higher-performance database.
Underestimated development time	Investigate buying-in components; investigate use of a program generator.

# Risk monitoring

- Checking if assumptions about the risks have not changed
  - if the risk is more or less likely to arise
  - if the seriousness and consequences of the risk have changed
- Risk indicators

Risk type	Potential indicators
Technology	Late delivery of hardware or support software; many reported technology problems.
People	Poor staff morale; poor relationships amongst team members; high staff turnover.
Organizational	Organizational gossip; lack of action by senior management.
Tools	Reluctance by team members to use tools; complaints about CASE tools; demands for higher-powered workstations.
Requirements	Many requirements change requests; customer complaints.
Estimation	Failure to meet agreed schedule; failure to clear reported defects.



# Cost Estimation

- Cost estimation is the approximate judgement of the costs for a project
- It is carried out after the requirements have been outlined for bidding a contract or planning
- Based on project size (estimate) to identify the duration and the effort (person-month) needed to complete the project

# Estimation techniques

- Algorithmic cost modelling
- Expert judgement
- Estimation by analogy
- Pricing to win

# Algorithmic model

- Use of mathematical equations to perform software estimation
- Equations are based on theory or historical data
- Use input such as project size ( e.g. KLOC - thousands lines of code), number of functions to perform, and other cost drivers (e.g. staff experience, etc.)
- Accuracy of model can be improved by calibrating the model to the specific environment

# Algorithmic model

- COCOMO basic model (COnstructive COst MOdel)
  - Developed by Boehm in 1981
  - One of the most popular cost model
  - Based on the data from 63 historical software projects

# COCOMO model

- Allow to identify:
  - Effort (man-month/person-month: one month of effort by one person- 152hours/person/month)
  - Duration/development time (month M)
- Sizing method: Source line of code or function points
- Work breakdown structure
  - Project element analysis
  - Estimate KLOC (thousands lines of code) of each project element
  - $KLOC(K) = \text{estimate KLOC} - \text{reuse code}$

- Equation:
  - Effort:  $MM = a * K^b$  (person-month)
  - Development time:  $TDEV = 2.5 * MM^c$  (month)
- The coefficients a, b and c depend on the software project type:

Development Mode	Project Characteristics			
	Size	Innovation	Deadline/constraints	Dev. Environment
Organic	Small	Little	Not tight	Stable
Semi-detached	Medium	Medium	Medium	Medium
Embedded	Large	Greater	Tight	Complex hardware/ customer interfaces

Basic COCOMO	a	b	c
Organic	2.4	1.05	0.38
Semi-detached	3.0	1.12	0.35
Embedded	3.6	1.20	0.32

(Software Cost Estimation workshop, 2002)

# Algorithmic model

- Advantages
  - Generate repeatable estimation
  - Easy to modify input data
  - Objectively calibrated to experience
- Disadvantages
  - Unable to deal with exceptional conditions
  - Some experience and factors can not be quantified

# Expert judgement (experience-based)

- Capture the knowledge and experience of practitioners and providing estimates based on all the projects to which the experts participated
- Example
  - Work breakdown structure (WBS)
    - A way of organising project element into a hierarchy that simplifies the task of budget estimation and control



# Estimation by Analogy

- Comparing the proposed project to the previously completed similar project in the same application domain
- Actual data from the completed projects are extrapolated
- Can be used either at system or component level

# Pricing to win

- Price believed necessary to win the contract
- Advantages
  - Often rewarded with the contract
- Disadvantages
  - Time and money run out before the job is done

# Key points

- Good project management is essential for project success.
- The intangible nature of software causes problems for management.
- Managers have diverse roles but their most significant activities are planning, estimating and scheduling.
- Planning and estimating are iterative processes which continue throughout the course of a project.

# Key points

- A project milestone is a predictable state where a formal report of progress is presented to management.
- Project scheduling involves preparing various graphical representations showing project activities, their durations and staffing.
- Risk management is concerned with identifying risks which may affect the project and planning to ensure that these risks do not develop into major threats.
- Cost estimation is the approximate judgement of the costs for a project, which includes estimating the duration and the effort (person-month) needed to complete the project