Syllabus Topic : The Make/Buy Decision

7.6.4 The Make/Buy Decision

- Software engineering Managers face many problems in Make and Buy decisions that later have many number of acquisition options such as :
  - should software be purchased off the shelf ?
  - should it use "Full-experience" or "partial-experience" software components ?
  - should the software be custom built by an outside contractor ?
- The make/buy decision can be made based on the following conditions
  - Will the software product be available sooner if given to outside contractor than internally developed software?
  - Will the cost of acquisition plus the cost of customization be less than the cost of developing the software internally?
  - Will the cost of outside maintenance support be less than the cost of internal support?

Review Questions

Q. 1 Describe the cost estimation process.

Q. 2 Write short notes on cost estimation techniques.

Q. 3 List and describe the cost estimation parameters.

Q. 4 What is cost estimation and explain COCOMO model.

Q. 5 Explain the concept of estimation in agile development.

Q. 6 Explain the concept of Make/Buy decision

Q. 7 Explain in brief about : Software scope and feasibility

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CHAPTER 8

UNIT II

Project Scheduling

Syllabus :

Basic Principles, Relationship between People and Effort, Effort Distribution, Time-Line Charts

8.1 Project Scheduling

Q. Explain the project scheduling process.

The *project schedule* is a calendar that is used to associate the tasks to be performed with the resources that will perform them. Before a project schedule is estimated, the project manager designs a work breakdown structure (WBS) which is an attempt to estimate the time needed to implement each task and the resources that are available for accomplishing each task.

Project Scheduling is dependent on project managers' intuition and experience.

Project Scheduling Process

- Divide the project into various tasks and estimate the duration and resources required to complete each task.
- Arrange the tasks so as to make optimal use of workforce.
- Reduce the task dependencies so as to avoid delays that might be caused by some task i.e. waiting for another to complete.

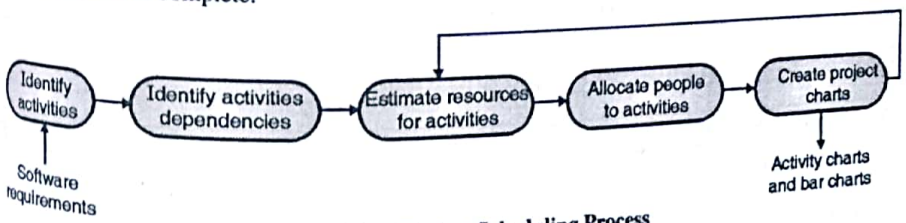


Fig. 8.1.1: Project Scheduling Process

Scheduling Problems

- Detecting the complexity of the problems and accordingly estimating the cost of developing a solution is difficult.

- Achieved productivity is not proportional to the number of people working on it.
- Adding new staff in the late project development moves the delivery date further far because of the communication gap between old staff and new staff.
- Always unforeseen events happen in the project development and these need to be considered in the planning.

Syllabus Topic : Basic Principles

8.2 Basic Principles

Q. List the basic principles of Project scheduling.

Project scheduling is about distributing or allocating the estimated efforts to specific software engineering tasks across the planed project duration.

Project scheduling builds a road map for the project manager when combined with estimation methods and risk analysis.

Basic principles guide software project scheduling:

1. Compartmentalization: The project must be categorized into number of manageable activities, actions and tasks by decomposing the process into sub processes.
2. Interdependency: Few compartmentalized activities, actions, or tasks occur in sequence where they are interdependent upon each other and while others occur in parallel.
3. Time allocation: Scheduling is very important where each task must be allocated some number of work units, defining their start date and completion date especially in case of the inter dependencies and also state whether work will be conducted on a full-time or part-time basis.
4. Effort allocation: The project manager must allocate number of people that must be are present at any given point of time.
5. Effort validation: The project manager must monitor that no more than the allocated number of people are present at any given point of time.
6. Defined responsibilities: Every task that is scheduled must be assigned to a specific team member.
7. Defined outcomes: Every task that is scheduled must have a defined outcome.
8. Defined milestones: Each set of tasks must be associated with a project milestone. And the milestone is said to be accomplished only when its associated tasks are reviewed for quality.

Syllabus Topic : Relationship between People and Effort

8.3 Relationship between People and Effort

Q. Explain the relationship between people and efforts in project scheduling

- A single person or just a small team of members is enough for working on small projects. But as the scope of the project increases, team size also increases. Adding unplanned and sometimes unskilled people in the later SDLC phases causes the schedules to slip even further. The people who are added later in the project should first of all understand the system properly which requires additional effort and time.
- Project schedules are flexible. As the project deadline gets closer and closer, you reach a point where the work cannot be completed on time, regardless of the number of people working on it.

And then a new delivery date is defined. If delivery is delayed, the PNR curve indicates that the project selling cost can be reduced substantially.

- Recommended *effort distribution* across the software process workflow is referred as 40-20-40 rule.
  - Front end analysis, design and back end testing are allocated 40% of all effort
  - 20% of effort is allocated to coding.
- Requirement analysis may comprise 40% of project effort.

Syllabus Topic : Effort Distribution

8.4 Effort Distribution

Recommended *effort distribution* across the software process workflow is referred as 40-20-40 rule.

- Front end analysis, design and back end testing are allocated 40% of all effort
- 20% of effort is allocated to coding.
- Requirement analysis may comprise 40% of project effort

8.4.1 Defining a Task Set

1. Consider the project type. Different types of projects

- Concept Projects: exploring new business concept or new application of technology
- New application development projects: new product requested by customer.
- Application enhancement projects: major modifications are done in functions, performance or interfaces.
- Application maintenance projects : correcting the existing functionality, adapting new functionality or extending existing software
- Reengineering projects : rebuilding all (or part) of a legacy system

2. Define the Degree of rigor. Various levels of degrees of rigor

- Casual : all framework activities are already applied, only minimum task set is required
- Structured: all framework and umbrella activities such as SQA, SCM, documentation, and measurement tasks are already streamlined.
- Strict: complete set of umbrella activities are applied to produce high quality products and robust documentation.
- Quick reaction: emergency situation and process framework is used but only tasks essential to good quality are applied.

3. Review rigor adaptation criteria. Various rigor adaptation criteria

- Project size
- Number of potential users
- Application durability
- Requirement stability
- Ease of communication with customer/developer

- Maturity of applicable technology
- Performance constraints
- Embedded/non-embedded characteristics
- Project staffing
- Reengineering factors

4. **Determine task selector value.**
   - The task sector value is computed by adjusting the scores of different weight based project characteristics.
   - This computed task selector value is then used to select appropriate task set (casual, structured, strict) for the project.
5. **Consider concept development tasks.**
   - Determine the overall project scope
   - Preliminary concept planning such as establishing development team's ability to undertake the proposed work
   - Evaluating the technology risks in the software.
   - Proof of concept that depicts the feasibility of the technology in the software context
   - Concept implementation in a form i.e. used to sell to the customer
   - Customer's feedback on new technology i.e. implemented.

Syllabus Topic : Time-Line Charts

8.5 Time-line Charts

- Project scheduling involves preparing various graphical representations showing project activities, their durations and staffing.
- Graphical notations are used to illustrate the project schedule.
- Project scheduling is done by breaking down the whole development work into various tasks. Tasks must not be too small but should take about a week or two to accomplish them.

Table 8.5.1: Project Scheduling – Project Breakdown into Tasks

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

- Following Activity chart describes the task dependencies and their critical path.

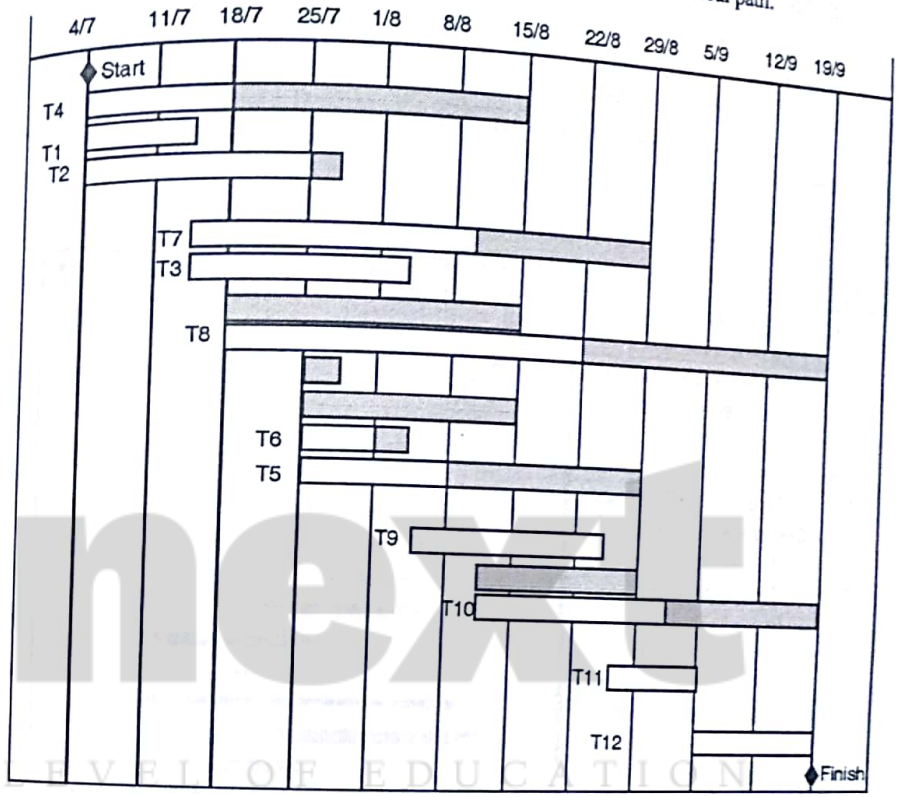


Fig. 8.5.1 : Project Scheduling - Activity Chart

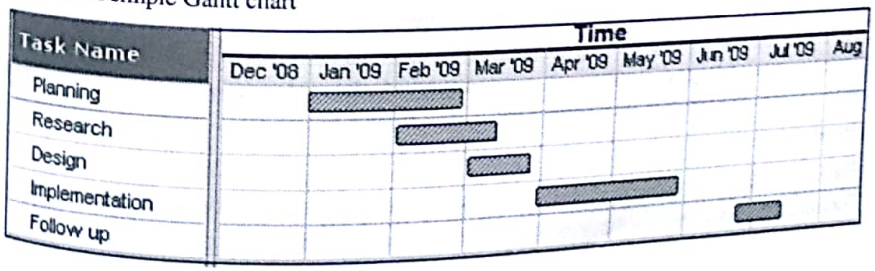
8.5.1 Gantt Chart

Q. What is the need of a Gantt chart and explain it with an example.

A Gantt chart used in project management is simply a graphical schedule that displays the activities (tasks or events) against time.

On the left of the Gantt chart is a list of the activities and along the top is a suitable time scale. Each activity is represented by a bar; the starting position of the bar reflects the start date, the length of the bar reflects the duration and the ending position of the bar reflects the end date of the activity.

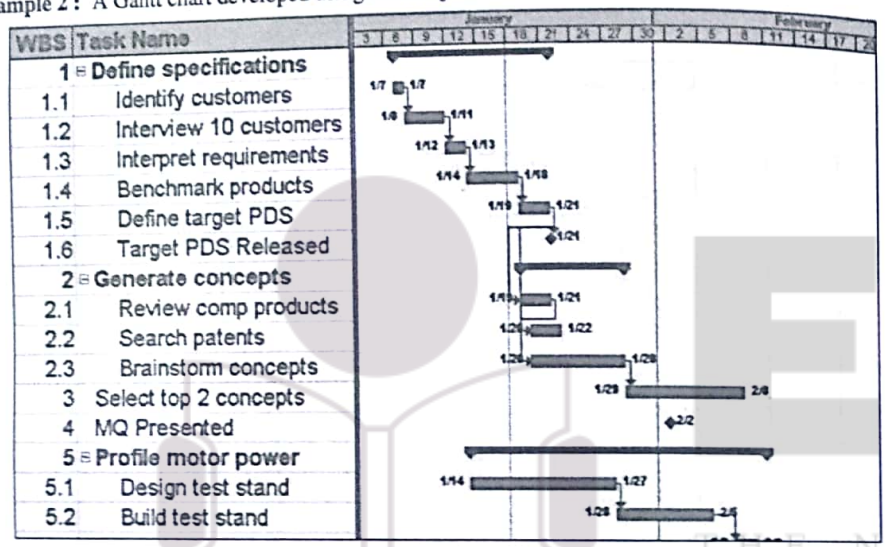
Example 1 : A simple Gantt chart



A Gantt chart is useful as it shows at a glance that

- What the various activities are ?
- When does each activity begin and end ?
- How long each activity is scheduled to last ?
- Where do the activities overlap with which activities do they overlap , and by how much time do they overlap ?
- The start and end date of the whole project

Example 2 : A Gantt chart developed using MS Project tool



Symbols used in the above Gantt Chart

- **Milestone :** These are represented by black diamonds which represent a significant event on a project with zero duration.
- **Summary Tasks :** These are represented by thick horizontal black bars with arrows at beginning and end. The WBS activities are referred to as tasks.
- **Individual tasks :** The light gray horizontal bars represent the duration of each individual task.
- **Relationships or Dependencies :** Vertical arrows connecting these symbols show relationships or dependencies between tasks.

Benefits

- The Gantt chart shows deadlines and some of the sequential nature of the tasks.
- It evaluates progress on a project by showing actual schedule information.
- It gives a comparison of planned and actual project schedule information. The planned schedule dates for activities are called the baseline dates.

Drawbacks

- The Gantt chart is incapable in identifying mid process deadlines and bottlenecks in the process.
- They often do not show relationships or dependencies between tasks.

8.5.2 PERT/CPM Chart

Q. Explain a PERT/CPM chart with an example.

- PERT (Programme Evaluation and Review Technique) and CPM (Critical Path Method) are the scheduling techniques used to represent the network of activities carried out in a project.
- PERT and CPM both are used to determine the critical path and are based on the network representation of activities and their scheduling. This determines the most critical activities to be performed so as to meet the completion date of the project.

A PERT/CPM chart is similar to a flow chart having lines (arrows) representing activities/tasks and nodes representing events or milestones.

These arrows go from left to right. Nodes represent the end and beginning of sequential activities.

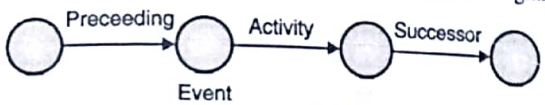


Fig. 8.5.2

Arrows departing from a node indicate parallel activities.

Example :

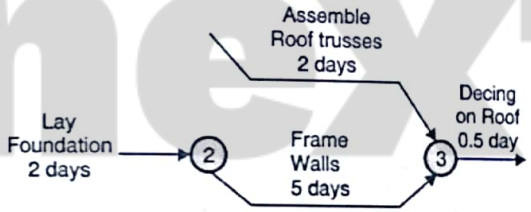


Fig. 8.5.3

This chart shows ;

- Assembly of roof trusses and framing of the walls can be done at the same time in parallel.
- Decking on the roof requires the both assembly of the roof trusses and framing of walls
- Assembling the roof trusses is not dependent upon the Foundation but Framing the walls is.

Both PERT and CPM provide quantitative tools that allow the software planner

1. **Determine the 'critical path' :** It is a chain of tasks that reflect the duration of the project.
2. **Estimate 'most likely time'** required to accomplish the individual tasks by applying statistical models.
3. **Calculate 'boundary times'** that define a 'time window' for a particular task where the ***Slippage*** in the design of one function can retard further development of other functions and the ***Riggs*** describe important boundary times that may be discerned from a PERT or CPM network:
   i. The earliest time that a task can begin when all preceding tasks are completed in the shortest possible time.
   ii. The latest time for task initiation before minimum project completion time is delayed.
   iii. The earliest finish is the sum of the earliest start and the task duration.

iv. The latest finish is the latest start time added to task duration.

v. The total *float* is the amount of surplus time allowed in scheduling the tasks so that the network critical path is maintained on schedule.

Calculating the Boundary time helps in determining the critical path and providing quantitative method for evaluating the processes as tasks complete.

8.5.2(A) Difference between PERT and CPM

Q. Give the difference between PERT and CPM

Table 8.5.2: Difference between PERT and CPM

Sr. No.	PERT	CPM
1.	Program Evaluation and Review Technique	Critical Path Method
2.	Developed by the US Navy with Booz Hamilton Lockheed on the Polaris Missile / Submarine program 1958.	Developed by El Dupont for Chemical Plant Shutdown Project- about same time as PERT
3.	Three estimates are used to form a weighted average of the expected completion time of each activity based on probability distribution of completion time.	Only one estimate of completion time of each activity is used.
4.	It is a tool used for planning and control of time.	It is a tool used for cost estimation apart from estimating time.
5.	It is used for one-time projects involving activities of non-repetitive nature (i.e. activities that are never performed before) in which time estimates are uncertain such as installing a new information system. It is used where times cannot be estimated with confidence.	It is used for completion of projects involving activities of repetitive nature. It is used where times can be estimated with confidence, familiar activities.
6.	Identifies critical path and activities, guides in monitoring and controlling the project.	Same as PERT
7.	Meeting the time target or estimating the percent completion is more important.	Minimizing cost is more important.
8.	Example: Involving new activities or products, research and development etc.	Example: construction projects, building one off machines, ships, etc.

8.5.2(B) Use of PERT & CPM Chart

Benefits of PERT/CPM chart are :

- It is useful in planning large projects. The sequential tasks can be analysed to determine the critical path and predict total project length.
- These techniques help in translating the high complex projects into a set of simple and logically arranged activities thereby;
  - Clarifying the thoughts and actions

  - Developing clear and unambiguous communication from top to bottom and vice versa among the people responsible for executing the project.
- These techniques provide a detailed analysis of network of activities that help project manager to early detect the difficulties that are expected to crop up during the course of execution in future thereby;
  - Minimizing the delays and holdups that may occur during execution in future
  - Take corrective actions well in time
- These techniques isolate the activities which control the project completion and therefore result in expeditious completion of the project.
- These techniques divide the responsibilities and improve the coordination between the different departments.
- These techniques help in timely allocation of resources to various activities to achieve optimal utilization of resources.

8.5.2(C) Solved PERT/CPM Network Diagrams

Example 8.5.1 :

Consider the list of four activities for making a simple product :

Activity	Description	Immediate predecessors
A	Buy Plastic Body	–
B	Design Component	–
C	Make Component	B
D	Assemble products	A,C

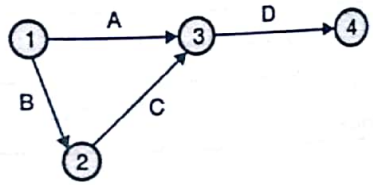
(Immediate predecessors for a particular activity are the activities that, when completed, enable the start of the activity in question.)

Solution :

Sequence of Activities

- Activities A and B can start at anytime, since neither of these activities depend upon the completion of prior activities.
- Activity C cannot be started until activity B has been completed
- Activity D cannot be started until both activities A and C have been completed.

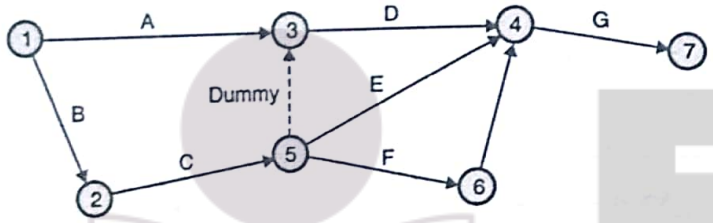
Network Diagram



Example 8.5.2 : Develop the network for a project with following activities and immediate predecessors.

Activity	Immediate predecessors
A	–
B	–
C	B
D	A,C
E	C
F	C
G	D,E,F

Solution :



D, E, and F as the immediate predecessors for activity G.

Dummy activities is used to identify precedence relationships correctly and to eliminate possible confusion of two or more activities having the same starting and ending nodes.

Dummy activities have no resources (time, labor, machinery, etc) purpose is to PRESERVE LOGIC of the network.

Example 8.5.3:

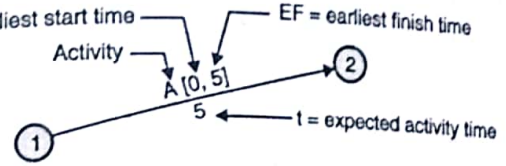
Draw the network diagram for this information that indicates that the total time required to complete activities is 51 weeks.

Activity	Immediate predecessors	Completion Time (Week)
A	–	5
B	–	6
C	A	4
D	A	3
E	A	1
F	E	4
G	D, F	14
H	B, C	12
I	G,H	2
	Total	**51**

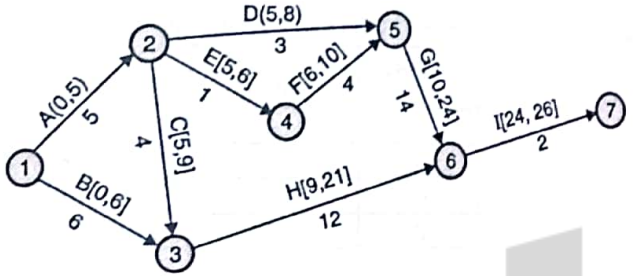
Solution :

- The earliest finish time is calculated as EF = ES + t.
  - For example, for activity A, ES = 0 and t = 5; thus EF = 0 + 5 = 5

A sample Arc with ES and EF time :

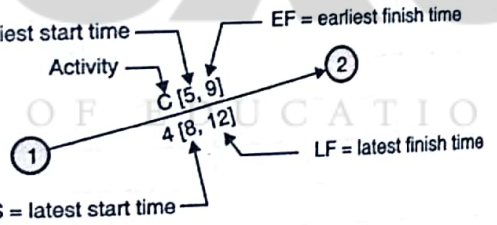


Network diagram with ES and EF time

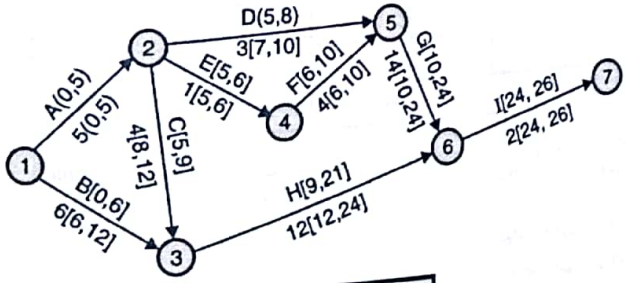


- The latest start time for each activity is calculated as; LS = LF – t
- For example, for activity I, LF = 26 and t= 2, thus the latest start time for activity I is LS = 26 – 2 = 24

A sample Arc with ES and EF time, LS and LF time



Final Network diagram with ES and EF time, LS and LF time



Review Questions

Q.1 Explain the project scheduling process.

Q.2 List the basic principles of Project scheduling.

Q. 3 Explain the relationship between people and efforts in project scheduling

Q. 4 Describe the effort distribution in project scheduling in brief

Q. 5 What is the need of a Gantt chart and explain it with an example.

Q. 6 What is the need of PERT/CPM chart.

Q. 7 Give the difference between PERT and CPM

Q. 8 Explain a PERT/CPM chart with an example

Q. 9 For the following data, draw the PERT/CPM network diagram.

Activity	Preceding Activity
A	-
B	A
C	A
D	B,C
E	B
F	D, E

Q. 10 Draw the network diagram for the following problem.

Activity	Preceding Activity	Time(days)
A	-	10
B	-	14
C	A	8
D	A	7
E	B	5
F	B	10
G	C	9
H	D, E	11
I	G, H	5

Q. 11 For a project that includes tasks like requirement analysis, designing, coding, testing and implementation; break the work down into small enough parts that you can estimate the time for completion.

Assignment 1: Build a WBS chart

Assignment 2: Use the WBS chart to create a Gantt chart.

Assignment 3: Use WBS chart to create a PERT/CPM Chart.

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UNIT III

CHAPTER 9

Risk Management

Syllabus

Software Risks, Risk Identification, Risk Projection and Risk Refinement, RMMM Plan.

Syllabus Topic : Software Risks

9.1 Software Risks

- A risk is a probability of an occurrence of some adverse circumstance.
- Risks are categorized into three paths:
  1. Important Risks but not resolved
  4. Unimportant Risks that are not resolved and later ultimately change into Important Risks.
  3. Unidentified Risks that later become Important Risks
- In order to manage feasibility throughout the project, risk management is needed.
- Risk management seeks to balance risk and reward.
- Different organizations are more or less adverse to risk, i.e. They are willing to take greater risks in order to achieve greater rewards.
- Software Risks possess two characteristics :
  1. **Uncertainty :** The risk may or may not happen; i.e. there are no 100% probable risks.
  2. **Loss :** The risk becomes a reality, unwanted consequences or losses may occur.
- It is important to measure the level of uncertainty and degree of loss associated with each risk.

The two basic kinds of Risks

1. **Predictable risks :** These are caused due to staff turnover, poor communication with customer, dilution of staff performance.
2. **Unpredictable risks :** These are extremely difficult to identify in advance.